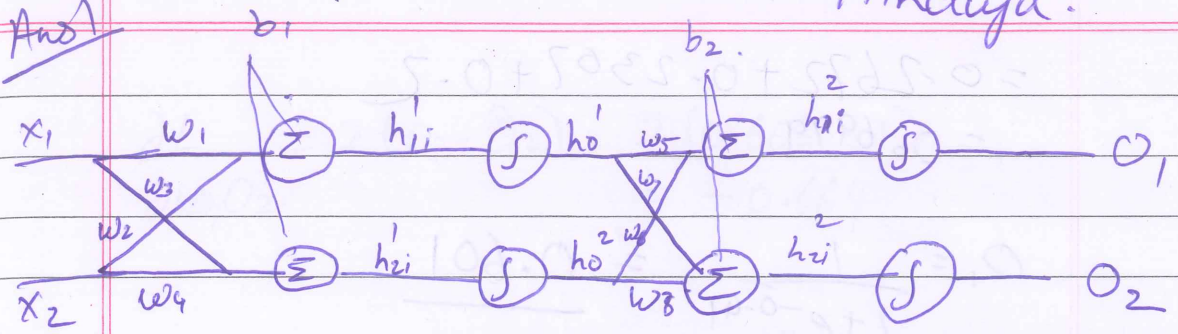
Saurabh Hinduja.

Ans)



$$h_{11}^1 = x_1 w_1 + x_2 w_2 + b_1$$
$$= 0.2 + 0.4 + 0.1 = 0.7$$

$$h_{21}^1 = x_2 w_4 + x_1 w_3 + b_1$$
$$= 0.8 + 0.3 + 0.1 = 1.2.$$

$$h_0^1 = \frac{1}{1+e^{-h_{11}}} = \frac{1}{1+e^{-0.7}} = \frac{1}{1.497} = 0.668$$

$$h_0^2 = \frac{1}{1+e^{-h_{21}}} = \frac{1}{1+e^{-1.2}} = 0.769$$

$$h_{11}^2 = h_0^1 w_5 + h_0^2 w_6 + b_2$$
$$= 0.2(0.668) + 0.1(0.769) + 0.2$$
$$= 0.1336 + 0.0769 + 0.2$$
$$= 0.41$$

$$h_{21}^2 = h_0^1 w_7 + h_0^2 w_8 + b_2$$
$$= 0.4(0.668) + 0.3(0.769) + 0.2$$

$$= 0.2672 + 0.2307 + 0.2$$
$$= 0.6979$$

$$O_1 = \frac{1}{1+e^{-0.41}} = \underline{0.601}$$

$$O_2 = \frac{1}{1+e^{-0.6979}} = \underline{0.668}$$

Ans2 $\quad L = (O_1 - \hat{O}_1)^2 + (O_2 - \hat{O}_2)^2$

$$\frac{\partial L}{\partial w_7} = \frac{\partial L}{\partial O_1} \cdot \frac{\partial O_1}{\partial h_{1i}^2} \cdot \frac{\partial h_{1i}^2}{\partial w_7} + \frac{\partial L}{\partial O_2} \cdot \frac{\partial O_2}{\partial h_{2i}^2} \cdot \frac{\partial h_{2i}^2}{\partial w_7}$$

$\frac{\partial h_{1i}^2}{\partial w_7} = 0$ @ h_{1i}^2 has no component of w

$$\frac{\partial L}{\partial w_7} = \frac{\partial L}{\partial O_2} \cdot \frac{\partial O_2}{\partial h_{2i}^2} \cdot \frac{\partial h_{2i}^2}{\partial w_7}.$$

$$\frac{\partial L}{\partial w_2 O_2} = 2(O_2 - \hat{O}_2) = 2(0.668 - 1)$$
$$= -0.664$$

$$\frac{\partial O_2}{\partial h_{21}^2} = \frac{\partial}{\partial h_{21}} \left(\frac{1}{1+e^{-h_{21}^2}} \right) = \frac{e^{-h_{21}^2}}{(1+e^{-h_{21}^2})^2} = 0.498 \times (0.668)^2$$

