

Assignment

Fractal -3 Assignment

CSL 7020 Machine Learning - 1

Name : Chinnaraaki

Roll NO : M22 A I 542

Problem - 1

Following training samples are given

x_1	x_2	class
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1	1	+1
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-1	-1	-1
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0	0.5	-1
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0.1	0.5	-1
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0.2	0.2	+1
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0.9	0.5	+1
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Assume weight vector of initial decision boundary $W^T x$. $W = [1, 1]$

$$\Rightarrow x_1 + x_2 = 0$$

$$b = 0$$

$$y_{in} = w_i^T x_i + b = w_1 x_1 + w_2 x_2 + b$$

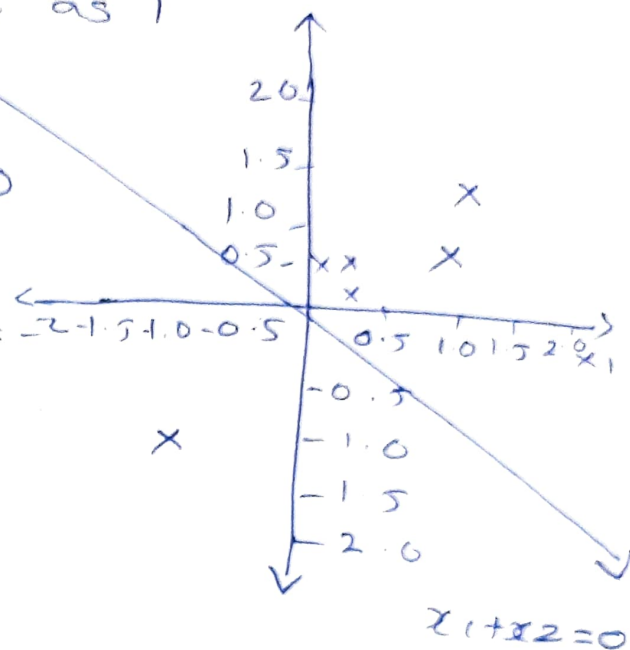
Assume learning rate as 1

$$y = \begin{cases} 1 & \text{if } y_{in} > 0 \\ 0 & \text{if } y_{in} = 0 \\ -1 & \text{if } y_{in} < 0 \end{cases}$$

$$\Delta w_1 = \alpha t x_1$$

$$\Delta w_2 = \alpha t x_2$$

$$\Delta b = \alpha t$$



Initial decision boundary
and samples

I)	x_1	x_2	class(t)	y_{in}	y	Δw_1	Δw_2	Δb	w_1	w_2	b
	1	1	1	2	1	0	0	0	1	1	0
	-1	-1	-1	-2	-1	0	0	0	1	1	0
	0	0.5	-1	0.5	1	0	-0.5	-1	1	0.5	-1
	0.1	0.5	-1	-0.65	-1	0	0	0	1	0.5	-1
	0.2	0.2	1	-0.7	-1	0.2	0.2	1	1.2	0.7	0
	0.9	0.5	1	1.43	1	0	0	0	1.2	0.7	0

11)

x_1	x_2	t	y_{in}	y	Δw_1	Δw_2	Δb	w_1	w_2	b
1	1	1	1.9	+1	0	0	0	1.2	0.7	0
-1	-1	-1	-1.9	-1	0	0	0	1.2	0.7	0
0	0.5	-1	0.35	1	0	-0.5	-1	1.2	0.2	-1
0.1	0.5	-1	-0.78	-1	0	0	0	1.2	0.2	-1
0.2	0.2	1	-0.72	-1	0.2	0.2	1	1.4	0.4	0
0.9	0.5	1	1.46	1	0	0	0	1.4	0.4	0

11)

x_1	x_2	t	y_{in}	y	Δw_1	Δw_2	Δb	w_1	w_2	b
1	1	1	1.8	1	0	0	0	1.4	0.4	0
-1	-1	-1	-1.8	-1	0	0	0	1.4	0.4	0
0	0.5	-1	0.2	1	0	-0.5	-1	1.4	-0.1	-1
0.1	0.5	-1	-0.81	-1	0	0	0	1.4	-0.1	-1
0.2	0.2	1	-0.74	-1	0.2	0.2	1	1.6	0.1	0
0.9	0.5	1	1.99	1	0	0	0	1.6	0.1	0

IV

x_1	x_2	t	y_{in}	y	Δw_1	Δw_2	Δb	w_1	w_2	b
1	1	1	1.7	1	0	0	0	1.6	0.1	0
-1	-1	-1	-1.7	-1	0	0	0	1.6	0.1	0
0	0.5	-1	0.05	1	0	-0.5	-1	1.6	-0.4	-1
0.1	0.5	-1	-1.04	-1	0	0	0	1.6	-0.4	-1
0.2	0.2	1	-0.76	-1	0.2	0.2	1	1.8	-0.2	0
0.9	0.5	1	1.52	1	0	0	0	1.8	-0.2	0

