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Q1) Given data:-

To apply perceptron learning algorithm we need to initiate weight vector & bias term.

Therefore, initial weight vector = $w = [1, 1]$.

Bias term = $b = 0$ $\quad \therefore x_1 + x_2 = 0$

learning rate = = 1.

data	x_1	x_2	class
	1	1	+1
	-1	-1	-1
	0	0.5	-1
	0.1	0.5	-1
	0.2	0.2	+1
	0.9	0.5	+1

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

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

& $\Delta w_1 = \alpha t x_1$, $\Delta b = \alpha t$.

$\Delta w_2 = \alpha t x_2$

Now apply the perceptron algorithm to give data & count the no of updat until all sample are classified correctly.

Iteration 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

II] Iteration - II

x_1	x_2	class	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

III] Iteration - III

x_1	x_2	class	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	1.49	+1	0	0	0	1.6	0.1	0

IV] Iteration - IV

x_1	x_2	class	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] Iteration - V

x_1	x_2	class	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

VI] Iteration VI

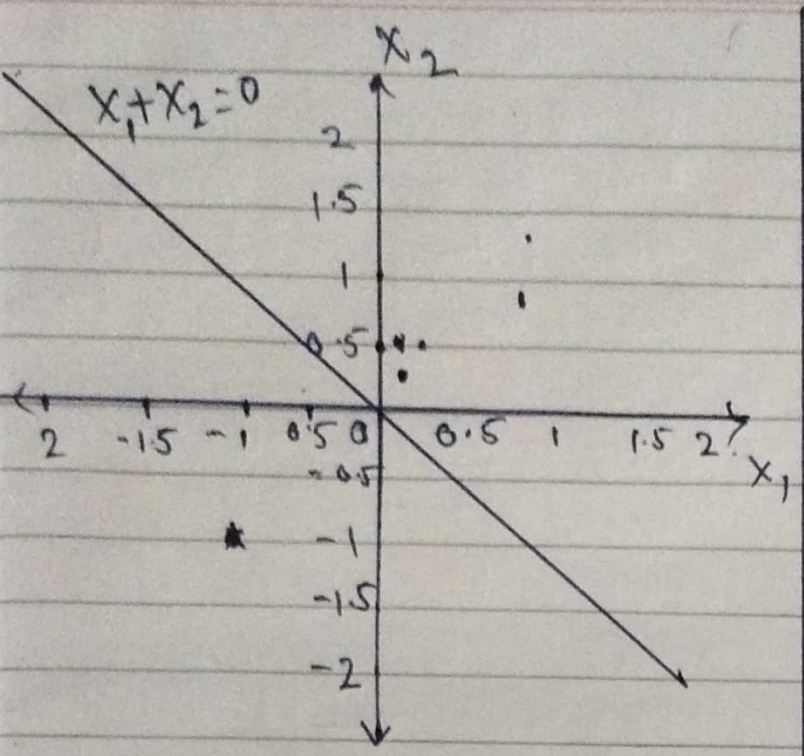
x_1	x_2	class	y_{in}	y	Δw_1	Δw_2	Δb	w_1	w_2	b
1	1	+1	1.4	+1	0	0	0	1.9	-0.5	0
-1	-1	-1	+1.4	-1	0	0	0	1.9	-0.5	0
0	0.5	-1	-0.25	-1	0	0	0	1.9	-0.5	0
0.1	0.5	-1	-0.06	-1	0	0	0	1.9	-0.5	0
0.2	0.2	+1	0.28	+1	0	0	0	1.9	-0.5	0
0.9	0.5	+1	1.46	+1	0	0	0	1.9	-0.5	0.

Task 1] → The perceptron learning algorithm converged in 6 iteration.

