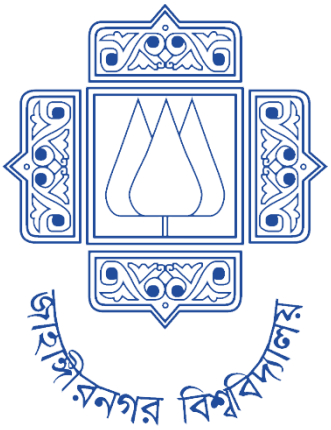
Institute of Information Technology (IIT)
Jahangirnagar University



Course Code: MICT 5402
Course Title: Advanced Machine Learning

Assignment - 02

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Example 01:

Forward Propagation

Input, $x_1 = 1$, $x_2 = 1$

Hidden Layer, $I_3 = (0.5 \times 1) + (-0.3 \times 1) + 0.6$

$= 0.8$

$I_4 = \sum w_i x_i + b$

$= (0.2 \times 1) + (0.5 \times 1) + (-0.4)$

$= 0.3$

Now, $O_3 = \frac{1}{1+e^{-0.8}} = 0.69$

$O_4 = \frac{1}{1+e^{-0.3}} = 0.5744$

output Layer, $I_5 = (O_3 \times 0.1) + (O_4 \times 0.3) + b_5$

$= (0.69 \times 0.1) + (0.5744 \times 0.3) + 0.8$

$= 1.04132$

$O_5 = \frac{1}{1+e^{-1.04132}} = 0.7391$

$\therefore$ Error = target $- O_5$

$= 0 - 0.7391$

$= -0.7391$

Output Layer Error, $E_5 = O_5 \times (1 - O_5) \times (\text{target} - O_5)$

$= 0.7391 \times (1 - 0.7391) \times (0 - 0.7391)$

$= -0.14252$

Hidden Layer Error, $E_3 = O_3 \times (1 - O_3) \times (E_5 \times W_{35})$

$= 0.69 \times (1 - 0.69) \times (-0.14252 \times 0.1)$

$= -0.00304$

$E_4 = O_4 \times (1 - O_4) (E_5 \times W_{45})$

$= 0.5744 \times (1 - 0.5744) (-0.14252 \times 0.3)$

$= -0.01045$

Update weight,

$W(\text{new}) = W(\text{old}) + \Delta W_{ij}$

$= W(\text{old}) + \eta \times \delta_j \times O_j$

η → Learning rate, δ_j → error term, O_j → output

$W_{13}(\text{new}) = 0.5 + (0.5 \times x_1 \times E_3)$

$= 0.5 + (0.5 \times 1 \times -0.00304)$

$= 0.49848$

$W_{14}(\text{new}) = 0.2 + (0.5 \times x_1 \times E_4)$

$= 0.2 + (0.5 \times 1 \times -0.01045)$

$= 0.194775$

$W_{23}(new) = -0.3 + (0.5 \times 1 \times -0.00304) = -0.30152$

$W_{24}(new) = 0.5 + (0.5 \times 1 \times -0.01045) = 0.494775$

$W_{35}(new) = 0.1 + (0.5 \times 0.69 \times -0.14252) = 0.05083$

$W_{45}(new) = 0.3 + (0.5 \times 0.5744 \times -0.14252) = 0.259$

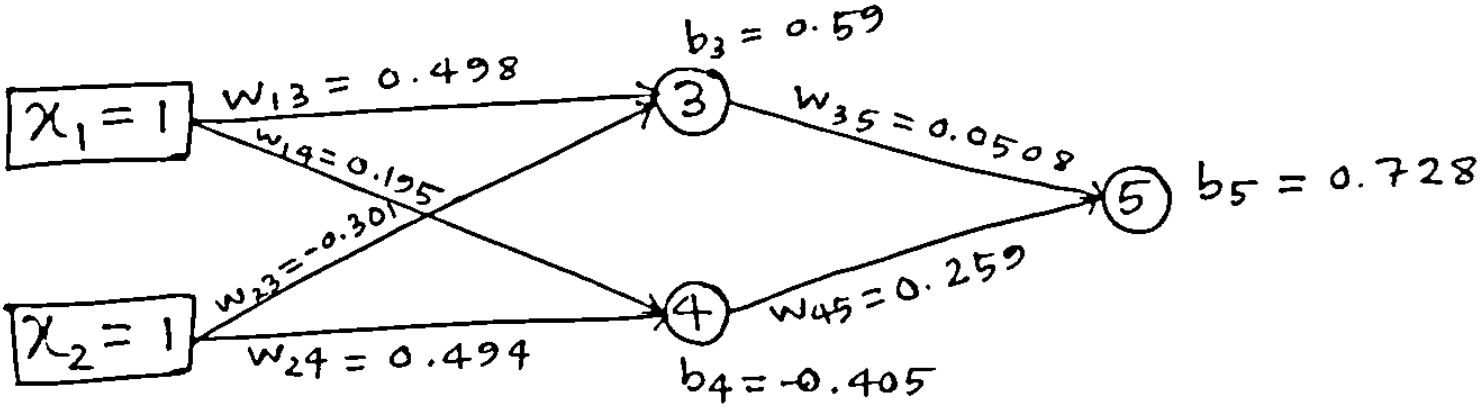
Update the bias $b_j(new) = b_j(old) + \eta \times \delta j$

