AI tutorial - 20 Nov. 2020

[Sagar Sikchi]
Roll NO. 65

## Perceptron Learning Rule

This rule can be stated as :-

$$\boxed{w^{k+1} = w^k + \Delta w}$$

where,

$\Delta w = c * r * x^k$

$c$ = learning rate

$r$ = learning signal

= $(d_k - O_k)$

$d_k$ = desired output

$O_k$ = actual output

$x^k$ = input vector at $k^{th}$ turn.

Hence,

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$$\boxed{w^{k+1} = w^k + c * (d_k - O_k) * x^k}$$

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(*) Outcome of training is updated weight vector.

(Sagar Sikchi)

Q. Single Perceptron Problem :-

Given :-

$x_0 = [1, -2, 1.5, 0] \longrightarrow d_0 = 1$

$x_1 = [1, -0.5, -2, -1.5] \longrightarrow d_1 = -1$

$x_2 = [0, 1, -1, 1.5] \longrightarrow d_2 = 1$

$w_0 = [1, -1, 0, 0.5]$

$$O = f(net) = \begin{cases} +1 & \text{if } net > 0 \\ -1 & \text{if } net < 0 \end{cases}$$

$$net = \sum_{i=1}^{n} w_i x_i$$

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$\Rightarrow$ Let, $x_0$ & $w_0$

$net_0 = 1 + 2 + 0 + 0 = 3 > 0$

$O_0 = 1$ & $d_0 = 1$ , $r_0 = 0$.

$\therefore w^1 = w^0 + c * r_0 * x^0$

$= w^0 = [1, -1, 0, 0.5]$

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$x_1$ & $w_1$

$net_1 = 1 + 0.5 + 0 - 0.75 = 0.75 > 0$

$O_1 = 1$ & $d_1 = -1$ , $r_1 = -2$

$\therefore w^2 = w^1 + c * r_1 * x^1$

$= w^1 - 2x^1$

$= [1, -1, 0, 0.5] - 2[1, -0.5, -2, -1.5]$

$= [-1, 0, 4, 3.5]$

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$x_2$ & $w_2$

$net_2 = 0 + 0 - 4 + (1.5)(3.5) = 1.25 > 0$

$O_2 = 1$ & $d_2 = 1$. $r_2 = 0$.

$\therefore w^3 = w^2 + c * r_2 * x_2 = w^2$

$= [-1, 0, 4, 3.5]$.

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Now Let $w_0 = w_3$ for training cycle no. 2

Hence, $w_0 = [-1, 0, 4, 3.5]$, $x_0 = [1, -2, 1.5, 0]$

1) $net_0 = \sum w_0 \cdot x_0 = -1 + 0 + 6 + 0 = 5 > 0$

$\therefore O_0 = 1$ & $d_0 = 1$ $\therefore r_0 = 0$.

$\therefore w_1 = w_0 + c * r_0 * x_0$

$= w_0 = [-1, 0, 4, 3.5]$

2) $net_1 = \sum w_1 \cdot x_1 = -1 + 0 - 8 - \left(\frac{7}{2}\right)\left(\frac{3}{2}\right)$

$= -9 - \frac{21}{4} = -9 - 5.25$.

$= -14.25 < 0$

$\therefore O_1 = -1$ & $d_1 = -1$ $\therefore r_1 = 0$.

$\therefore w_2 = w_1 + c * r_1 * x_1$

$= w_1 = [-1, 0, 4, 3.5]$.

3) $net_2 = \sum w_2 \cdot x_2 = 0 + 0 - 4 + (3.5)(1.5)$

$= 1.25 > 0$

$\therefore O_2 = +1$ & $d_2 = +1$, $r_2 = 0$.

$\therefore w_3 = w_2 + c * r_2 * x_2$

$= w_2 = [-1, 0, 4, 3.5]$

Hence,
all desired output are same with actual outputs for all inputs $x_0, x_1, x_2$ having weights as $\rightarrow$
$w_0 = w_1 = w_2 = w_3 = [-1, 0, 4, 3.5]$