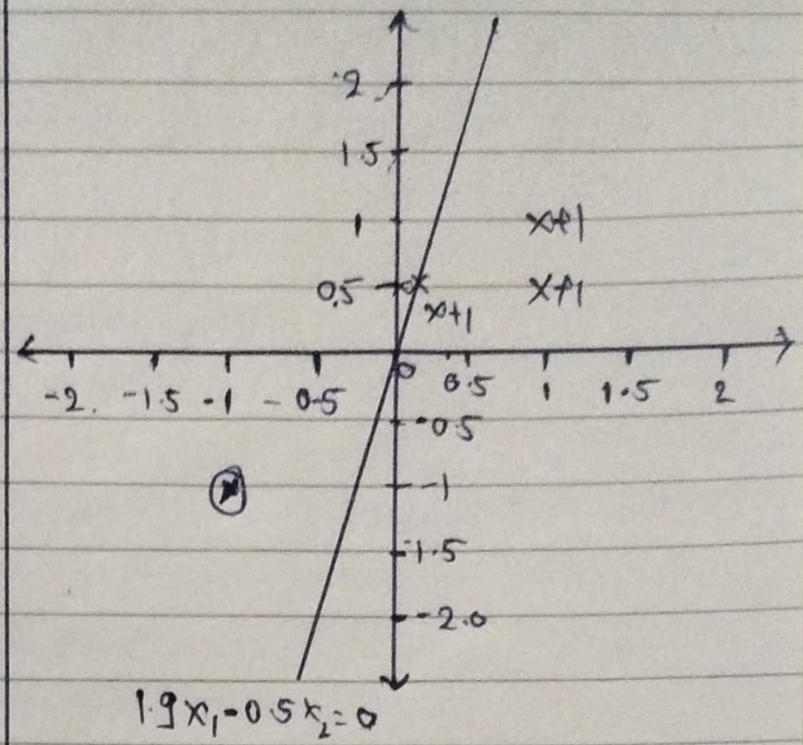
Task 2] → The final weight vector of the decision boundry is $w = [1.9, -0.5]$

$\therefore w_1 x_1 + w_2 x_2 = 0 \Rightarrow 1.9 x_1 - 0.5 x_2 = 0$.

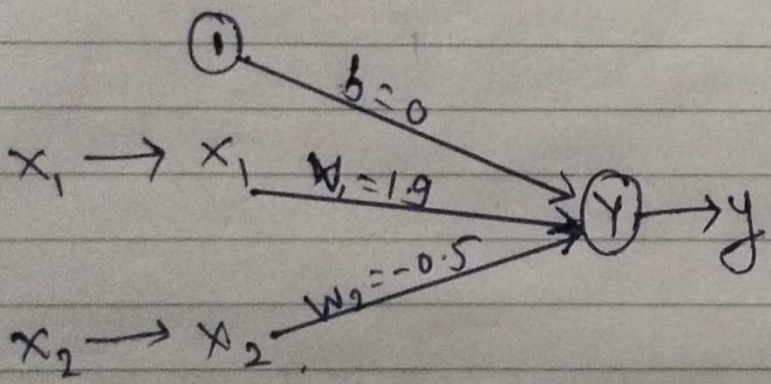
We can see that $1.9x_1 - 0.5x_2 = 0$ line seprate the two classes.



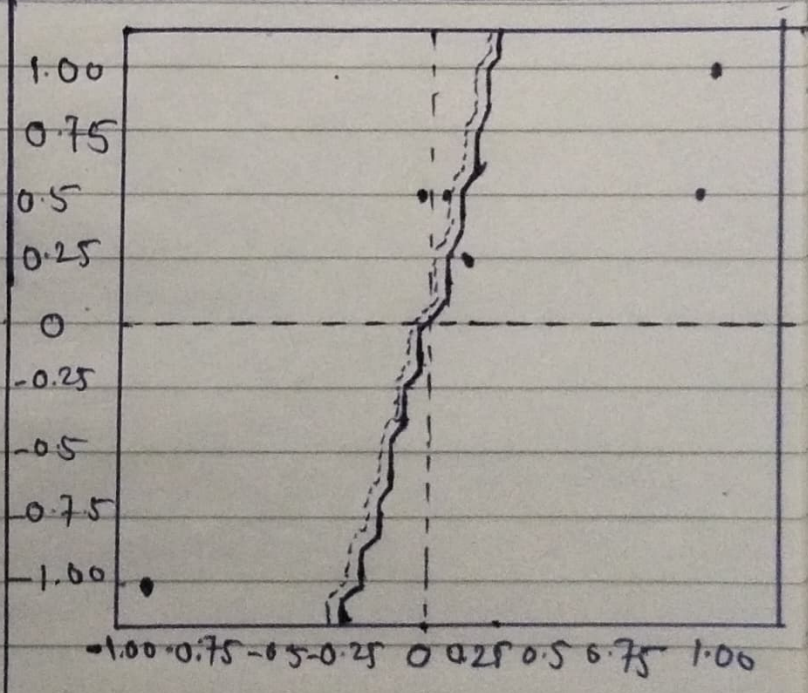
Initial boundry & sample plotting.



Final decision boundry.



∴ Neural network corresponding to perceptron.



code output.