$b_3(new) = 0.6 + (0.5 \times E_3)$

$= 0.6 + (0.5 \times -0.00304) = 0.59848$

$b_4(new) = -0.4 + (0.5 \times -0.01045) = -0.4052$

$b_5(new) = 0.8 + (0.5 \times -0.14252) = 0.72874$



Fonward Propagation

Hidden Layen, $I_3' = (1 \times 0.498) + (1 \times -0.301) + 0.59$

$= 0.787$

$I_4' = (1 \times 0.195) + (1 \times 0.494) + (-0.405)$

$= 0.284$

$O_3' = \frac{1}{1 + e^{-0.787}} = 0.687$

$O_4' = \frac{1}{1 + e^{-0.284}} = 0.5705$

Output Layen, $I_5' = (0.687 \times 0.0508) + (0.5705 \times 0.259) + 0.728$

$= 0.91065$

$O_5' = \frac{1}{1 + e^{-0.91065}} = 0.713$

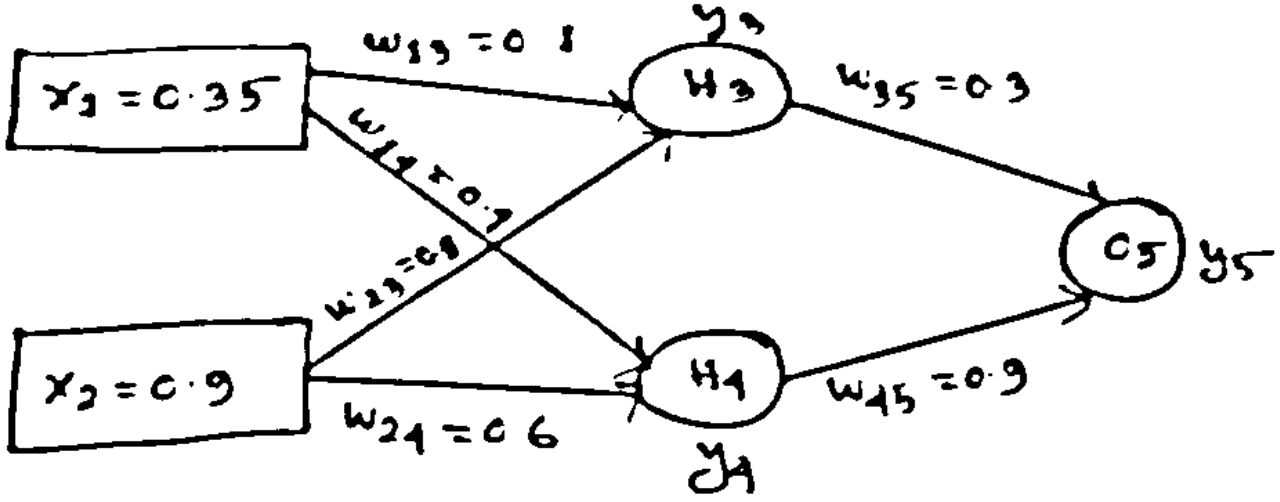
$\therefore$ Ennon = target $- O_5'$

$= 0 - 0.713$

$= -0.713$

$\therefore$ Ennon is minimizing gnadually.

Problem - 02:



(i) the actual output of y is 0.5 and learning rate is 1.

