ADAPTIVE LINEAR NEURON (ADALINE)

Algorithm:

Step 1: Weights & bias are set to some random values but not zero. Set learning rate parameter α.

Step 2: Calculate net input to output unit

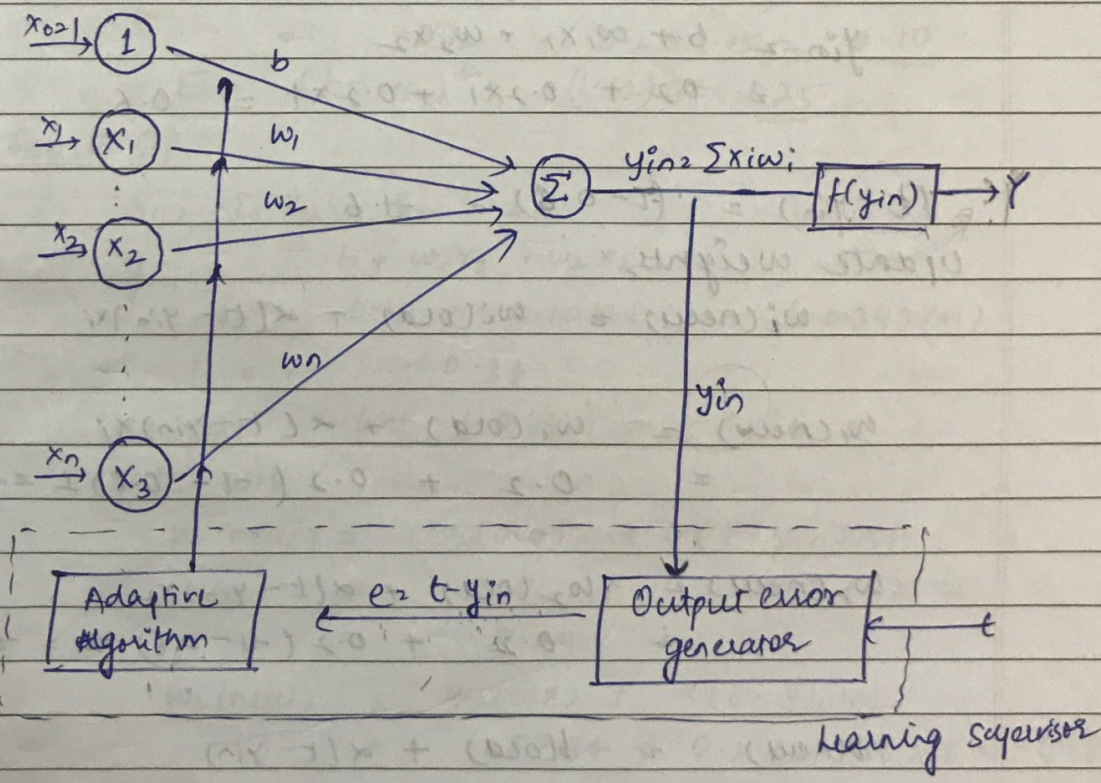
$$y_{in} = b + \sum_{i=1}^{n} x_i w_i$$

Step 3: → Until least mean square is obtained $(t - y_{in})$, Update the weights & bias for $i = 1$ to n:

$$w_i(new) = w_i(old) + \alpha(t - y_{in})x_i \quad \text{Delta Rule}$$

$$b(new) = b(old) + \alpha(t - y_{in})$$

ADALINE MODEL:



Ques. Use Adaline network to train ANDNOT function with bipolar inputs & targets. Perform 2 epochs of training.

Sol.

x_1	x_2	t
1	1	-1
1	-1	1
-1	1	-1
-1	-1	-1

The initial weights are taken to be $w_1 = w_2 = b = 0.2$, & learning rate also 0.2.
The weights are calculated until least mean square error is obtained.

