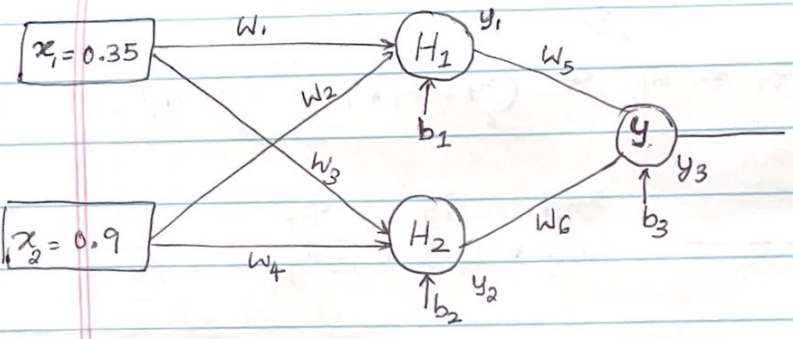
(8)



$w_6 = 0.5$
$w_1 = 0.1$ $\quad b_1 = 0.3$
$w_2 = 0.3$ $\quad b_2 = 0.5$
$w_3 = 0.2$ $\quad b_3 = 0.4$
$w_4 = 0.4$
$w_5 = 0.45$

$\boxed{y = 0.95}$

$H = \sum x_i * w_i + bias$

Sigmoid function $= \frac{1}{1+e^{-x}}$

Forward Pass

$H_1 = x_1 * w_1 + x_2 * w_2 + b_1$

$= 0.35 * 0.1 + 0.9 * 0.3 + 0.3$

$0.035 + 0.27 + 0.3$

$\boxed{H_1 = 0.605}$

$H_2 = x_1 * w_3 + x_2 * w_4 + b_2$

$= 0.35 * 0.2 + 0.9 * 0.4 + 0.5$

$= 0.07 + 0.36 + 0.5$

$\boxed{H_2 = 0.93}$

Out $H_1 = y_1 = \frac{1}{1+e^{-0.605}} = \boxed{0.64 = y_1}$

Out $H_2 = y_2 = \frac{1}{1+e^{-0.93}} = \boxed{0.71 = y_2}$

Calculating y.

$y = y_1 * w_5 + y_2 * w_6 + b_3$

$= 0.64 * 0.45 + 0.71 * 0.5 + 0.4$

$0.288 + 0.355 + 0.4$

$\boxed{y = 1.043}$

$y_3 = \text{Out } y = \frac{1}{1+e^{-1.043}} \Rightarrow \boxed{y_3 = 0.739}$

$T = \boxed{\text{Target} = 0.95}$

$E_{total} = \frac{1}{2}(\text{Target} - y_3)^2$

$E_{total} = \frac{1}{2}(0.95 - 0.739)^2 \Rightarrow \boxed{0.022}$

$\boxed{E_{total} = 0.022}$

Backward propogation : To update weights

Error at w_5 = $\frac{\partial E_{total}}{\partial w_5} \Rightarrow \frac{\partial E_{total}}{\partial y_3} * \frac{\partial y_3}{\partial y} * \frac{\partial y}{\partial w_5}$ ---- (1)

Error @ w_5

$$\frac{\partial E_{total}}{\partial y_3} = \frac{1}{2}(Target - y_3)^2 \Rightarrow 2 * \frac{1}{2}(Target - y_3) \Rightarrow 0.95 - 0.739$$

$$\boxed{\frac{\partial E_{total}}{\partial y_3} = 0.211} \text{ ---- (a)}$$

$\frac{\partial y_3}{\partial y}$ = Derivative of Sigmoid function $\sigma(x)$ = $\frac{\partial\left(\frac{1}{1+e^{-x}}\right)}{\partial x}$ = (a) $\boxed{\frac{\partial(\sigma(x)}{\partial x} = \sigma(x)(1-\sigma(x))}$

$$\frac{\partial y_3}{\partial y} = y_3(1-y_3) = 0.739(1-0.739)$$

$$\boxed{\frac{\partial y_3}{\partial y} = 0.192} \text{ ---- (b)}$$

$$\frac{\partial y}{\partial w_5} = \frac{\partial(y_1 * w_5 + y_2 * w_6 + b_3)}{\partial w_5}$$

$$\frac{\partial y}{\partial w_5} = y_1 = \boxed{\frac{\partial y}{\partial w_5} = 0.64} \text{ -- (c)}$$

