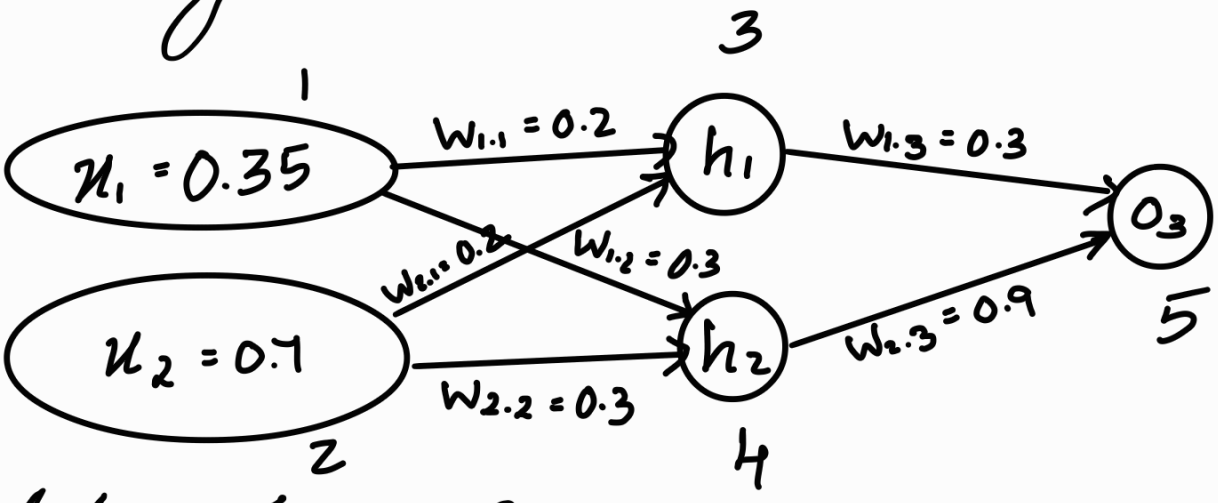
Q. Assume the neurons use the sigmoid activation func. for the forward and backward pass. The target output is 0.5 and the learning rate is 1.



