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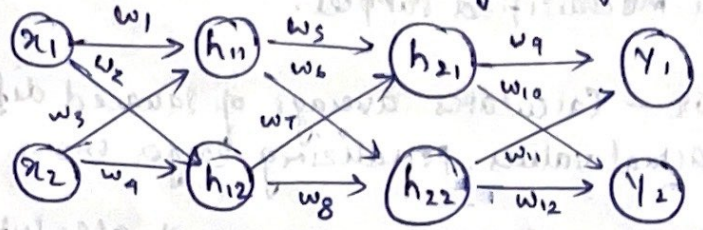
ANN Numerical Assignment 3

Q1] find mean squared error for given feed forward N/w.



Given, $x_1 = 0.3$, $x_2 = 0.5$,
$w_1 = 0.5$, $w_2 = 0.6$, $w_3 = 0.7$, $w_4 = 0.8$
$w_5 = 0.9$, $w_6 = 0.1$, $w_7 = 0.2$, $w_8 = 0.3$
$w_9 = 0.4$, $w_{10} = 0.5$, $w_{11} = 0.6$, $w_{12} = 0.7$
$Y_0 = 0$, $Y_1 = 1$, $b_1 = b_2 = b_3 = 0.2$, $\lambda = 1$

⇒ i] $Net_{11} = \sum w_i x_i + b_1$
$= w_1 x_1 + w_2 x_2 + b_1 = (0.5 \times 0.3) + (0.7 \times 0.5) + 0.2$
$= 0.7$

$h_{11} = f(Net) = \frac{1}{1+e^{-\lambda Net}} = \frac{1}{1+e^{-0.7}} = 0.668$

ii] $Net_{12} = \sum w_i x_i + b_1$
$= w_2 x_1 + w_1 x_2 + b_1 = (0.6 \times 0.3) + (0.8 \times 0.5) + 0.2$.

$Net_{12} = 0.78$
$h_{12} = 0.686$.

iii] $Net_{21} = \sum w_i x_i + b_2 = w_5 \times h_{11} + w_4 h_{12} + b_2$
$= 0.9 \times 0.668 + 0.2 \times 0.686 + 0.2$
$= 0.938$

$h_{21} = 0.719$

iv] $Net_{22} = \sum w_i x_i + b_2 = w_6 h_{11} + w_8 h_{12} + b_2$
$= 0.1 \times 0.668 + 0.3 \times 0.686 + 0.2 = 0.473$

$h_{22} = f(Net_{22}) = \frac{1}{1+e^{-0.473}} = 0.616$

v] $Y_1 = w_9 h_{21} + w_{11} h_{22} = 0.4 \times 0.719 + 0.6 \times 0.616$.

$= 0.657$.

$Y_1 = F(Net_1) = \frac{1}{1+e^{-0.657}} = \underline{0.659}$

vi] $Net_2 = w_{10} h_{21} + w_{12} h_{22} = 0.5 \times 0.719 + 0.7 \times 0.616$.

$= 0.791$.

$Y_2 = f(Net_2) = \frac{1}{1+e^{-0.791}} = \underline{0.688}$

vii] Mean Squared error →

$MSE = \frac{1}{2}\left[\text{actual } op_1 - \text{target } op_1\right]^2 + \frac{1}{2}\left[\text{actual } op_2 - \text{target } op_2\right]^2$

$= \frac{1}{2}(0.659-0)^2 + \frac{1}{2}(0.688-1)^2$.

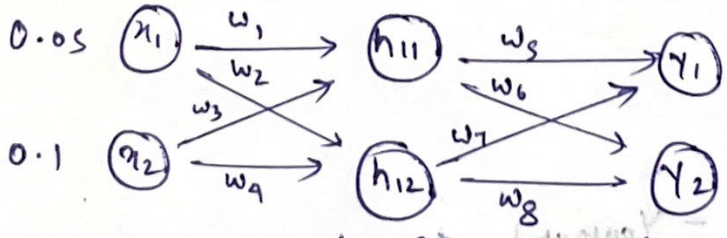
$= \underline{0.266}$

Q2] Train network using backward propagation using forward & backward pass. Assume $\alpha = 0.5$, $Y_1 = 0.01$, $Y_2 = 0.99$.

⇒ $x_1 = 0.05$, $x_2 = 0.1$, $b_1 = 0.35$, $b_2 = 0.6$.