Substituting (a), (b) & (c) in (1)

$$\frac{\partial E_{total}}{\partial w_5} = 0.211 * 0.192 * 0.64 = \frac{\partial E_{total}}{\partial w_5} = 0.0259 \rightarrow \text{Change in } w_5$$

Updating w_5

$$w_5 = w_5 - \eta * \frac{\partial E_{total}}{\partial w_5} = 0.45 - 0.5(0.0259) \qquad \boxed{\eta = 0.5}$$

$$\boxed{w_5 = 0.437}$$

Error @ w_6

$$\frac{\partial E_{total}}{\partial w_6} = \frac{\partial E_{total}}{\partial y_3} * \frac{\partial y_3}{\partial y} * \frac{\partial y}{\partial w_6} \text{ ------ (2)}$$

$$\frac{\partial y}{\partial w_6} = \frac{\partial(y_1 * w_5 + y_2 * w_6 + b_3)}{\partial w_6} \Rightarrow \frac{\partial y}{\partial w_6} = y_2 \Rightarrow \boxed{\frac{\partial y}{\partial w_6} = 0.71} \text{ --- (d)}$$

Substituting (a), (b) & (d) in (2)

$$\frac{\partial E_{total}}{\partial w_6} = 0.211 * 0.192 * 0.71 \Rightarrow \frac{\partial E_{total}}{\partial w_6} = 0.0287$$

Updating W_6

$$w_6 = w_6 - \eta * \frac{\partial E_{total}}{\partial w_6} = 0.5 - 0.5(0.0287)$$

$$\boxed{W_6 = 0.4856}$$

Updating W_1, W_2, W_3, W_4

$$\text{Error @ } w_1 = \frac{\partial E_{total}}{\partial w_1} = \frac{\partial E_{total}}{\partial y_1} * \frac{\partial y_1}{\partial H_1} * \frac{\partial H_1}{\partial w_1} \quad \text{------- (3)}$$

$$\frac{\partial E_{total}}{\partial y_1} = \frac{\partial E_{total}}{\partial y} * \frac{\partial y}{\partial y_1} \quad \text{--- (4)}$$

$$\frac{\partial E_{total}}{\partial y_3} = \frac{\partial E_{total}}{\partial y_3} * \frac{\partial y_3}{\partial y} = \frac{\partial E_{total}}{\partial y} = 0.211 * 0.192 = \boxed{\frac{\partial E_{total}}{\partial y_3} = 0.04} \quad \text{--- (5)}$$

$$\frac{\partial y}{\partial y_1} = \frac{\partial}{\partial y_1}(y_1 * w_5 + y_2 * w_6 + b_3) = \boxed{\frac{\partial y}{\partial y_1} = 0.45} \quad \text{— (6)}$$

(5) & (6) in (4)

$$\frac{\partial E_{total}}{\partial y_1} = 0.04 * 0.45 \qquad \boxed{\frac{\partial E_{total}}{\partial y_1} = 0.018} \quad \text{— (7)}$$

$$\frac{\partial y_1}{\partial H_1} = y_1(1 - y_1) = 0.64(1 - 0.64) \rightarrow \boxed{\frac{\partial y_1}{\partial H_1} = 0.2304} \quad \text{— (8)}$$

$$\frac{\partial H_1}{\partial w_1} = \frac{\partial(x_1 * w_1 + x_2 * w_2 + b_1)}{\partial w_1} = x_1 = \boxed{\frac{\partial H_1}{\partial w_1} = 0.35} \quad \text{— (9)}$$

Substituting (7), (8) & (9) in (3)

$$\frac{\partial E_{total}}{\partial w_1} = 0.018 * 0.2304 * 0.35 \qquad \boxed{\frac{\partial E_{total}}{\partial w_1} = 0.001451}$$

Updating W_1 : $w_1 = w_1 - \eta \frac{\partial E_{total}}{\partial w_1} = 0.1 - 0.5 \times 0.001451$ $\boxed{w_1 = 0.09927}$

Error at $w_2 \Rightarrow \frac{\partial E_{total}}{\partial w_2} = \frac{\partial E_{total}}{\partial y_1} * \frac{\partial y_1}{\partial H_1} * \frac{\partial H_1}{\partial w_2}$ — (10)

