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* Consider the following set of input vectors

$$x_1 = \begin{bmatrix} 1 \\ -2 \\ 0 \\ -1 \end{bmatrix} \quad x_2 = \begin{bmatrix} 0 \\ 1.5 \\ -0.5 \\ -1 \end{bmatrix} \quad x_3 = \begin{bmatrix} -1 \\ 1 \\ 0.5 \\ -1 \end{bmatrix}$$

$d_1 = -1$ $d_2 = -1$, $d_3 = 1$ are the desired responses for x_1, x_2, x_3 respectively.

Initial weight vector $W_1 = \begin{bmatrix} 1 \\ -1 \\ 0 \\ 0.5 \end{bmatrix}$

randomly chosen learning constant $c = 0.1$

$\lambda = 1$ for fnet.

Use delta learning rule to calculate final weights. Use bipolar continuous activation function.

Solution:-

$$net_i = w_i^t x_i$$

$$O_i = f(net_i) = \frac{2}{1 + \exp^{-\lambda net}} - 1$$

$$f'(net_i) = \frac{1}{2}(1 - O_i^2)$$

step 1:

first training pair, x_1, d_1

$$x_1 = \begin{bmatrix} 1 \\ -2 \\ 0 \\ -1 \end{bmatrix} \quad d_1 = -1$$

$$net_1 = w_1^t \cdot x_1$$

$$= \begin{bmatrix} 1 & -1 & 0 & 0.5 \end{bmatrix} \begin{bmatrix} 1 \\ -2 \\ 0 \\ -1 \\ \cancel{0.5} \end{bmatrix} = 2.5$$

$$o^1 = f(net^1) = \frac{2}{1 + exp^{-1 \times 2.5}} - 1 = 0.848$$

$$f'(net^1) = \frac{1}{2}\left[1 - (o^1)^2\right] =$$

$$= \frac{1}{2}\left[1 - 0.848^2\right]$$

$$= 0.140$$

$$w^2 = c \cdot (d_1 - o^1) f'(net^1) x_1 + w^1$$

$$= (0.1) \times (-1 - 0.848) \times 0.140 \times \begin{bmatrix} 1 \\ -2 \\ 0 \\ -1 \end{bmatrix} + \begin{bmatrix} 1 \\ -1 \\ 0 \\ 0.5 \end{bmatrix}$$

$$= \begin{bmatrix} 0.974 \\ -0.948 \\ 0 \\ 0.526 \end{bmatrix}$$

Step 2:

Input is vector x_2, weight vector is w^2.

$$\cancel{x_2} - net^2 = w^{2t} x_2$$

$$= \begin{bmatrix} 0.974 & -0.948 & 0 & 0.526 \end{bmatrix} \begin{bmatrix} 0 \\ 1.5 \\ -0.5 \\ -1 \end{bmatrix}$$

$$= -1.948$$

$$o^2 = f(net^2) = \frac{2}{1+\exp^{-\lambda net^2}} - 1 = -0.75$$

$$f'(net^2) = \frac{1}{2}[1-(o^2)^2]$$

$$= \frac{1}{2}[1-(-0.75)^2]$$

$$= 0.218$$

$$w^3 = c\cdot(d_2 - o^2)\cdot f'(net^2) x_2 + w^2$$

$$(0.1)\times(-1+0.75)\times 0.218 \times \begin{bmatrix} 0 \\ 1.5 \\ -0.5 \\ -1 \end{bmatrix} + \begin{bmatrix} 0.974 \\ -0.948 \\ 0 \\ 0.526 \end{bmatrix}$$

$$= \begin{bmatrix} 0.974 \\ -0.956 \\ 0.002 \\ 0.531 \end{bmatrix}$$

Step 3 :

Input is x_3, weight vector is w^3

$$net^3 = w^{3t} \cdot x_3$$

$$= [0.974, -0.956, 0.002, 0.531] \begin{bmatrix} -1 \\ 1 \\ 0.5 \\ -1 \end{bmatrix}$$

$$= -2.46$$

$$o^3 = f(net^3) = \frac{2}{1+\exp^{-\lambda net^3}} - 1 = -0.842$$

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$$f'(net3) = \frac{1}{2}\left[1 - (o^3)^2\right]$$

$$= \frac{1}{2}\left[1 - (-0.842)^2\right]$$

$$= 0.145$$

$$\cancel{f'(net^3)} =$$

$$w^4 = c\,(d_3 - o^3) \cdot f'(net^3) \cdot x_3 + w^3$$

$$= (0.1) \times (1 - (-0.842)) \times 0.145 \times \begin{bmatrix} -1 \\ 1 \\ 0.5 \\ -1 \end{bmatrix} + \begin{bmatrix} 0.974 \\ -0.956 \\ 0.002 \\ 0.531 \end{bmatrix}$$

$$= \begin{bmatrix} 0.947 \\ -0.929 \\ 0.016 \\ 0.505 \end{bmatrix}$$