$w_1 = 0.15$, $w_2 = 0.2$, $w_3 = 0.25$, $w_4 = 0.36$

$w_5 = 0.4$, $w_6 = 0.45$, $w_7 = 0.5$, $w_8 = 0.55$.



— forward pass :

i) $net_1 = w_1 x_1 + w_3 x_2 + b_1$

$= 0.15 \times 0.05 + 0.25 \times 0.01 + 0.35 = \underline{0.38}$

$h_{11} = f(Net_1) = \frac{1}{1+e^{-\lambda Net_1}} = \frac{1}{1+e^{-0.38}} = \underline{0.593}$

ii) $Net_2 = w_2 x_1 + w_1 x_2 + b_1$

$= 0.2 \times 0.05 + 0.36 \times 0.1 + 0.35$

$= \underline{0.396}$

$h_{22} = f(Net_2) = \frac{1}{1+e^{-0.396}} = \underline{0.398}$

iii) $Net_3 = w_5 h_{14} + w_7 \times h_2 + b_2$.

$= 0.4 \times 0.595 + 0.5 \times 0.598 + 0.6$.

$= \underline{1.137}$

$Y_1 = \frac{1}{1+e^{-1.137}} = \underline{0.757}$

iv) $Net = w_6 h_1 + w_8 h_2 + b_2$

$= 0.95 \times 0.598 + 0.55 \times 0.598 + 0.6$.

$= 1.196$.

$Y_2 = f(Net) = \frac{1}{1+e^{-1.196}} = 0.767$

Mean Squared error (MSE)

$= \frac{1}{2}(\text{Actual } op_1 - \text{target } op_1)^2 + \frac{1}{2}(\text{actual } op_2 - \text{target } op_2)^2$.

$= \frac{1}{2}(0.757 - 0.01)^2 + \frac{1}{2}(0.767 - 0.99)^2$.

$= \underline{0.3}$

—— Backward pass

$\delta_5 = Y_1(1-Y_1)(y_{target} - y_{output})$.

$= 0.757(1-0.757)(0.01 - 0.757)$.

$= \underline{-0.138}$

$\delta_6 = y_2 (1-y_2)(y_{target} - y_{actual})$
$= 0.767 (1-0.767)(0.99-0.767)$
$= 0.041$

computing new wt value.

$\Delta w_5 = \eta \delta_5 y_1$
$= (-0.138)(0.75)$
$= -0.1035$

$\Delta w_5 new = \Delta w_5 + w_{old}$
$= 0.4 + (-0.1035)$

$w_{5new} = 0.296$

$\Delta w_7^{new} = w_7^{old} + \Delta w_5$
$= 0.5 + (-0.103)$

$\Delta w_7^{new} = 0.397$

$\Delta w_6 = \eta \delta_6 y_2$
$= 1(0.041)(0.76)$
$= 0.03$

$w_6^{new} = w_6^{old} + \Delta w_6$
$= 0.45 + 0.03$
$= 0.48$

$w_8^{new} = w_8^{old} + \Delta w_6$
$= 0.55 + 0.03$

Hidden layer

$\delta_4 = y_4(1-y_4) w_6 \delta_6$
$= h_{22}(1-h_{22}) w_8^{new} \delta_6$
$= 0.598 (1-0.598) \times 0.58 \times 0.04$
$= 0.0057$

$$\delta_3 = h_{11}(1-h_{11})\, w_6^{new}\, \delta_6$$

$$= 0.595\,(1-0.595)\,0.981 \times 0.041$$

$$= 0.0097$$

$$w_1^{new} = w_1^{old} + \Delta w_1$$

$$= 0.15 + 0.0027$$

$$= 0.1527$$

$$w_3^{new} = w_3^{old} + \Delta w_1$$

$$= 0.25 + 0.0027$$

$$= 0.2527$$

$$w_2^{new} = w_2^{old} + \Delta w_2$$

$$= 0.2 + 0.0034$$

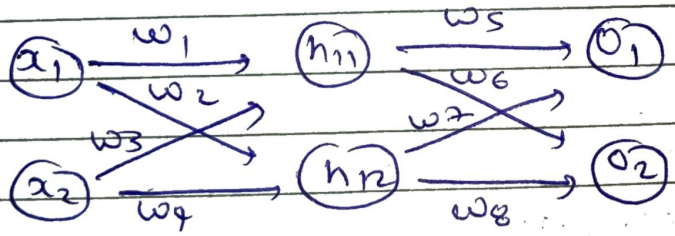
$$w_2^{new} = 0.2034$$

$$w_4^{new} = w_4^{old} + \Delta w_2$$

$$= 0.35 + 0.0034$$

$$= 0.3534$$

Q3)



$w_1 = 0.1$ $\quad w_5 = 0.5$

$w_2 = 0.2$ $\quad w_6 = 0.6$

$w_3 = 0.3$ $\quad w_7 = 0.7$

$w_4 = 0.4$ $\quad w_8 = 0.8$

$\eta = 0.25 \quad \lambda = 1 \quad x_1 = 0.1 \quad x_2 = 0.5$

→

→ forward pass.

