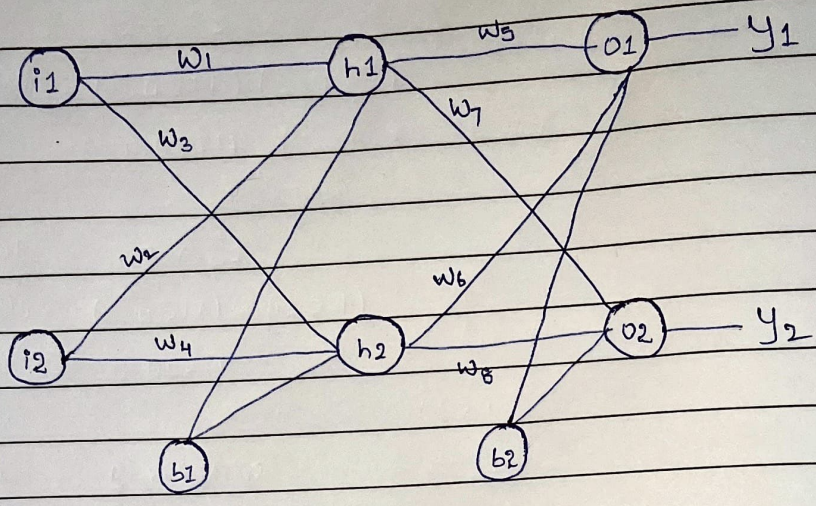
INTRODUCTION TO ARTIFICIAL NEURAL NETWORKS

ASSIGNMENT - 1



Given : $i_1 = 0.05$ $w_1 = 0.15$ $w_5 = -0.14$

$i_2 = 0.03$ $w_2 = 0.20$ $w_6 = 0.45$

$o_1 = -0.01$ $w_3 = -0.02$ $w_7 = -0.15$

$o_2 = 0.09$ $w_4 = 0.03$ $w_8 = 0.55$

$b_1 = -0.25$

$b_2 = 0.16$

$lr = 0.5$

$$\sigma = \frac{1}{1+e^{(-x)}}, \quad \sigma' = \sigma(1-\sigma)$$

Forward Pass:

$net\text{-}h1 = i_1 w_1 + i_2 w_2 + b_1$

$= (0.05)(0.15) + (0.03)(0.20) + (-0.25)$

$= (0.0075) + (0.006) - 0.25$

$= -0.2365$

$h1 = \sigma(net\text{-}h1)$

$= 0.4412$

$net\text{-}h2 = i_1 w_3 + i_2 w_4 + b_1$

$= (0.05)(-0.02) + (0.03)(0.03) + (-0.25)$

$= (-0.001) + (0.0009) - 0.25$

$= -0.2501$

$h2 = \sigma(net\text{-}h2)$

$= 0.4377$

$net\text{-}o1 = h1w_5 + h2w_6 + b2$

$= (0.4412)(-0.14) + (0.4377)(0.45) + 0.16$

$= -0.0617 + 0.1969 + 0.16$

$= 0.2953$

$out1 = -(net\text{-}o1)$

$= 0.5733$

$net\text{-}o2 = h2w_8 + h1w_7 + b2$

$= (0.4377)(0.58) + (0.4412)(-0.15) + 0.16$

$= 0.2407 + (-0.6618) + 0.16$

$= 0.3345$

$out2 = -(net\text{-}o2)$

$= 0.583$

Error $E = \frac{1}{2}((o1 - out1)^2 + (o2 - out2)^2)$

$= \frac{1}{2}((-0.01 - 0.5733)^2 + (0.09 - 0.583)^2$

$= \frac{1}{2}(0.3402 + 0.243)$

$= 0.2916$

Backpropogation:

$\delta 1 = (out1 - o1) \times out1(1 - out1)$

$= (0.5733 + 0.01) \times 0.5733(1 - 0.5733)$

$= (0.5833)(0.2446)$

$= 0.1427$

$\delta 2 = (out2 - o2) \times out2(1 - out2)$

$= (0.583 - 0.09) \times 0.583(1 - 0.583)$

$= (0.493)(0.2431)$

$= 0.1198$

Updating weights: $\frac{\partial E}{\partial w_5} = h1 \times \delta 1$

$= 0.4412 \times 0.1427$

$= 0.0629$

$$\frac{\partial E}{\partial w_8} = h_2 \times \delta_2$$

$$= (0.4377)(0.1198)$$

$$= 0.0524$$

$$\frac{\partial E}{\partial w_6} = h_2 \times \delta_1$$

$$= (0.4377)(0.1427)$$

$$= 0.0624$$

$$\frac{\partial E}{\partial w_7} = h_1 \times \delta_2$$

$$= (0.4412)(0.1198)$$

$$= 0.05285$$

$$\frac{\partial E}{\partial b_2} = \delta_1 + \delta_2$$

$$= (0.1198) + (0.1427)$$

$$= 0.2626$$

$$\frac{\partial E}{\partial w_1} = i_1 \times [\delta_1 w_5 + \delta_2 w_7) \times h_1(1-h_1)$$