V)	x_1	x_2	t	y_{in}	y	Δw_1	Δw_2	Δb	w_1	w_2	b
	1	1	1	1.6	1	0	0	0	1.8	-0.2	0
	-1	-1	-1	-1.6	-1	0	0	0	1.8	-0.2	0
	0	0.5	-1	-0.1	-1	0	0	0	1.8	-0.2	0
	0.1	0.5	-1	0.08	1	-0.1	-0.5	-1	1.7	-0.7	-1
	0.2	0.2	1	-0.8	-1	0.2	0.2	1	1.9	-0.5	0
	0.9	0.5	1	1.46	1	0	0	0	1.9	-0.5	0

V1)	x_1	x_2	t	y_{in}	y	Δw_1	Δw_2	Δb	w_1	w_2	b
	1	1	1	1.4	1	0	0	0	1.9	-0.5	0
	-1	-1	-1	-1.4	-1	0	0	0	1.9	-0.5	0
	0	0.5	-1	-0.25	-1	0	0	0	1.9	-0.5	0
	0.1	0.5	-1	-0.06	-1	0	0	0	1.9	-0.5	0
	0.2	0.2	1	0.28	1	0	0	0	1.9	-0.5	0
	0.9	0.5	1	1.46	1	0	0	0	1.9	-0.5	0

The perceptron learning algorithm converged in 6 steps.

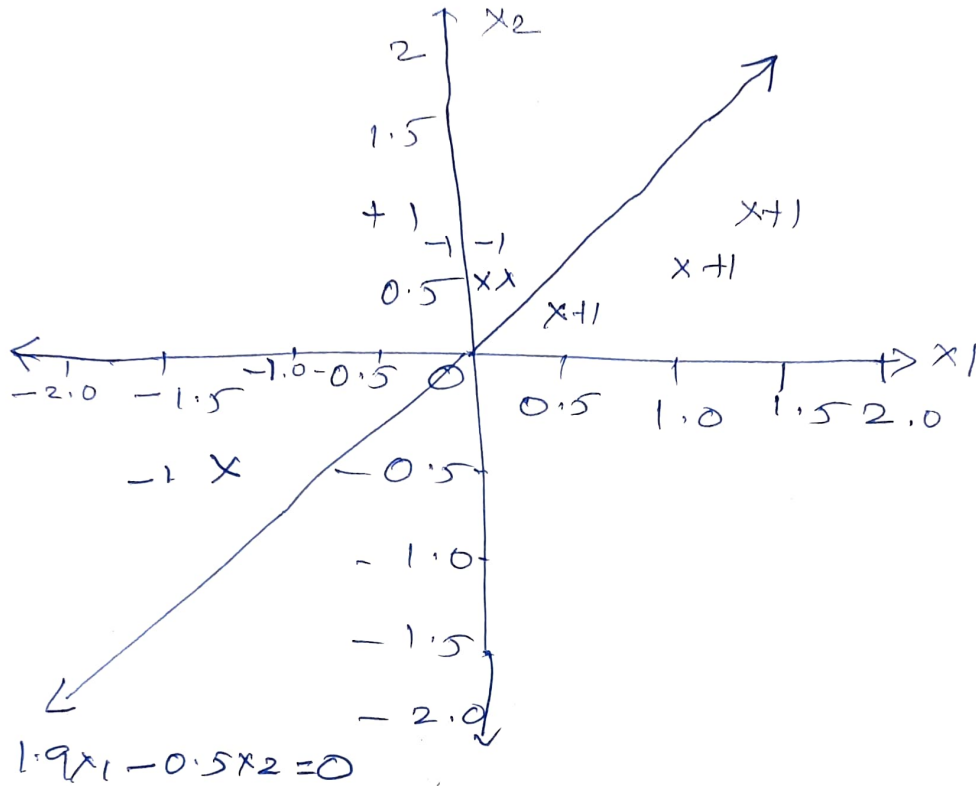
The final weight vector of the decision boundary is $w = [1.9, -0.5]$

$$1.9x_1 + (-0.5)x_2 = 0$$

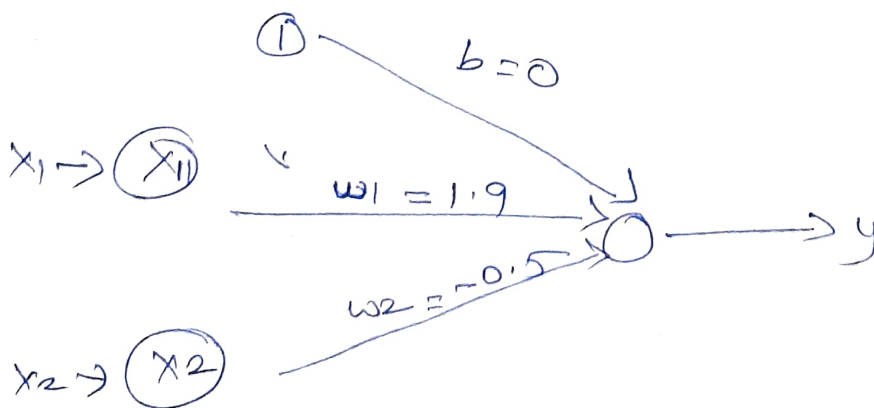
$$\Rightarrow 1.9x_1 - 0.5x_2 = 0$$

Let's plot the final decision boundary.

We can see that $1.9x_1 - 0.5x_2 = 0$ line separates the two classes correctly.



Final decision boundary



Neural network corresponding to the Perceptron.