(a) $net_{11} = w_1 x_1 + w_3 x_2 + b_1$

$= 0.1 \times 0.1 + 0.3 \times 0.5 + 0.025$

$= 0.185$

$h_{11} = f(net_{11}) = \frac{1}{1+e^{-net_{11}}} = \frac{1}{1+e^{-0.185}}$

$h_{11} = 0.54$

(b) $net_{22} = w_2 x_1 + w_4 x_2 + b_1$

$= 0.2 \times 0.1 + 0.4 \times 0.5 + 0.025$

$= 0.245$

$h_{22} = f(net_{22}) = \frac{1}{1+e^{-0.245}}$

$= 0.56$

(c) $net_1 = w_5 h_{11} + w_6 h_{22} + b_2$

$= 0.55 \times 0.54 + 0.6 \times 0.56 + 0.35$

$= 0.956$

$o_1 = f(net_1) = \frac{1}{1+e^{-0.012}}$

$= 0.722$

(d) $net_2 = w_7 h_{11} + w_8 h_{22} + b_2$

$= 0.7 \times 0.54 + 0.8 * 0.56 + 0.35$

$= 1.176$

$o_2 = f(net_2) = \frac{1}{1+e^{-1.122}}$

$= 0.75$

$MSE = \frac{1}{2}[(0.722 - 0.05)^2 + (0.75 - 0.95)^2]$

$= 0.243 \approx 0.25$

Backward pass.