Forward pass: compute output for y_3, y_4 and y_5

$$a_j = \sum_j (w_{ij} \cdot x_i)$$

$$y_j = F(a_j) = \frac{1}{1+e^{-a_j}}$$

$$a_3 = (w_{13} \times x_1) + (w_{23} \times x_2)$$

$$= 0.1 \times 0.35 + 0.8 \times 0.9 = 0.355$$

$$y_3 = f(a_0) = \frac{1}{1+e^{-0.355}} = 0.68$$

$$a_2 = 0.4 \times 0.35 + 0.6 \times 0.9 = 0.68$$

$\Delta w_{14} = \eta \delta_4 x_1 = 1 \times (-0.0082) \times 0.35 = -0.00287$

$w_{14}(new) = -0.00282 + 0.4 = 0.3932$

Similarly, update all other weights

i	j	w_{ij}	δ_j	x_i	η	updated w_{ij}
1	3	0.1	-0.00265	0.35	1	0.0991
2	3	0.8	-0.00265	0.9	1	0.7926
1	4	0.4	-0.0082	0.35	1	0.3931
2	4	0.6	-0.0082	0.9	1	0.5926
3	5	0.3	-0.0406	0.68	1	0.2724
4	5	0.9	-0.0406	0.6632	1	0.8731

Forward Pass: Compute output for y_3, y_4 and y_5

$a_1 = 0.0991 \times 0.35 + 0.7926 \times 0.9 = 0.7525$

$y_3 = \frac{1}{1+e^{-0.7525}} = 0.6797$

$a_2 = (0.3931 \times 0.35 + 0.5926 \times 0.9) = 0.6723$

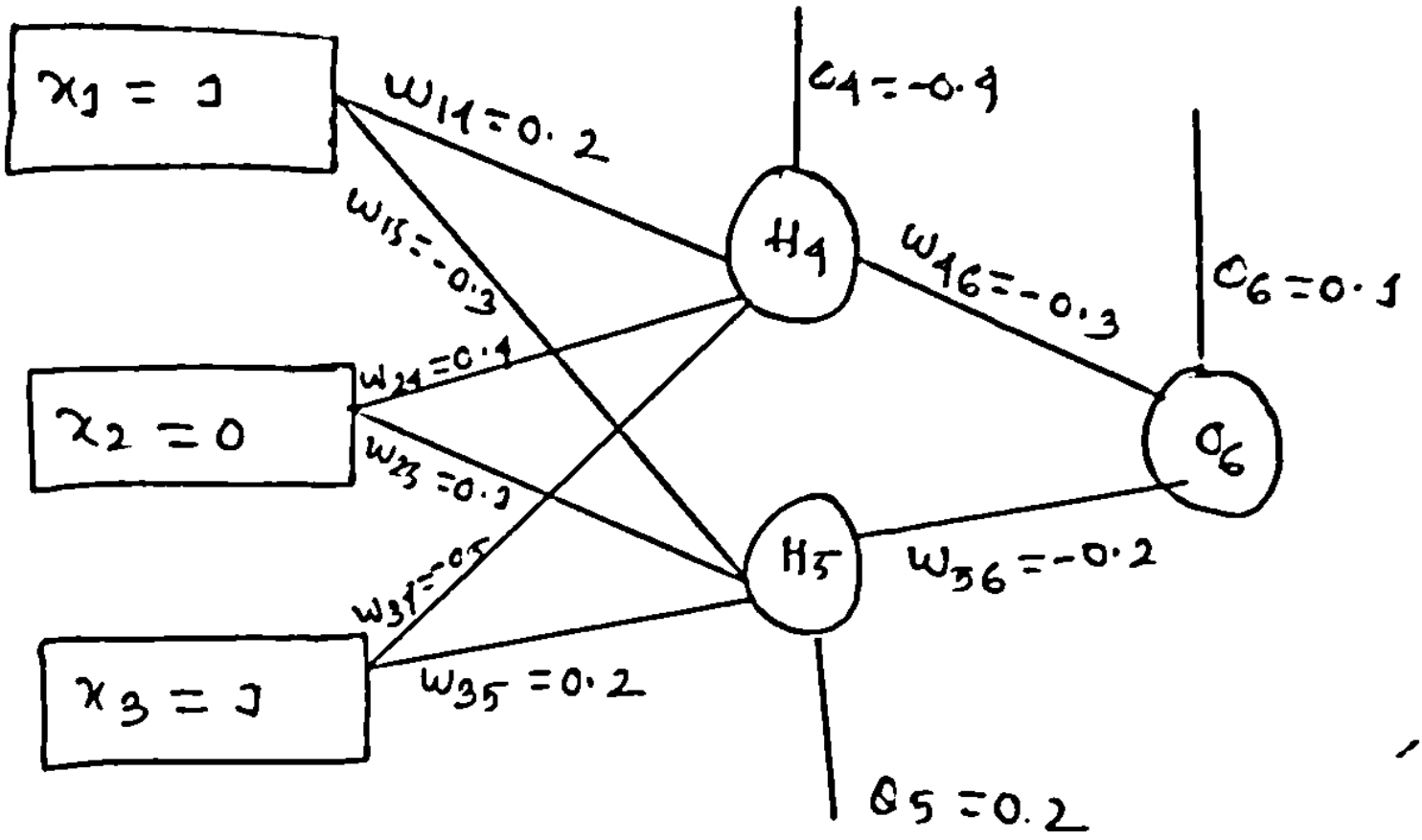
$y_4 = \frac{1}{1+e^{-0.6723}} = 0.6620$

