



$$w_{11} = 0.2$$

$$w_{12} = 0.4$$

$$w_{13} = 0.1$$

$$w_{14} = 0.3$$

$$v_1 = 0.5$$

$$v_2 = 0.6$$

sigmoid

$$h_{in_1} = w_{11}x_1 + w_{13}x_2 + b_1$$

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

$$= 0.2 + 0.05 + 0.1$$

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

$$h_{out_1} = \frac{1}{1+e^{-0.35}} = 0.5866$$

(beer)

$$\begin{aligned}
 h_{in_2} &= \omega_{12}x_1 + \omega_2\omega_{14} + b_1 \\
 &= 0.4 \times 1 + 0.5(0.3) + 0.1 \\
 &= 0.4 + 0.15 + 0.1 \\
 &= 0.65
 \end{aligned}$$

~~100~~

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

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

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

$$\frac{\partial \varepsilon}{\partial v_1} = \frac{\partial \varepsilon}{\partial o} \times \frac{\partial o}{\partial v_1} = -2(y-0) \times h_{out_1}$$

$$= -2(1-0.8875) \times 0.5866 \quad \text{cancel out}$$

$$= -0.225 \times 0.5866 = 0.13198$$

$$\frac{\partial \varepsilon}{\partial v_2} = \frac{\partial \varepsilon_o}{\partial o} \times \frac{\partial o}{\partial v_2} = -2(y-0) \times h_{out_2}$$

$$= -2(1-0.8875)(0.6570)$$

$$= -0.225 \times 0.6570 = -0.14781$$

$$\frac{\partial \varepsilon}{\partial o} = -2(1-0.8875)$$

$$= -0.225$$

$$\frac{\partial \varepsilon}{\partial w_{11}} = \frac{\partial \varepsilon}{\partial o} \times \frac{\partial o}{\partial h_{out_1}} \times \frac{\partial h_{out_1}}{\partial h_{in_1}} \times \frac{\partial h_{in_1}}{\partial w_{11}}$$

$$= -0.225 \times v_1 \times h_{out_1}(1-h_{out_1}) \times 1$$

$$= -0.225 \times 0.5 \times 0.5866(1-0.5866) \times 1$$

$$= -0.225 \times 0.5 \times 0.5866(1-0.5866) \times 1 = -0.02728$$

$$\frac{\partial \varepsilon}{\partial w_{13}} = \frac{\partial \varepsilon}{\partial o} \times \frac{\partial o}{\partial h_{out_1}} \times \frac{\partial h_{out_1}}{\partial h_{in_1}} \times \frac{\partial h_{in_1}}{\partial w_{13}}$$

$$= -0.225 \times v_1 \times h_{out_1}(1-h_{out_1}) \times 0.5$$

$$= -0.225 \times 0.5 \times 0.5866(1-0.5866) \times 0.5$$

$$= -0.225 \times 0.5 \times 0.5866(1-0.5866) \times 0.5 = -0.01364$$

$$\begin{aligned}\frac{\partial E}{\partial w_{12}} &= \frac{\partial E}{\partial o} \times \frac{\partial o}{\partial h_{out_2}} \times \frac{\partial h_{out_2}}{\partial h_{in_2}} \times \frac{\partial h_{in_2}}{\partial w_{12}} \\ &= -0.225 \times v_2 \times h_{out_2}(1-h_{out_2}) \times z_1 \\ &= -0.225 \times 0.6 \times 0.6570(1-0.6570) \times 1 \\ &= \text{delisted} \quad 0.03042\end{aligned}$$

$$\begin{aligned}\frac{\partial E}{\partial w_{14}} &= \frac{\partial E}{\partial o} \times \frac{\partial o}{\partial h_{out_2}} \times \frac{\partial h_{out_2}}{\partial h_{in_2}} \times \frac{\partial h_{in_2}}{\partial w_{14}} \\ &= -0.225 \times v_2 \times h_{out_2}(1-h_{out_2}) \times z_2 \\ &= -0.225 \times 0.6 \times (0.6570)(1-0.6570) \times 0.5 \\ &= \text{delisted} \quad 0.01521\end{aligned}$$

first hidden cell

$$\begin{aligned}\frac{\partial E}{\partial b_1} &= \frac{\partial E}{\partial o} \times \left[ \frac{\partial o}{\partial h_{out_1}} \times \frac{\partial o}{\partial h_{in_1}} \times \frac{\partial h_{in_1}}{\partial b_1} \right. \\ &\quad \left. + \frac{\partial o}{\partial h_{out_2}} \times \frac{\partial o}{\partial h_{in_2}} \times \frac{\partial h_{in_2}}{\partial b_1} \right] \\ &= -0.225 \left[ v_1 \times h_{out_1} \times (1-h_{out_1}) \times 1 \right. \\ &\quad \left. + v_2 \times h_{out_2} \times (1-h_{out_2}) \times 1 \right] \\ &= -0.225 \left[ 0.5 \times (0.5866)(1-0.5866) \right. \\ &\quad \left. + 0.6 \times (0.6570)(1-0.6570) \right] \\ &= \text{delisted} \quad 0.225 \times 0.25646 = -0.0577\end{aligned}$$

second hidden cell

$$\begin{aligned}
 b_1 &= b_1 - \alpha \frac{\partial E}{\partial b_1} & -0.0577 \\
 &= 0.1 - 0.01 \times (\cancel{0.22500}) \\
 &= \cancel{0.875} \cancel{0.1} \quad \cancel{0.000475} \cancel{0.000027} \\
 &= \underline{\underline{1.00577}}
 \end{aligned}$$

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

$$\begin{aligned}
 b_{out}^0 &= b_{out} - \alpha \left( \frac{\partial E}{\partial b_{out}} \right) \\
 &= 0.2 - (0.01)(-0.225) \\
 &= \underline{\underline{0.20225}}
 \end{aligned}$$