Soln:- Forward Pass:-

$$h_1 = x_1 w_{11} + x_2 w_{21} = 0.35 \times 0.2 + 0.7 \times 0.2$$

$$= 0.21$$

$$y_1 = \frac{1}{1+e^{-0.21}} = 0.552$$

$$h_2 = x_1 w_{12} + x_2 w_{22} = 0.35 \times 0.3 + 0.7 \times 0.3$$

$$= 0.315$$

$$y_2 = \frac{1}{1+e^{-0.315}} = 0.578$$

$$O_3 = y_1 w_{13} + y_2 w_{23} = 0.552 \times 0.3 + 0.578 \times 0.9$$

$$= 0.6858$$

$$O_3 = \frac{1}{1 + e^{-0.685}} = 0.665$$

$t = 0.5$

$$E = \frac{1}{2}[t - O_3)^2 = \frac{1}{2}(0.5 - 0.66)^2$$

$$= [0.0132]$$

Backward Pass :-

$$\delta_5 = 0.665(1 - 0.665)(0.5 - 0.665) = -0.036$$

$$\delta_3 = 0.552(1 - 0.552)\, 0.3 \times (-0.036)$$

$$= -0.00267$$

$$\delta_4 = 0.578[1 - 0.578) W_{23} \delta_3 = 0.578(1 - 0.578)$$

$$09 \times -0.036$$

$$= -0.0079$$

$$\Delta W_{13} = \alpha \times \delta_5 \times y_1$$

$$= 1 \times -0.036 \times 0.552$$

$$= -0.0198$$

$$W_{13(new)} = 0.3 - 0.0198 = 0.28$$

$$\Delta W_{23} = \alpha \times \delta_5 \times y_2$$

$$= 1 \times -0.036 \times 0.578$$

$$= -0.0208$$

$$W_{23(new)} = 0.9 - 0.0208 = 0.879$$

$$\Delta W_{11} = \alpha \times \delta_3 \times x_1$$

$$= 1 \times -0.0026 \times 0.35 = -0.00093$$

$$W_{11(new)} = 0.2 - 0.00093 = 0.199$$

$$\Delta W_{12} = \alpha \times \delta_4 \times x_2$$

$$= -0.0079 \times 0.35 = -0.0027$$

$$W_{12(new)} = 0.3 - 0.0027 = 0.297$$

$$\Delta W_{21} = 1 \times \delta_3 \times x_2$$

$$= -0.00267 \times 0.7 = -0.00186$$

$$W_{21(new)} = 0.2 - 0.00065 = 0.199$$

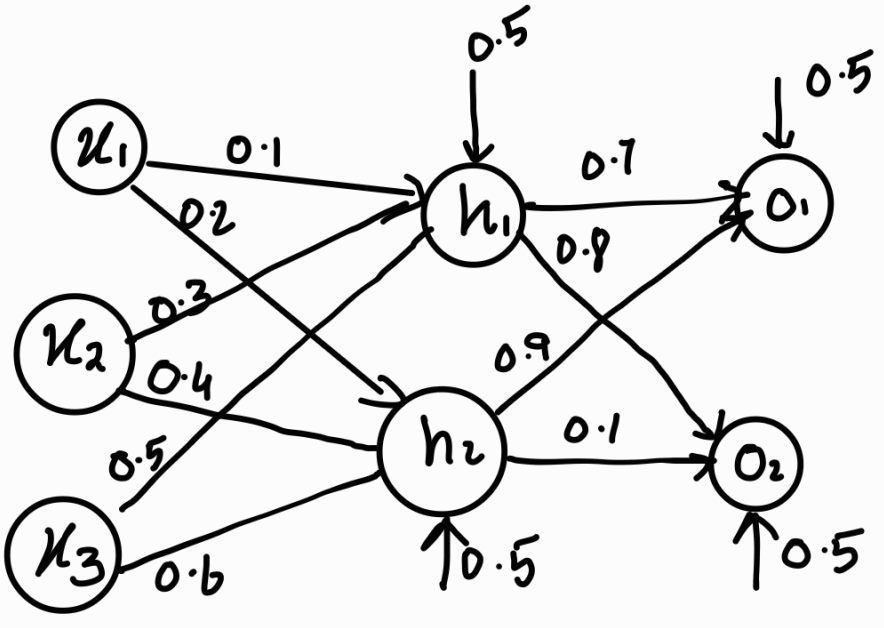
$$\Delta W_{22} = 1 \times \delta_4 \times x_2$$

$$= -0.0079 \times 0.7$$

$$= -0.00553$$

$$W_{22(new)} = 0.2941$$

Q.



Soln.

$$Z_{h_1} = 0.1 \times 1 + 0.2 \times 4 + 0.3 \times 5 + 0.5$$

$$= 2.9$$

$$Z_{h_2} = 0.4 \times 1 + 0.5 \times 4 + 0.6 \times 5 + 0.5$$

$$= 5.9$$

$$h_1 = \frac{1}{1+e^{-2.9}} = 0.947$$

$$h_2 = \frac{1}{1+e^{-5.9}} = 0.997$$

$$Z_{O_1} = 0.7 \times 0.947 + 0.8 \times 0.99 + 0.5$$
$$= 1.9613$$

$$Z_{O_2} = 0.9 \times 0.947 + 0.1 \times 0.99 + 0.5$$
$$= 1.452$$

$$O_1 = 0.88$$

$$O_2 = 0.81$$

$$Loss = \frac{1}{2}\left((0.1 - 0.8766)^2 + (0.05 - 0.810)^2\right)$$

$$= 0.5907$$

Backward pass :-

$$\delta_{o1} = (O_1 - t_1).O_1(1-O_1) = (0.876 - 0.1)\ 0.87\ (1-0.876)$$

$$\approx 0.0839$$

$$\delta_{o_2} = (O_2 - t_2).O_2(1-O_2) \approx 0.11682$$

$$\Delta W_{h_1 o_1} = \delta_{o_1} \times h_1 = 0.083 \times 0.947 = 0.0795$$

$$\Delta W_{h_2, o_1} = 0.0839 \times 0.99 = 0.0837$$

$$\Delta W_{h_1, o_2} = \delta_{o_2} \times h_1 = 0.1107$$

$$\Delta W_{h_2, o_2} = \delta_{o_2} \times h_2 = 0.1165$$

$$\Delta b_{o_2} = \delta_{o_2} = 0.1168$$

$$\delta_{h_1} = (\delta_{o_1} W_{h_1 o_1} + \delta_{o_2} W_{h_1 o_2}) \times h_1 (1-h_1)$$

$$= (0.083 \times 0.7 + 0.11 \times 0.9).0.947(1-0.947)$$

$$\approx 0.00810$$

$$\delta_{h_2} = (\delta_{o_1} W_{h_2, o_1} + \delta_{o_2} W_{h_2, o_2}).h_2(1-h_2)$$

$$= 0.000214$$

$$\Delta W_{x_1 h_1} = \delta_{h_1} x_1 = 0.0081 \times 1 = 0.0081$$

$$\Delta W_{x_2 h_1} = \delta_{h_1} x_2 = 0.0081 \times 4 = 0.032$$

$$\Delta W_{x_3 h_1} = \delta_{h_1} x_3 = 0.0081 \times 5 = 0.040$$

$$\Delta b_{h_1} = \delta_{h_1} = 0.0081$$

$$\Delta W_{x_1 h_2} = \delta_{h_2} x_1 = 0.000214 \times 1$$

$$\Delta W_{x_2 h_2} = \delta_{h_2} x_2 = 0.00085$$

$$\Delta W_{x_3 h_2} = \delta_{h_2} x_3 = 0.00107$$

$$\Delta b_{h_2} = 0.000214$$

$$W_{h_1 o_1 (new)} = 0.7 - 0.1 \times 0.079 = 0.692$$

$$W_{h_2 o_1 (new)} = 0.8 - 0.1 \times 0.083 = 0.7916$$

$$b_{o_1}^{(new)} = 0.5 - 0.1 \times 0.083 = 0.49$$

$$W_{x_1 h_1}^{(new)} = 0.1 - 0.1 \times 0.08$$

$$W_{x_2 h_1}^{(new)} = 0.1964$$

$$W_{x_3 h_1}^{(new)} = 0.295$$

$$b_{h_1}^{(new)} = 0.4991$$