

ADALINE

adaptive linear Neuron

Log OR operation

x_1	x_2	bias (1)	t
1	1	1	1
1	-1	1.0	1
-1	1	1.0	1
-1	-1	1.0	-1

Epoch 1 : initial weights

$$w_1 = w_2 = b = 0.1$$

(1) $x_1 = 1 \quad x_2 = 1 \quad t = 1 \quad \text{Learning rate} = 0.1$

$$y_{in} = b + \sum_{i=1}^2 x_i w_i$$

$$\Rightarrow b + x_1 w_1 + x_2 w_2$$

$$\Rightarrow 0.1 + 1(0.1) + 1(0.1) = 0.3$$

$$\text{net input} = \underline{\underline{0.3}}$$

$$(t - y_{in}) = 1 - 0.3 \Rightarrow \underline{\underline{0.7}} \quad \alpha = 0.1$$

Weight changes :

$$w_i (\text{new}) = w_i (\text{old}) + \Delta w_i$$

$$\Rightarrow 0.1 + 0.1 (0.7) \times 1 = \underline{\underline{0.17}}$$

$$\Delta w_1 = \alpha (t - y_{in}) x_1 \Rightarrow (0.7)(1) = \underline{\underline{0.7}} \Rightarrow 0.11$$

$$\Delta w_2 = \alpha (t - y_{in}) x_2 \Rightarrow (0.7)(1) = \underline{\underline{0.7}} \Rightarrow 0.11$$

$$\Delta b = \alpha (t - y_{in}) \Rightarrow (0.7) = \underline{\underline{0.7}} \Rightarrow 0.17$$

weight changes & New weight:

$$w_1(\text{new}) = w_1(\text{old}) + \Delta w_1 \Rightarrow 0.1 + 0.07 = \underline{\underline{0.01}}$$

$$w_2(\text{new}) = w_2(\text{old}) + \Delta w_2 \Rightarrow 0.1 + 0.07 = \underline{\underline{0.17}}$$

$$b(\text{new}) = b(\text{old}) + \Delta b \Rightarrow 0.1 + 0.07 * 0.1 = \underline{\underline{0.17}}$$

$$\textcircled{1} \quad \Delta w_1 = \alpha (t - y_{in}) x_1$$

$$\textcircled{2} \quad \Delta w_2 = \alpha (t - y_{in}) x_2$$

$$\textcircled{3} \quad \Delta b = \alpha (t - y_{in})$$

$$\textcircled{1} \Rightarrow 0.1 \times (0.1) \times 1 = \underline{\underline{0.07}}$$

$$\textcircled{2} = 0.1 (0.1) x_1 = \underline{\underline{0.07}}$$

$$\textcircled{3} \quad \underline{\underline{0.07}} = \underline{\underline{0.07}}$$

$$\text{error} \Rightarrow (t - y_{in})^2 = (0.1)^2 = \underline{\underline{0.01}}$$

$$\textcircled{2} \quad \begin{array}{lll} x_1 & x_2 & b \\ = 1 & = -1 & = 1 \end{array} \quad \begin{array}{ll} w_1 = 0.17 \\ w_2 = 0.17 \\ b = 0.17 \end{array}$$

$$\begin{aligned} y_{in} &= b + x_1 w_1 + x_2 w_2 \\ &\Rightarrow 0.17 + 1(0.17) + 1(0.17) \\ &\Rightarrow 0.17 + 0.17 + 0.17 \\ &\Rightarrow 0.17 + 1(0.17) = 0.17 \\ &\Rightarrow \underline{\underline{0.17}} \end{aligned}$$

$$(t - y_{in}) \Rightarrow 1 - 0.17 = \underline{\underline{0.83}} \quad \alpha = \underline{\underline{0.1}}$$

weight changed & New weight

$$w_1(\text{new}) = 0.17 + 0.1 \times (0.83) \quad |$$

$$= 0.17 + 0.083$$

$$\Rightarrow \cancel{0.17} \quad \cancel{0.083} \quad \underline{\underline{0.253}} \Rightarrow \underline{\underline{0.083}}$$

$$w_2(\text{new}) = -1/0.083 \Rightarrow 0.17 + 0.1 \times (0.083) \quad |$$

$$\Rightarrow \cancel{0.17} \quad \cancel{-1/0.083} \quad \underline{\underline{0.1 \times (0.083)}} = \underline{\underline{0.0083}}$$

$$b(\text{new}) \Rightarrow \cancel{0.17} \quad \cancel{-1/0.083} \quad b(\text{new}) \Rightarrow 0.253 \quad \underline{\underline{0.253}}$$