For first input,

$x_1 = 1, x_2 = 1, t = -1$

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

$= 0.2 + 0.2 \times 1 + 0.2 \times 1 = 0.6$

$(t - y_{in}) = (-1 - 0.6) = -1.6 \neq 0$

Update weights,

$w_i(new) = w_i(old) + \alpha(t - y_{in}) x_i$

$w_1(new) = w_1(old) + \alpha(t - y_{in}) x_1$

$= 0.2 + 0.2(-1 - 0.6) 1 = -0.12$

$w_2(new) = w_2(old) + \alpha(t - y_{in}) x_2$

$= 0.2 + 0.2(-1 - 0.6) \times 1 = -0.12$

$b(new) = b(old) + \alpha(t - y_{in})$

$= 0.2 + 0.2 \times (-1.6) = -0.12$

$\Delta w_1 = -0.32, \Delta w_2 = -0.32, \Delta b = -0.32$

compute error,

$E = (t - y_{in})^2 = (-1.6)^2 = 2.56$

For II i/p,

$x_1 = 1, x_2 = -1, t = 1$

$y_{in} = b + \sum_{i=1}^{4} x_i w_i = b + w_1 x_1 + w_2 x_2$

$= -0.12 + (-0.12)1 + (-0.12)(-1)$

$= -0.12$

$(t - y_{in}) = (1 + 0.12) = 1.12$

update weights,

$w_1(new) = w_1(old) + \alpha(t - y_{in}) x_1$

$= -0.12 + 0.2 \times 1.12 \times 1$

$= 0.10$

$\Delta w_1 = 0.22$

$\Delta w_2 = -0.22$

$\Delta b = 0.22$

$w_2(new) = w_2(old) + \alpha(t - y_{in}) x_2$

$= -0.12 + 0.2 \times 1.12 \times (-1)$

$= -0.34$

$b(new) = b(old) + \alpha(t - y_{in})$

$= -0.12 + 0.2 \times 1.12 = 0.10$

$E = (t - y_{in})^2 = (1.12)^2 = 1.25$

For III i/p

$x_1 = -1, x_2 = 1, t = 1$

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

$= 0.10 + 0.10 \times (-1) + (-0.34)(+1)$

$= -0.34$

$(t - y_{in}) = (-1 - (-0.34)) = -0.66$

update wts,

$w_1(new) = w_1(old) + \alpha(t - y_{in}) x_1$

$= 0.10 + 0.2 \times -0.66 \times -1$

$= 0.24$

$w_2(new) = w_2(old) + \alpha(t - y_{in}) x_2$

$= -0.34 + 0.2 \times -0.66 \times 1 = -0.48$

$b(new) = b(old) + \alpha(t - y_{in})$

$= 0.10 + 0.2 \times -0.66 = -0.03$

$\Delta w_1 = 0.13, \quad \Delta w_2 = -0.13, \quad \Delta b = -0.13$

$E = (t - y_{in})^2 = (-0.66)^2 = 0.43$

For IV ip.

$x_1 = -1, \quad x_2 = -1, \quad t = -1$

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

$= -0.03 + 0.24 \times (-1) + (-0.48)(-1) = 0.21$

$(t - y_{in}) = (-1 - 0.21) = -1.2$

Update weights,

$w_1(new) = w_1(old) + \alpha(t - y_{in}) x_1$

$= 0.24 + 0.2(-1.2)(-1)$

$= 0.24 + 0.24 = 0.48$

$w_2(new) = w_2(old) + \alpha(t - y_{in}) x_2$

$= -0.48 + 0.2(-1.2)(-1)$

$= -0.48 + 0.24 = -0.24$

$b(new) = b(old) + \alpha(t - y_{in})$

$= -0.03 + 0.2 \times -1.2 = -0.27$

$E = (t - y_{in})^2 = 1.47$

Epoch-I completed

For I input,

$x_1 = 1, \quad x_2 = 1, \quad t = -1$

$y_{in} = b + w_1 x_1 + w_2 x_2 = -0.27 + (0.48)(1) + (-0.24)(1)$

$= -0.02$

$(t - y_{in}) = (-1 + 0.02) = -0.98$

update wts,

$w_1(new) = w_1(old) + \alpha(t - y_{in}) x_1$

$= 0.48 + 0.2(-0.98)1 = 0.28$

$w_2(new) = +0.43$

$b(new) = -0.46$

Error $= (t - y_{in})^2 = 0.95$

	x_1	x_2	t	yin	t-yin	Δw_1	Δw_2	Δb	w_1	w_2	b	Error
Epoch-I	1	1	-1	0.6	-1.6	-0.32	-0.32	-0.32	-0.12	0.12	-0.12	2.56
	1	-1	1	-0.12	1.12	0.22	-0.22	0.22	0.10	-0.34	0.10	1.25
	-1	1	-1	-0.34	-0.66	0.13	-0.13	-0.13	0.24	-0.48	-0.03	0.43
	-1	-1	-1	0.21	-1.2	0.24	0.24	0.24	0.48	-0.24	-0.27	1.47
Epoch-II	1	1	-1	-0.02	-0.98	-0.195	-0.195	-0.195	0.28	-0.43	-0.46	0.95
	1	-1	1	0.25	0.76	0.15	-0.15	0.15	0.43	-0.58	-0.31	0.57
	-1	1	-1	-1.33	0.33	-0.065	0.065	0.065	0.37	-0.51	-0.24	0.106
	-1	-1	-1	-0.11	-0.90	0.18	0.18	-0.18	0.55	-0.38	0.43	0.8

Mean Error in Epoch-I,

$$\frac{2.56 + 1.25 + 0.43 + 1.47}{4} = 1.4275$$

Epoch-II = 0.6065

Total mean square Error

Ep-I $2.56 + 1.25 + 0.43 + 1.47 = 5.71$

Ep-II $0.95 + 0.57 + 0.106 + 0.8 = 2.426$