$\frac{\partial H_1}{\partial w_2} = \frac{\partial (x_1 * w_1^0 + x_2 * w_2 + b_1^0)}{\partial w_2} \rightarrow \frac{\partial H_1}{\partial w_2} = x_2 \Rightarrow \boxed{\frac{\partial H_1}{\partial w_2} = 0.9}$ — (11)

Substituting (7), (8) & (11) in (10)

$\frac{\partial E_{total}}{\partial w_2} = 0.018 \times 0.2304 \times 0.9 \Rightarrow \boxed{\frac{\partial E_{total}}{\partial w_2} = 0.00373}$

Updating w_2: $w_2 = w_2 - \eta \frac{\partial E_{total}}{\partial w_2} = 0.3 - 0.5(0.00373)$

$\boxed{W_2 = 0.2981}$

Error @ $W_3 \rightarrow \frac{\partial E_{total}}{\partial w_3} = \frac{\partial E_{total}}{\partial y_2} * \frac{\partial y_2}{\partial H_2} * \frac{\partial H_2}{\partial w_3}$ — (12)

$\frac{\partial E_{total}}{\partial y_2} = \frac{\partial E_{total}}{\partial y} * \frac{\partial y}{\partial y_2}$ — (13)

$\frac{\partial E_{total}}{\partial y} = \frac{\partial E_{total}}{\partial y_3} * \frac{\partial y_3}{\partial y} = 0.04$

$\frac{\partial y}{\partial y_2} = \frac{\partial (y_1 * w_5^0 + y_2 * w_6 + b_3^0)}{\partial y_2} \Rightarrow \frac{\partial y}{\partial y_2} = w_6 = \boxed{\frac{\partial y}{\partial y_2} = 0.5}$ — (14)

Substituting (5), (14) in (13)

$\frac{\partial E_{total}}{\partial y_2} = 0.04 * 0.5 \quad \boxed{\frac{\partial E_{total}}{\partial y_2} = 0.02}$ — (15)

$\frac{\partial y_2}{\partial H_2} = y_2 (1 - y_2) \Rightarrow 0.71 (1 - 0.71) \Rightarrow \boxed{\frac{\partial y_2}{\partial H_2} = 0.2059}$ — (16)

$$\frac{\partial H_2}{\partial w_3} = \frac{\partial (x_1 * w_3 + x_2 * w_4 + b_2)}{\partial w_3} \Rightarrow \boxed{\frac{\partial H_2}{\partial w_3} = 0.35} \quad (17)$$

Substituting (15), (16) & (17) in (12)

$$\frac{\partial E_{total}}{\partial w_3} = 0.02 * 0.2059 * 0.35 \Rightarrow \boxed{\frac{\partial E_{total}}{\partial w_3} = 0.001441}$$

Updating w_3 = $w_3 = w_3 - \eta \frac{\partial E_{total}}{\partial w_3} = 0.2 - 0.5(0.001441)$

$$\boxed{w_3 = 0.1992}$$

Error@ $w_4 \rightarrow \frac{\partial E_{total}}{\partial w_4} = \frac{\partial E_{total}}{\partial y_2} * \frac{\partial y_2}{\partial H_2} * \frac{\partial H_2}{\partial w_4}$ — (18)

$$\frac{\partial H_2}{\partial w_4} = \frac{\partial (x_1 * w_3 + x_2 * w_4 + b_2)}{\partial w_4} \Rightarrow \boxed{\frac{\partial H_2}{\partial w_4} = 0.9} \rightarrow (19)$$

Substituting (15), (16) & (19) in (18)

$$\frac{\partial E_{total}}{\partial w_4} = 0.02 * 0.2059 * 0.9 \Rightarrow \boxed{\frac{\partial E_{total}}{\partial w_4} = 0.003706}$$

Updating w_4 $w_4 = w_4 - \eta \frac{\partial E_{total}}{\partial w_4} = 0.4 - 0.5(0.003706)$

$$\boxed{w_4 = 0.3981}$$

New weights.

Weights	New weights	Old weight
w_1 =	0.09927	0.1
w_2 =	0.2981	0.3
w_3 =	0.1992	0.2
w_4 =	0.3981	0.4
w_5 =	0.437	0.45
w_6 =	0.4856	0.5