$$\Delta w_1 = 0.0083$$

$$\Delta w_2 = -0.0083$$

$$\Delta b = \underline{0.083}$$

$$w_1 = 0.253$$

$$w_2 = -0.087$$

$$w_1 = 0.253$$

$$w_2 = 0.087$$

$$b = 0.253 //$$

$$\text{Error} = (t - y_{in})^2 = (0.83)^2 = 0.69$$

③

$$x_1 = -1$$

$$x_2 = 1$$

$$t = 1$$

$$\alpha = 0.1$$

$$b // f //$$

$$w_1 = 0.253$$

$$w_2 = 0.087$$

$$b = 0.253$$

$$y_{in} = b + x_1 w_1 + x_2 w_2$$

$$0.253 + -1(0.253) + 0.087 //$$

$$= \underline{\underline{0.087}}$$

$$(t - y_{in}) = 1 - 0.087$$

$$= 0.913$$

weight changes & updated weight :-

$$w_1(\text{new}) = w_1(\text{old}) + \Delta w_1$$

$$\Delta w_1 = \alpha (t - y_{in}) x_1$$

$$= 0.1 \times (0.913) \times -1$$

$$= -0.0913$$

$$= 0.253 - 0.0913$$

$$= 0.1617 //$$

$$w_1(\text{now}) = w_1(\text{old}) + \Delta w_1$$

$$\Delta w_1 = \alpha(t - \gamma_{in})x_2$$

$$= 0.1 \times (0.0913) \times 1$$

$$\Rightarrow \underline{\underline{0.0913}}$$

$$\rightarrow 0.087 + 0.0913$$

$$\Rightarrow \underline{\underline{0.1783}}$$

$$④ b(\text{new}) = b(\text{old}) + \Delta b$$

$$\Delta b = \alpha(t - \gamma_{in})$$

$$= 0.1 \times (0.0913)$$

$$\Rightarrow \underline{\underline{0.0913}}$$

$$\rightarrow 0.253 + 0.0913$$

$$\Rightarrow \underline{\underline{0.3443}}$$

$$\text{Error} = (t - \gamma_{in})^2 = (0.0913)^2 \Rightarrow \underline{\underline{0.083}}$$

$$④ x_1 = -1 \quad w_1 = 0.1617$$

$$x_2 = -1 \quad w_2 = 0.1783$$

$$\zeta = -1 \quad b = -0.3443$$

$$\alpha = 0.1$$

$$b \cancel{\neq} 1 \quad \gamma_{in} \Rightarrow \underline{\underline{0.0043}}$$

$$(t - \gamma_{in}) = -0.043 \Rightarrow \underline{\underline{-1.0043}}$$

$$\Delta w_1 = w_1(\text{old}) + \Delta w_1$$

$$\Rightarrow \underline{\underline{0.004}}$$

$$w_1 = 0.2621$$

$$w_2 = 0.27787$$

$$b = \underline{\underline{0.2439}}$$

$$\Delta w_2 = w_2(\text{old}) - \Delta w_2$$

$$\Rightarrow \underline{\underline{0.1004}}$$

$$\text{Error} = (t - \gamma_{in})^2 = (-0.0043)^2 = \underline{\underline{0.0016}}$$

$$\Delta w_1 = 0.1004$$

$$\Delta w_2 = 0.1004$$

$$(t - y_{lm}) \approx -1.004$$

$$\Delta b = -0.1004$$

$$w_1 = 0.2621$$

$$w_2 = 0.2787$$

$$b = 0.2439$$

$$B = 1.00$$

End of epoch 1

Epoch 2

x1	x2	t	
1	1	1	1
1	-1	1	1
-1	1	1	1
-1	-1	1	-1

$$y_{lm} = b + w_1x_1 + w_2x_2$$

$$\Rightarrow 0.2439 + 1(0.2621) + 1(0.2787)$$

$$= 0.7847$$

$$(t - y_{lm}) \Rightarrow 0.1 - 0.7847$$

$$= 0.2153$$

$$\Delta w_1 = \alpha(t - y_{lm})x_1$$

$$= 0.1(0.2153)$$

$$= 0.02153$$

$$\Delta w_2 = \alpha(t - y_{lm})x_2$$

$$= 0.1(0.2153)$$

$$= 0.02153$$

$$\Delta b = \alpha(t - y_{lm})$$

$$= 0.1(0.2153)$$

$$= 0.02153$$

$$w_1(m_{\text{old}}) = w_1(\text{old}) + \Delta w_1$$

$$\Rightarrow \underline{\underline{0.261004 + 0.0215}} + 0.02(5)$$

$$\Rightarrow \underline{\underline{0.2837}} \quad \underline{\underline{0.2621}}$$

$$w_2(m_{\text{old}}) = w(\text{old}) + \Delta w_2$$

$$\Rightarrow \underline{\underline{27.87}} + 0.0215$$

$$\Rightarrow \underline{\underline{0.3003}}$$

$$b(m_{\text{old}}) = b(\text{old}) + \underline{\underline{0.05}}$$

$$\Rightarrow \underline{\underline{0.2439}} + 0.0215$$

$$\Rightarrow \underline{\underline{0.2654}}$$

$$\text{Error} \Rightarrow (\underline{\underline{t - y_{\text{im}}}})^2 \Rightarrow \underline{\underline{0.046}}$$

