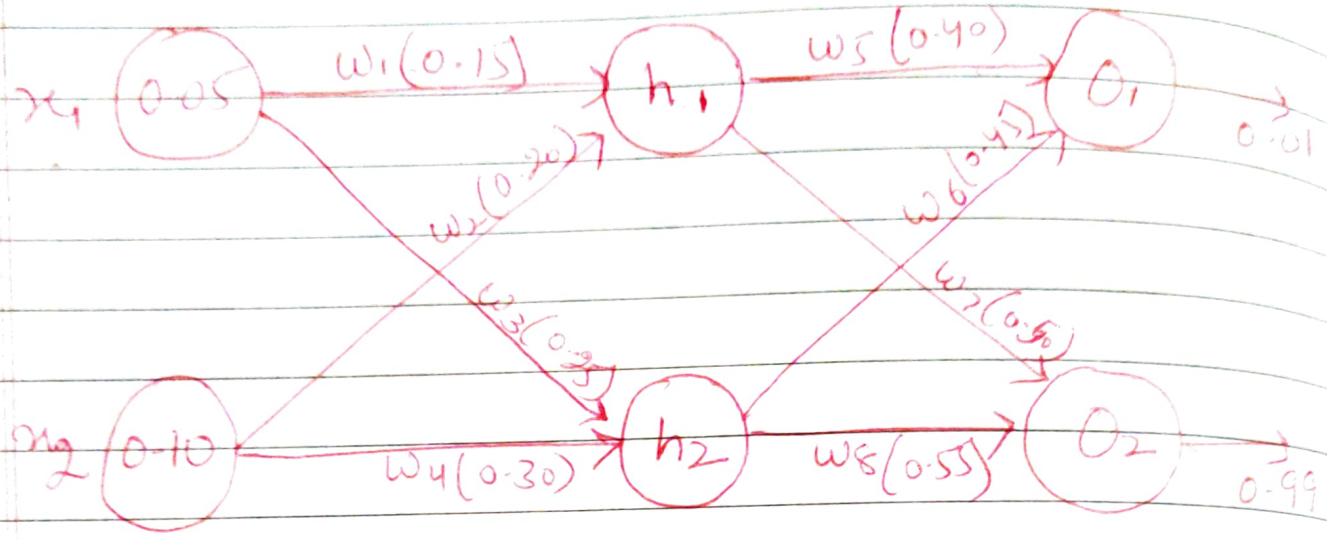
(Backpropagation)