$$= 0.222$$

$$\frac{\partial h_{21}^2}{\partial w_1} = h_0' = 0.668$$

$$\frac{\partial L}{\partial w_1} = (-0.664)(0.222)(0.668) = -0.098.$$

$$\frac{\partial L}{\partial w_3} = \frac{\partial L}{\partial O_1} \cdot \frac{\partial O_1}{\partial h_{11}^2} \left[\frac{\partial h_{11}^2}{\partial h_0^1} \left[\frac{\partial h_0^1}{\partial h_{11}^1} \cdot \frac{\partial h_{11}^1}{\partial w_3} \right] \right.$$

$$\left. + \frac{\partial h_{11}^2}{\partial h_0^2} \left[\frac{\partial h_0^2}{\partial h_{21}^1} \cdot \frac{\partial h_{21}^1}{\partial w_3} \right] \right]$$

$$+ \frac{\partial L}{\partial O_2} \cdot \frac{\partial O_2}{\partial h_{21}^2} \left[\frac{\partial h_{21}^2}{\partial h_0^1} \left[\frac{\partial h_0^1}{\partial h_{11}^1} \cdot \frac{\partial h_{11}^1}{\partial w_3} \right] \right.$$

$$\left. + \frac{\partial h_{21}^2}{\partial h_0^2} \left[\frac{\partial h_0^2}{h_{21}^1} \cdot \frac{\partial h_{21}^1}{\partial w_3} \right] \right]$$

$\frac{\partial h_{11}^1}{\partial w_3} = 0$ as h_{11}^1 has no component w_3.

$$\frac{\partial L}{\partial w_3} = \frac{\partial L}{\partial O_1} \cdot \frac{\partial O_1}{\partial h_{11}^2} \cdot \frac{\partial h_{11}^2}{\partial h_0^2} \cdot \frac{\partial h_0^2}{\partial h_{21}^1} \cdot \frac{\partial h_{21}^1}{\partial w_3}$$

$$+ \frac{\partial L}{\partial O_2} \cdot \frac{\partial O_2}{\partial h_{21}^2} \cdot \frac{\partial h_{21}^2}{\partial h_0^2} \cdot \frac{\partial h_0^2}{\partial h_{21}^1} \cdot \frac{\partial h_{21}^1}{\partial w_3}$$

$$= \frac{\partial h_0^2}{\partial h_{2i}^1} \frac{\partial h_{2i}^1}{\partial w_3} \left[\frac{\partial L}{\partial O_1} \cdot \frac{\partial O_1}{\partial h_{1i}^2} \frac{\partial h_{1i}^2}{\partial h_0^2} + \frac{\partial L}{\partial O_2} \cdot \frac{\partial O_2}{\partial h_{2i}^2} \frac{\partial h_{2i}^2}{\partial h_0^2} \right]$$

- $\frac{\partial L}{\partial O_1} = 2(O_1 - \hat{O}_1) = 2(0.601 - 0) = 1.202$

$$\frac{\partial L}{\partial O_2} = -0.664$$

$$\frac{\partial O_1}{\partial h_{1i}^2} = \frac{e^{-h_{1i}^2}}{(1+e^{h_{1i}^2})^2} = 0.664 \times (0.601)^2 = 0.24$$

$$\frac{\partial O_2}{\partial h_{2i}^2} = 0.222$$

$$\frac{\partial h_{1i}^2}{\partial h_0^2} = w_6 = 0.1$$

$$\frac{\partial h_{2i}^2}{\partial h_0^2} = w_8 = 0.3$$

$$\frac{\partial h_0^2}{\partial h_{2i}^1} = h_0^2(1-h_0^2)$$

$$= 0.178.$$

$$\frac{\partial h_{2i}^1}{\partial w_3} = x_1 = 1$$

$$= 1 \times 0.178 \times (1.202 \times 0.24 \times 0.1 + (-0.664) \times 0.2$$

$$= 0.178\,(0.029 - 0.044).$$

$$= 0 - 0.00267$$