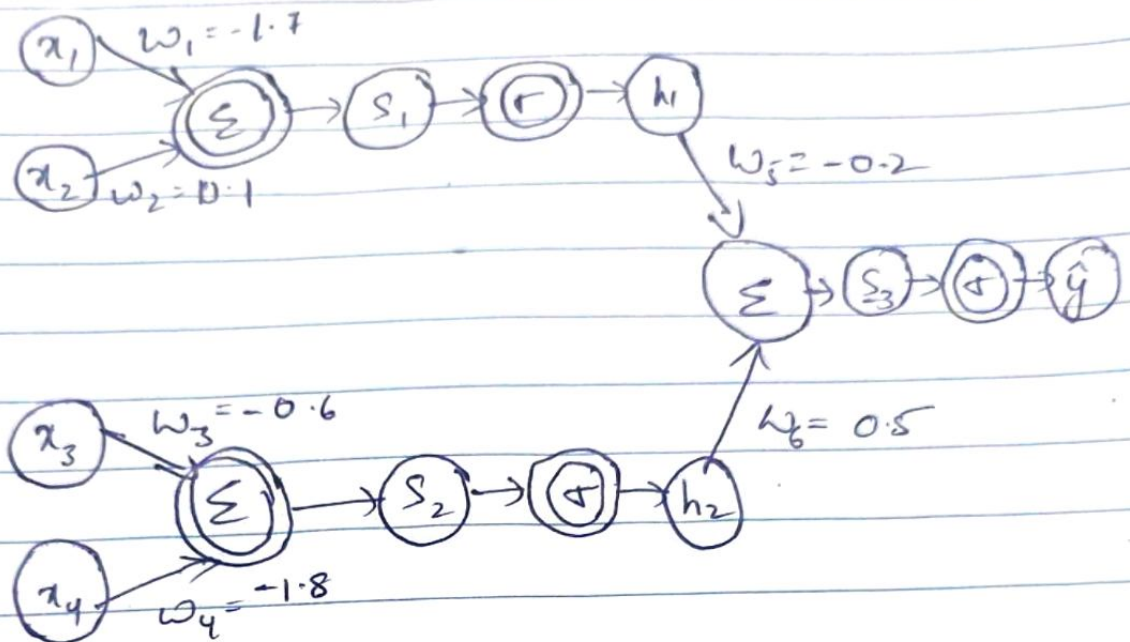


# Deep Learning Assignment - 2

Pg 1



$$\sigma(z) = \frac{1}{1 + e^{-z}}$$

$$h_1 = \frac{1}{1 + e^{w_1 x_1 - w_2 x_2}}$$

$$L_2 \text{ loss } L(y, \hat{y}) = \|\hat{y} - y\|^2$$

$$x_1 = 0.7$$

$$x_2 = 1.2$$

$$x_3 = 1.1$$

$$x_4 = 2$$

$$y = 0.5$$

Q2

$$\begin{aligned}S_1 &= x_1 w_1 + x_2 w_2 \\&= (0.7)(-1.7) + (1.2)(0.1) \\&= (-1.19) + (0.12) \\&= -1.07\end{aligned}$$

$$\therefore S_1 = -1.07$$

$$\begin{aligned}S_2 &= x_3 w_3 + x_4 w_4 \\&= (1.1)(-0.6) + (2)(-1.8) \\&= (-0.66) + (-3.6) \\&= -4.26\end{aligned}$$

$$\therefore S_2 = -4.26$$

$$\text{Now, } h_1 = \frac{1}{1 + e^{-x_1 w_1 - x_2 w_2}}$$

$$h_1 = \frac{1}{1 + e^{-(0.7)(-1.7) - (1.2)(0.1)}}$$

$$h_1 = \frac{1}{1 + e^{(1.19) - 0.12}}$$

$$h_1 = \frac{1}{1 + e^{1.07}}$$

$$h_1 = \frac{1}{3.915}$$

$$h_1 = 0.255$$

$$\therefore h_1 = 0.255$$

Q93

$$h_2 = \frac{1}{1 + e^{-x_3 w_3 - x_4 w_4}}$$

$$= \frac{1}{1 + e^{-(1.1)(0.6) - (2)(-1.8)}}$$

$$= \frac{1}{1 + e^{0.66 + 3.6}}$$

$$= \frac{1}{1 + e^{4.26}}$$

$$= \frac{1}{1 + 70.5} = \frac{1}{71.5}$$

$$\therefore h_2 = 0.0139$$

$$s_3 = h_1 w_5 + h_2 w_6$$

$$= (0.255)(-0.2) + (0.0139)(0.5)$$

$$= -0.051 + 0.00695$$

$$s_3 = -0.0445$$

$$\hat{y} = \frac{1}{1 + e^{-h_1 w_5 - h_2 w_6}}$$

$$= \frac{1}{1 + e^{-(0.255)(-0.2) - (0.0139)(0.5)}}$$

$$= \frac{1}{1 + e^{0.051 - 0.00695}}$$

$$= \frac{1}{1 + e^{0.04405}} = \frac{1}{1 + 1.04}$$

$$\hat{y} = 0.4889$$



Q4

Now, the gradient of  $L_2$  loss function

$$\|y - \hat{y}\|^2 \text{ is } 2\|\hat{y} - y\| = \frac{\partial E}{\partial y}$$

Using Backward Propagation

$$\frac{\partial E}{\partial w_1} = \frac{\partial E}{\partial y} \times \frac{\partial y}{\partial s_3} \times \frac{\partial s_3}{\partial h_1} \times \frac{\partial h_1}{\partial s_1} \times \frac{\partial s_1}{\partial w_1}$$

$$\frac{\partial E}{\partial w_1} = 2\|\hat{y} - y\| \times \sigma'(s_3) \times w_5 \times \sigma'(s_1) \times n_1$$

As  $\frac{\partial s_3}{\partial h_1} = w_5$

$\frac{\partial s_1}{\partial w_1} = n_1$

Substituting  $\uparrow$

$$\sigma'(s_3) = \sigma(s_3)(1 - \sigma(s_3)) \quad \sigma'(s_1) = \sigma(s_1)(1 - \sigma(s_1))$$

$$\frac{\partial E}{\partial w_1} = 2\|0.4889 - 0.5\| \times [\sigma(s_3)(1 - \sigma(s_3))] \times (-0.2) \times [\sigma(s_1)(1 - \sigma(s_1))] \times (0.7)$$

$$= 2(0.107) \times [0.2554(1 - 0.2554)] \times 0.2 \times [0.4884(1 - 0.4884)] \times 0.7$$

$$\frac{\partial E}{\partial w_1} = -0.00114$$

$$\frac{\partial E}{\partial w_1} = 0.0014$$