$b_1 = 0.35$

$b_2 = 0.60$

$h_1(in) = x_1 w_1 + x_2 w_2 + b_1$

$= (0.05) \times (0.15)) + (0.10 \times 0.20) + 0.35$

$= 0.0075 + 0.02 + 0.35$

$= 0.3775$

$$h_1(out) = \frac{1}{1 + e^{-h_1(in)}}$$

$= 0.5932$

$$h_2(in) = x_1 w_3 + x_2 w_4 + b_1$$

$$= (0.05 \times 0.25) + (0.10 \times 0.30) + 0.35$$

$$= 0.0125 + 0.03 + 0.35$$

$$= 0.3925$$

$$h_2(out) = \frac{1}{1 + e^{-h_2(in)}}$$

$$= 0.5968$$

$$O_1(in) = h_1(out) \times w_5 + h_2(out) \times w_6 + b_2$$

$$= (0.5932 \times 0.40) + (0.5968 \times 0.45) + 0.6$$

$$= 1.105$$

$$O_1(out) = \frac{1}{1 + e^{-O_1(in)}} = 0.7513$$

$$O_2(out) = 0.7729$$

$$O_2(in) = h_1(out) \times w_7 + h_2(out) \times w_8 + b_2$$

$$= 0.5932 \times 0.50 + 0.5968 \times 0.55 + 0.6$$

$$= 0.2966 + 0.32824 + 0.6$$

$$= 1.22484$$

$O_1(out) = 0.7513$

$O_2(out) = 0.7729$

Error / $EO_1 = |(0.7513 - 0.01)| =$

Error = $EO_2 = |(0.7729 - 0.99)| =$

$E_{O_1} = E_{total} = \sum \frac{1}{2}(target - o/p)^2$

$= \sum \frac{1}{2}(0.01 - 0.7513)^2$

$= \frac{0.5495}{2} = 0.275$

$E_{O_2} = \sum \frac{1}{2}(0.99 - 0.7729)^2$

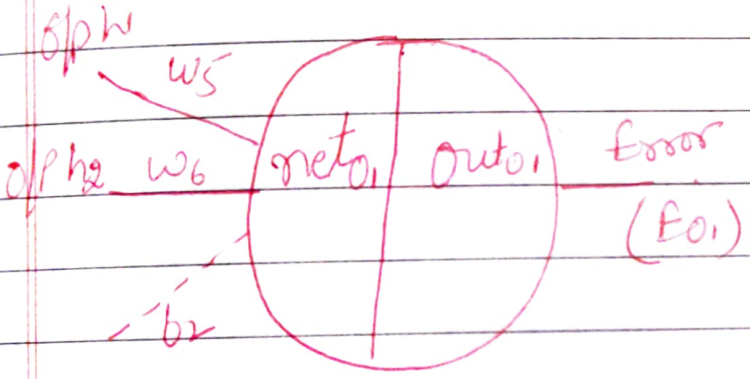
$= \frac{0.0472}{2} = 0.0236$

$E_{total} = E_{O_1} + E_{O_2}$

$= 0.275 + 0.0236$

$= 0.2983$

upto this forward pass was explained. Now we have to reduce this error to zero so we move in backward direction from o/p to hidden layer then to i/p layer.



$$\frac{\partial E_{total}}{\partial w_5} = \frac{\partial E_{total}}{\partial out_{o1}} * \frac{\partial out_{o1}}{\partial net_{o1}} * \frac{\partial net_{o1}}{\partial w_5}$$

$$\frac{\partial E_{total}}{\partial out_{o1}} = Out_{o1} - target_{o1}$$

$$= 0.751365 - 0.01$$

$$= 0.741365$$

$$\frac{\partial out_{o1}}{\partial net_{o1}} = Out_{o1}(1 - Out_{o1})$$

$$= 0.751365(1 - 0.751365)$$

$$= 0.18681$$

$$\frac{\partial net_{o1}}{\partial w_5} = Out(h_1) = 0.59326$$

Now put these in formula

$$\frac{\partial E_{total}}{\partial w_5} = 0.0821764$$

$$w_5^* = w_5 - \alpha * \frac{\partial E_{total}}{\partial w_5}$$

learning rate (0.6)

$$= 0.4 - 0.6 * 0.0821764$$

$$= 0.35069$$

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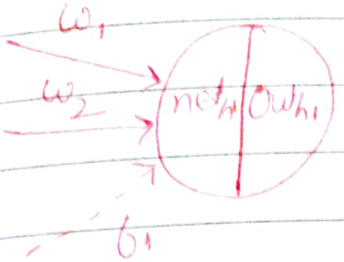
Hidden Layer



$$\frac{\partial E_{total}}{\partial w_1} = \frac{\partial E_{total}}{\partial out_{h1}} * \frac{\partial out_{h1}}{\partial net_{h1}} * \frac{\partial net_{h1}}{\partial w_1}$$

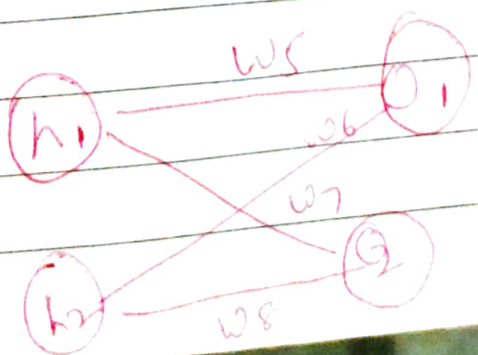
$$\frac{\partial E_{total}}{\partial out_{h1}} = \frac{\partial E_{o1}}{\partial out_{h1}} + \frac{\partial E_{o2}}{\partial out_{h1}}$$

$$\left(\frac{\partial E_{o1}}{\partial net_{o1}} * \frac{\partial net_{o1}}{\partial out_{h1}}\right) + \left(\frac{\partial E_{o2}}{\partial net_{o2}} * \frac{\partial net_{o2}}{\partial out_{h1}}\right)$$

w_5 (0.4) w_7 (0.50)

$$\left(\frac{\partial E_{o1}}{\partial out_{o1}} * \frac{\partial out_{o1}}{\partial net_{o1}}\right) \qquad \left(\frac{\partial E_{o2}}{\partial out_{o2}} * \frac{\partial out_{o2}}{\partial net_{o2}}\right)$$

0.13849856 -0.0380782



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$$\frac{\partial E_{O_2}}{\partial out_{O_2}} = out_{O_2} - target_{O_2}$$

$$= 0.77292 - 0.99$$

$$= -0.21707$$

$$\frac{\partial E_{total}}{\partial out_{h_1}} = \frac{\partial E_{O_1}}{\partial out_{h_1}} + \frac{\partial E_{O_2}}{\partial out_{h_1}}$$

$$= 0.05539 + (-0.01904)$$

$$= 0.03635$$

$$out_{O_2}(1 - out_{O_2}$$

$$= 0.175510032$$