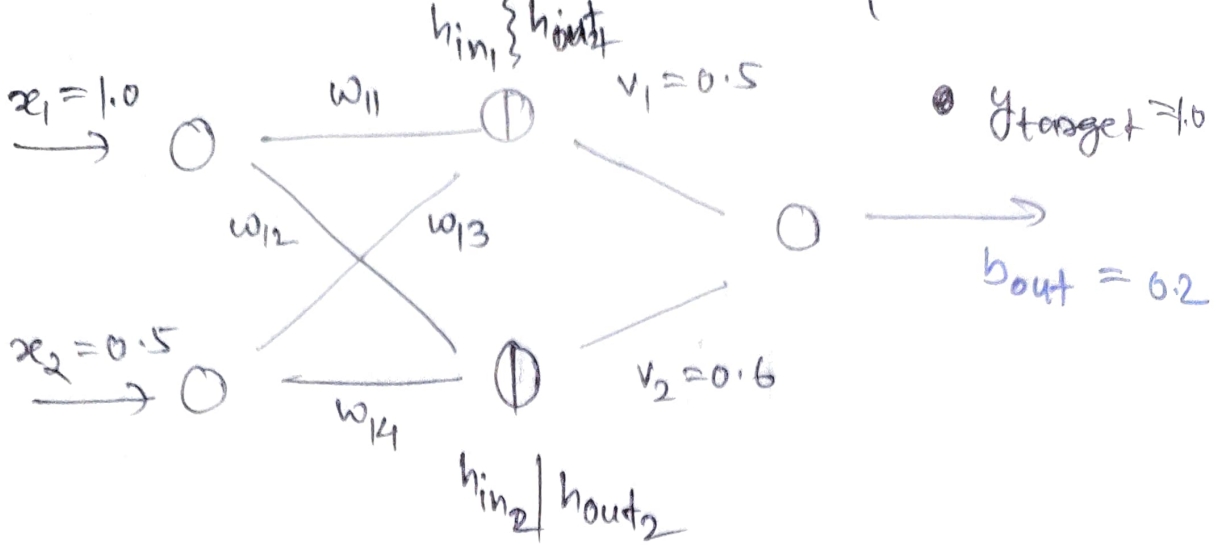
$\eta = 0.01$



sigmoid

$w_{11} = 0.2$

$w_{12} = 0.4$

$w_{13} = 0.1$

$w_{14} = 0.3$

$v_1 = 0.5$

$v_2 = 0.6$

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

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

$$= 0.2 + 0.05 + 0.1$$

$$= 0.25 + 0.1 = 0.35$$

$$h_{out_{h_1}} = \frac{1}{1 + e^{-0.35}} = 0.5866$$

$$h_{in_2} = w_{12} x_1 + x_2 w_{14} + b_1$$

$$= 0.4 \times 1 + 0.5\,(0.3) + 0.1$$

$$= 0.4 + 0.15 + 0.1$$

$$= 0.65$$

$$h_{out_2} = \frac{1}{1 + e^{-h_{in_2}}} = \frac{1}{1 + e^{-0.65}}$$

$$= 0.6570$$

$$o = v_1 h_{out_1} + v_2 h_{out_2} + b_{out}$$

$$= 0.5(0.5866) + 0.6(0.6570) + 0.2$$

$$= 0.6875 + 0.2 = 0.8875$$

$$\text{Error} = (y_{target} - o)^2$$

$$= (y - o)^2$$

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

$$= 0.01265$$

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

$$= -2(1-0.8875) \times 0.5866$$

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

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

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

$$\frac{\partial \varepsilon}{\partial o} = -2(1-0.6875)$$

$$= -0.225 \qquad = -0.14781$$

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

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

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

$$= -0.02728$$

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

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

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

$$= -0.01364$$

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

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

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

$$= 0.03042$$

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

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

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

$$= 0.01521$$

$$\frac{\partial \varepsilon}{\partial b_1} = \frac{\partial \varepsilon}{\partial o} \times \left[\frac{\partial o}{\partial h_{out_1}} \times \frac{\partial h_{out_1}}{\partial h_{in_1}} \times \frac{\partial h_{in_1}}{\partial b_1} \right.$$

(first hidden cell; second hidden cell)

$$\left. + \frac{\partial o}{\partial h_{out_2}} \times \frac{\partial h_{out_2}}{\partial h_{in_2}} \times \frac{\partial h_{in_2}}{\partial b_1} \right]$$

$$= -0.225 \left[v_1 \times h_{out_1} \times (1-h_{out_1}) \times 1 \right.$$

$$\left. + v_2 \times h_{out_2}(1-h_{out_2}) \times 1 \right]$$

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

$$= 0.225 \times 0.25646 = -0.0577$$

$$b_1 = b_1 - \alpha \frac{\partial \varepsilon}{\partial b_1}$$

$$= 0.1 - 0.01 \times (-0.0577)$$

$$= 1.00577$$

$$\frac{\partial \varepsilon}{\partial b_{out}} = \frac{\partial \varepsilon}{\partial o} \times \frac{\partial o}{\partial b_{out}}$$

$$= -0.225 \times 1$$

$$= -0.225$$

$$b_{out} = b_{out} - \alpha \left(\frac{\partial \varepsilon}{\partial b_{out}} \right)$$

$$= 0.2 - (0.01)(-0.225)$$

$$= 0.20225$$