o/p layer

$\delta_6 = O_1 (1-O_1)(T_1 - O_1)$

$= 0.722(1-0.722)(0.05-0.722)$

$= -0.134$

$\Delta w_5 = \eta \delta_5 O_1$

$= 0.25 \times (-0.134)\, 0.722$

$= 0.024$

$\Delta w_5 = \Delta w_6$

$w_5^{new} = w_5^{old} + \Delta w_5$

$= 0.5 - 0.024$

$= 0.476$

$w_6^{new} = w_6^{old} + \Delta w_6$

$= 0.6 - 0.024$

$= 0.576$

$\delta_6 = O_2 (1-O_2)(T_2 - O_2)$

$= 0.75 (1-0.754)(0.95-0.764)$

$= 0.037$

$\Delta w_7 = \eta \delta_6 O_2$

$= 0.25 \times 0.037 \times 0.75$

$= 0.0069$

$\Delta w_8 = \Delta w_7$

$w_7^{new} = w_7^{old} + w_7$

$= 0.7 + 0.0069$

$w_7^{new} = 0.7069$

$$w_8^{new} = w_8^{old} + 0.0069$$

$$= 0.8069$$

Hidden layer

$$\delta_3 = h_{11}(1-h_{11})\, w_5^{new}\, \delta_5$$

$$= 0.54\,(1-0.54)\,0.47\,(-0.13)$$

$$= 0.015$$

$$\Delta w_1 = \eta \delta_3 h_{11}$$

$$= 0.25 \times (-0.015 \times 0.54) = -0.002$$

$$\Delta w_3 = \Delta w_1$$

$$\Delta w_3 = \Delta w_3 = -0.002$$

$$w_3^{new} = w_1^{old} + \Delta w_1$$

$$= 0.1 + (-0.002)$$

$$= 0.098$$

$$w_3^{new} = w_3^{old} + \Delta w_3$$

$$= 0.3 + (-0.002)$$

$$= 0.298$$

$$\delta_4 = h_{22}(1-h_{22})\, w_8^{new}\, \delta_6$$

$$= 0.56\,(1-0.56)\,0.80 \times 0.037$$

$$= 0.007$$

$$\Delta w_2 = \eta \delta_4 h_{22}$$

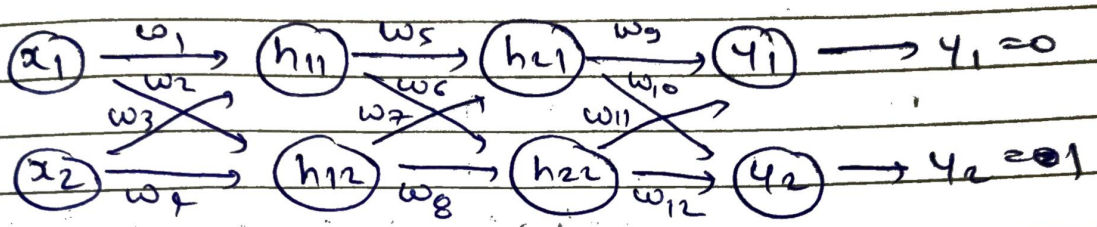
$$= 0.25 \times 0.007 \times 0.56 = 0.0009$$

$$\Delta w_4 = \Delta w_2 = 0.0009$$

$$w_2^{new} = w_2^{old} + \Delta w_2$$
$$= 0.2 + 0.000g$$
$$= 0.200g$$

$$w_4^{new} = w_4^{old} + \Delta w_4$$
$$= 0.4 + 0.00g$$
$$w_4^{new} = 0.400g$$

Q)



$b_1 = 0.5$ $b_2 = 0.5$

Find the error for given feed forward network

$w_1 = 0.1$ $w_6 = 0.6$ $w_{11} = 0.2$
$w_2 = 0.3$ $w_7 = 0.7$ $b_1 = 0.5$
$w_3 = 0.3$ $w_8 = 0.8$ $b_2 = 0.5$
$w_4 = 0.4$ $w_9 = 0.9$ $y_1 = 0$
$w_5 = 0.5$ $w_{10} = 0.1$ $y_2 = 1$

→

$$net_{11} = \Sigma w_i x_i + b_1$$
$$= w_1 x_1 + w_3 x_2 + b_1$$
$$= 0.1 \times 0.3 + 0.3 \times 0.5 + 0.5$$
$$= 0.68$$

$$net_{12} = \Sigma w_i x_i + b_1$$
$$= w_2 x_1 + w_4 x_2 + b_1$$
$$= 0.3 \times 0.3 + 0.4 \times 0.5 + 0.5$$
$$net_{12} = 0.79$$

$$h_{11} = F(net_{11}) = \frac{1}{1+e^{-\lambda net_{11}}} = \frac{1}{1+e^{-0.68}}$$

$$h_{11} = 0.664$$

$$h_{12} = \frac{1}{1+e^{-0.79}}$$

$$h_{12} = 0.68$$

$$net_{21} = \sum w_i x_i + b_2$$
$$= h_{11} w_5 + h_{12} w_7 + b_2$$
$$= 0.664 \times 0.5 + 0.68 \times 0.7 + 0.5$$
$$= 0.332 + 0.476 + 0.5$$
$$net_{21} = 1.308$$

$$h_{21} = F(net_{21})$$
$$= \frac{1}{1+e^{-1.308}} = 0.78$$

$$net_{22} = \sum w_i x_i + b_2$$
$$= (h_{11} \times w_6) + (h_{12} \times w_8) + b_2$$
$$= 0.664 \times 0.6 + 0.68 \times 0.8 + 0.5$$
$$= 0.898 + 0.544 + 0.5$$
$$= 1.442$$
$$net_{22} = F(net_{22})$$
$$= 1$$

$net_1 = h_{21} \times w_9 + h_{22} w_{11}$

$= 0.78 \times 0.9 + 0.809 \times 0.2$

$= 0.864$

$y_1 = F(net_1)$

$= 0.703$

$net_2 = h_{21} \times w_{10} + h_{22} \times w_{12}$

$= 0.78 \times 0.1 + 0.809 \times 0.3$

$= 0.321$

$y_2 = F(net_{82})$

$y_2 \doteq 0.58$

$$MSE = \frac{1}{2}\left[\left(\begin{matrix}\text{Actual} \\ o/p\,1\end{matrix}\right) - \left(\begin{matrix}\text{Target} \\ o/p\,1\end{matrix}\right)\right]^2 + \left[\left(\begin{matrix}\text{Actual} \\ o/p\,2\end{matrix}\right) - \left(\begin{matrix}\text{target} \\ o/p\,2\end{matrix}\right)\right]^2$$

$= \frac{1}{2}\left[(0.703-0)^2 + (0.58-1)^2\right]$

$= \frac{1}{2}\left[0.494 + 0.176\right)$

$= 0.335$