(2)

$$y_{\text{im}} = b + w_1 x_1 + w_2 x_2$$

$$\Rightarrow \underline{\underline{0.2654}} + 1(\underline{\underline{0.283}}) + -1(\underline{\underline{0.3003}})$$

$$\Rightarrow \underline{\underline{0.2488}}$$

$$(\underline{\underline{t - y_{\text{im}}}}) \Rightarrow \underline{\underline{-0.0043}}$$

$$\Delta w_1 \Rightarrow \lambda(t - y_{\text{im}}) x_1 \quad \Delta b = \underline{\underline{-0.1004}}$$

$$= 0.1(-0.0043) +$$

$$\underline{\underline{0.7512}} \Rightarrow \underline{\underline{0.7512}} \quad \text{Error} \Rightarrow \underline{\underline{0.564}}$$

$$\Delta w_2 = \lambda(t - y_{\text{im}}) x_2$$

$$= 0.1(-0.0043)(-1)$$

$$\Rightarrow \underline{\underline{-0.0751}}$$

$$w(m_{\text{new}}) \Rightarrow \underline{\underline{0.7512}} + \underline{\underline{0.2837}}$$

$$\Rightarrow \underline{\underline{0.2621}} \quad \underline{\underline{0.3588}}$$

$$w_2(m_{\text{new}}) = \underline{\underline{0.2251}}$$

$$b(m_{\text{new}}) = \underline{\underline{0.34051}}$$

③

$$x_1 = -1$$

$$x_2 = 1$$

$$\epsilon = 1$$

$$w_1 = 0.3405$$

$$\omega_2 = 0.2251$$

$$b = 0.3405$$

$$y_{im} \Rightarrow b + w_1 x_1 + w_2 x_2$$

$$= 0.3405 + -1(0.3405) + 1(0.2251)$$

$$\Rightarrow \underline{\underline{0.2069}}$$

$$(t - y_{im}) = -0.2069$$

$$= \underline{\underline{-0.793}}$$

$$b(\text{meas}) = b(\text{old}) + \Delta b$$

$$= 0.3405 + 0.793$$

$$\Rightarrow \underline{\underline{1.1335}}$$

$$\Delta w_1 \Rightarrow (t - y_{im})(x_1)$$

$$= \underline{\underline{-0.793}}$$

$$\beta_{HOS} =$$

$$(t - y_{im})^2$$

$$\Delta w_2 \Rightarrow (t - y_{im})(x_2)$$

$$= \underline{\underline{0.793}}$$

$$= (0.793)^2$$

$$\Rightarrow \underline{\underline{0.699}}$$

$$\Delta b = \frac{(t - y_{im})}{1}$$

$$w_1(\text{new}) = w_1(\text{old}) + \Delta w_1(\text{new})$$

$$0.3405 + 0.793$$

$$\Rightarrow \underline{\underline{0.2795}}$$

$$w_2(\text{new}) = w_2(\text{old}) + \Delta w_2$$

$$\Rightarrow \underline{\underline{-0.2251}} +$$

$$0.2251 + 0.793$$

$$= \underline{\underline{0.3044}}$$

④

$$\begin{aligned}x_1 &= -1 \\x_2 &= -1 \\t &= -1 \\a &= 0.1\end{aligned}$$

$$\begin{aligned}w_1 &= 0.2795 \\w_2 &= 0.3044 \\b &= 0.4198\end{aligned}$$

Date _____

$$\begin{aligned}y_{in} &= b + w_1x_1 + w_2x_2 \\&\Rightarrow 0.4198 + -1(0.2795) + -1(0.3044) \\&\Rightarrow \underline{\underline{-0.0164}}\end{aligned}$$

$$(t - y_{in}) \Rightarrow -0.8359 \quad E = (t - y_{in})$$

$$\begin{aligned}\Delta w_1 &= \alpha(t - y_{in})x_1 \\&= 0.1 \times (-0.8359) \times -1 \\&= \underline{\underline{0.0836}}\end{aligned} \Rightarrow \underline{\underline{0.699}}$$

$$\begin{aligned}\Delta w_2 &= \alpha(t - y_{in})x_2 \\&= 0.1(-0.0836) - 1 \\&= \underline{\underline{0.3136}}\end{aligned}$$

$$\begin{aligned}\Delta b &= \alpha(t - y_{in}) \\&= 0.1(-0.8359), 0.1 \times (-0.0836) \\&= \underline{\underline{-0.0836}}\end{aligned}$$

$$\begin{aligned}w_{1\text{ new}} &= w_1(\text{old}) + \Delta w_1 \\&\Rightarrow 0.2795 + 0.0836 \\&= \underline{\underline{0.3631}}\end{aligned}$$

$$\begin{aligned}w_{2\text{ new}} &\Rightarrow w_2(\text{old}) + \Delta w_2 \\&= 0.3044 + 0.3136 \\&= \underline{\underline{0.6180}}\end{aligned}$$

$$\begin{aligned}b &= b(\text{old}) + \Delta b \\&= 0.4198 + -0.0836 \\&= \underline{\underline{0.3362}}\end{aligned}$$