$a_3 = (0.2724 \times 0.6797) + (0.8731 \times 0.6620) = 0.7631$

... output :

Multilayer Perceptron Network

Problem-03:



θ = bias

Actual Output = 1

Assume that the actual output of y is 1 and learning rate is 0.9.

Forward Pass: Compute outputs for y_4, y_5 and y_6

$$a_4 = w_{14} \times x_1 + w_{24} \times x_2 + w_{34} \times x_3 + \theta_4$$

$$= 0.2 \times 1 + 0.4 \times 0 + (-0.5 \times 1) + (-0.4) = -0.7$$

$$O(H_4) = \frac{1}{1+e^{0.7}} = 0.332$$

$$a_5 = (-0.3 \times 1) + (0.1 \times 0) + (0.2 \times 1) + 0.2 = 0.1$$

$$O(H_5) = \frac{1}{1+e^{-0.1}} = 0.525$$

$$a_6 = (-0.3 \times 0.332) + (-0.2 \times 0.525) + 0.1 = -0.105$$

$$O(O_6) = \frac{1}{1+e^{0.105}} = 0.474$$

$$\text{Error} = y_{target} - y_6 = 0.526$$

Backward pass: Compute δ_4, δ_5 and δ_6

For output unit:

$$\delta_6 = y_6(1-y_6)(y_{target} - y_6) = 0.474 \times (1-0.474)(1-0.474)$$

$$= 0.1311$$

For hidden unit:

$$\delta_5 = 0.525 \times (1-0.525) \times (-0.2 \times 0.1311) = -0.0065$$

$\delta_4 = 0.332(1-0.332) \times (-0.3 \times 0.1311)$

$= -0.0087$

Compute new weights

$\Delta w_{46} = \eta \delta_6 y_4 = 0.9 \times 0.1311 \times 0.332$

$= 0.03913$

$w_{46}(new) = \Delta w_{46} + w_{46}(old) = 0.03913 + (-0.3)$

$= -0.261$

$\Delta w_{14} = 0.9 \times (-0.0087) \times 1 = -0.0078$

$w_{14}(new) = -0.0078 + 0.2 = 0.192$

Similarly update all other weights

i	j	w_{ij}	δ_i	x_i	η	update w_{ij}
4	6	-0.3	0.1311	0.332	0.9	-0.261
5	6	-0.2	0.1311	0.525	0.9	-0.138
1	4	0.2	-0.0087	1	0.9	0.192
1	5	-0.3	-0.0065	1	0.9	-0.306
2	4	0.4	-0.0087	0	0.9	0.4
2	5	0.1	-0.0065	0	0.9	0.1
3	4	-0.5	-0.0087	1	0.9	-0.508
3	5	0.2	-0.0065	1	0.9	0.194

Similarly update this weights

(i)	Previous θ_j	δ_j	η	updated θ_j
θ_0	0.1	0.1311	0.9	0.218
θ_4	0.2	−0.0065	0.9	0.194
θ_1	−0.4	−0.0083	0.9	−0.408

Forward pass: Compute output for y_4, y_5 and y_6

$a_4 = 0.192 \times 1 + 0.4 \times 0 + (-0.506 \times 1) + (-0.408) = -0.324$

$o(H_4) = \frac{1}{1+e^{0.324}} = 0.323$

$a_5 = -0.306 \times 1 + 0.1 \times 0 + 0.194 \times 1 + 0.194 = 0.082$

$o(H_5) = \frac{1}{1+e^{-0.082}} = 0.520$

$a_6 = -0.261 \times 0.323 + (-0.138 \times 0.520) + 0.218 = 0.06$

$o(H_6) = \frac{1}{1+e^{-0.06}} = 0.515$ (Network output)

Error $= y_{target} - y_6 = 0.485$

THE END