$$= 0.05 \times ((0.1427)(-0.14) + (0.1198)(0.15)) \times 0.4412[1-0.441$$

$$= 0.05 \times ((-0.01997) + (-0.0179)) \times (0.2465)$$

$$= 0.05 \times (-0.0378)(0.2465)$$

$$= -0.00046$$

$$\frac{\partial E}{\partial w_2} = i_2 \times [\delta_1 w_5 + \delta_2 w_7) \times h_1(1-h_1)$$

$$= 0.03 \times ((0.1427)(0.14) + (0.1198)(-0.15) \times 0.4412(1-0.441$$

$$= 0.03 \times (-0.0378)(0.2465)$$

$$= -0.00027$$

$$\frac{\partial E}{\partial w_3} = i_1 \times [\delta_1 w_6 + \delta_2 w_8) \times h_2(1-h_2)$$

$$= 0.05 \times ((0.1427)(0.45) + (0.1198)(0.55)) \times 0.4377(1-0.43$$

$$= 0.05 \times [0.0642 + 0.0658)(0.2461)$$

$$= [0.05)(0.13009)(0.2461)$$

$$= 0.0016$$

$$\frac{\partial E}{\partial w_4} = i_2 \times (\delta_1 w_6 + \delta_2 w_8) \times h_2(1-h_2)$$

$$= 0.03 \times ((0.1427)(0.45) + (0.1198)(0.55)) \times 0.4377(1-0.4377)$$

$$= 0.03 \times 0.13009 \times 0.2461$$

$$= 0.00096$$

$$\frac{\partial E}{\partial b_1} = (\delta_1 w_6 + \delta_2 w_8) \times h_2(1-h_2) + (\delta_1 w_5 + \delta_2 w_7) \times (h_1 \times 1 - h_1)$$

$$= (0.13009) \times (0.2461) + (-0.0378) \times (0.2465)$$

$$= 0.032 + (-0.00931)$$

$$= 0.02269$$

update weights :

$$w_1 = w_1 - \left(lr \times \frac{\partial E}{\partial w_1}\right)$$

$$w_1 = 0.15 - (0.5) \times (-0.00046)$$

$$w_1 = 0.1497$$

$$w_2 = w_2 - \left(lr \times \frac{\partial E}{\partial w_2}\right)$$

$$= 0.2 - (0.5 \times -0.00027)$$

$$w_2 = 0.2001$$

$$w_3 = w_3 - \left(lr \times \frac{\partial E}{\partial w_3}\right)$$

$$= -0.02 - (0.5 \times 0.0016)$$

$$w_3 = -0.0193$$

$$w_4 = w_4 - \left(lr \times \frac{\partial E}{\partial w_4}\right)$$

$$= (0.03) - (0.5 \times 0.00096)$$

$$w_4 = 0.0252$$

$$w_5 = w_5 - \left(lr \times \frac{\partial E}{\partial w_5}\right)$$

$$= (-0.14) - (0.5 \times 0.0629)$$

$$w_5 = -0.1714$$

$$w_6 = w_6 - \left(lr \times \frac{\partial E}{\partial w_6}\right)$$

$$= 0.45 - (0.5 \times 0.0624)$$

$$= 0.45 - 0.0312$$

$$w_6 = 0.4188$$

$$w_7 = w_7 - \left(lr \times \frac{\partial E}{\partial w_7}\right)$$

$$= -0.15 - (0.5 \times 0.0528)$$

$$w_7 = 0.1764$$

$$w_8 = w_8 - \left(lr \frac{\partial E}{w_8}\right)$$

$$= 0.55 - (0.0524 \times 0.5)$$

$$= 0.5238$$

$$b_1 = b_1 - \left(lr \times \frac{\partial E}{b_1}\right)$$

$$b_1 = -0.25 - (0.5 \times 0.02269)$$

$$b_1 = -0.261$$

$$b_2 = b_2 - \left(lr \times \frac{\partial E}{b_2}\right)$$

$$= 0.16 - (0.5 \times 0.2626)$$

$$b_2 = 0.0287$$