

### (Ruchemald Charledle Gauss)

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	Sym. Subject: Mathematics for AI & ML
E	ca mable
	suppose we are given with following positive labled data points:
	(3,1) (3,-1) (6,1) (6,-1)
	& following negative labelled data points.
ſ	(1,0), (0,1), (0,-1), (-1,0)
	find optimal hyperplane.
$\Rightarrow$	The plot of the points belonging to two classes is shown as -
	Showic as -
1	is the property of the second
	-2 -1 1 2 30 4 15 -6 '.
,	· · · · · · · · · · · · · · · · · · ·
now,	we need to identify the nearest data points on either side of these particular datapoints, so, we select
	side of these particular datapoints, so, we select
	suppost rectors as >



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	(1,0) - from negatively labeled data points
	(3,1) 2 - positively $(3,-1)$
	(3,-1)
	so, support vectors,
	$S_1 = \begin{pmatrix} 1 \\ 0 \end{pmatrix}$ , $S_2 = \begin{pmatrix} 3 \\ 1 \end{pmatrix}$ , $S_3 = \begin{pmatrix} 3 \\ -1 \end{pmatrix}$
	Here each vector is augmented with a 1 as
	bias input,
	So, $S_1 = \begin{pmatrix} 1 \\ 0 \end{pmatrix}$ , then $\tilde{S}_1 = \begin{pmatrix} 1 \\ 0 \end{pmatrix}$
	Company of the state of the sta
	Similarly $S_{2} = \begin{pmatrix} 3 \\ 1 \end{pmatrix}, \text{ then } S_{2} = \begin{pmatrix} 3 \\ 1 \end{pmatrix}$
	$S_2 = \begin{pmatrix} 1 \end{pmatrix}$ , from $S_2 = \begin{pmatrix} 1 \end{pmatrix}$
	1 2 1 2 1
	$S_3 = \begin{pmatrix} 3 \\ -1 \end{pmatrix}$ thus $S_3 \begin{pmatrix} 3 \\ -1 \end{pmatrix}$
	Here we nave taken 3 support vectors, so we
	need to calculate of three parameters
	need to calculate as three parameters and as based on following three linear
	equations:
	Si S
	$\alpha_1 \widetilde{S}_1 \cdot \widetilde{S}_1 + \alpha_2 \widetilde{S}_2 \cdot \widetilde{S}_1 + \alpha_3 \widetilde{S}_3 \cdot \widetilde{S}_1 = -1 $ { neg dans }
	$\alpha_{1}, S_{2} + \alpha_{2}, S_{2} + \alpha_{3}, S_{3} + \alpha_{3}, S_{3} = 1$ $\beta_{2}, S_{3}$ $\beta_{1}, S_{2} + \alpha_{3}, S_{3} + \alpha_{3}, S_{3} = 1$ $\beta_{1}, S_{2}, S_{3}$ $\beta_{2}, S_{3} + \alpha_{3}, S_{3}, S_{3} = 1$ $\beta_{1}, S_{2}, S_{3}$
	x, 5, 53 + xx 52.53 + xx 53.53 = 1 ( por class)
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substitute 5, 52, 53 in above eq.
$\alpha_1\left(\frac{1}{p}\right)\left(\frac{1}{p}\right) + \alpha_2\left(\frac{3}{1}\right)\left(\frac{1}{p}\right) + \alpha_3\left(\frac{3}{1}\right)\left(\frac{1}{p}\right) = -1$
$\alpha_1 \begin{pmatrix} 1 \\ 1 \end{pmatrix} \begin{pmatrix} 3 \\ 1 \end{pmatrix} + \alpha_2 \begin{pmatrix} 3 \\ 1 \end{pmatrix} \begin{pmatrix} 3 \\ 1 \end{pmatrix} + \alpha_3 \begin{pmatrix} 3 \\ -1 \\ 1 \end{pmatrix} = 1$
after einplitication, we get
2×1 + 4×2 + 4×3 = -1
$4x_1 + 11x_2 + 9x_3 = 1$ , $4x_1 + 9x_2 + 11x_3 = 1$
$44_{1} + 94_{2} + 114_{3} = 1$
we get $\alpha_1 = -3.5$
The hyperplane that discriminate the positive class from negative class is given by
dans from negative dans is given by
$\widetilde{\omega} = \Xi \alpha_i S_i$
/2\
$= -3.5 \begin{pmatrix} 1 \\ 0 \end{pmatrix} + 0.75 \begin{pmatrix} 3 \\ 1 \end{pmatrix} + 0.75 \begin{pmatrix} -1 \\ 1 \end{pmatrix}$

Department of Computer Science & Engineering (AI & ML)

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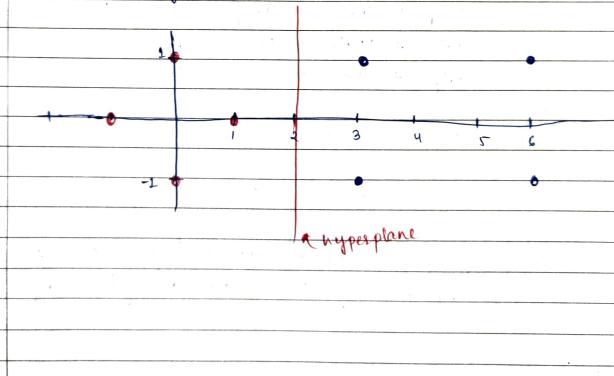
$$\widetilde{\omega} : \begin{pmatrix} 0 \\ -2 \end{pmatrix}$$

rith a bias thence we can equall the last on entry in was the hyperplane offset to.

Therefore the seperating hyperplane equation

with  $w = \begin{pmatrix} 1 \\ 0 \end{pmatrix}$  and  $b = \begin{pmatrix} -2 \end{pmatrix}$ 

w= (b) means x=1, the line is parallel to y axis.





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k.	
.ع	x: find optimal hyperplane for the set of data points:
6	(blue)
	class 1: $\{(1,1),(2,1),(5,-1),(6,0)\}$ (Red)
	53
	$S_{1} = \begin{pmatrix} 2 \\ 1 \end{pmatrix} \qquad S_{2} = \begin{pmatrix} 2 \\ -1 \end{pmatrix} \qquad S_{3} = \begin{pmatrix} 4 \\ 0 \end{pmatrix}$
	we use vector augmented with I as a bias input, se
	$\frac{S_1}{S_1} = \begin{pmatrix} 2 \\ 1 \end{pmatrix} \qquad \frac{S_2}{S_2} = \begin{pmatrix} 2 \\ -1 \\ 1 \end{pmatrix} \qquad \frac{S_3}{S_3} = \begin{pmatrix} 4 \\ 0 \\ 1 \end{pmatrix}$
	we need to find $\alpha_1$ , $\alpha_2$ , $\alpha_3$ based on following egn
	$\begin{array}{cccccccccccccccccccccccccccccccccccc$
	Solving we get $6x_1 + 4d_2 + 9d_3 = -1$ $4d_1 + 6x_2 + 9d_3 = -1$
	9d, + 9d2 + 17d3 = 1
	· · · · · · · · · · · · · · · · · · ·
	$=$ $d_1 = -3.25$ , $d_2 = -3.25$ , $d_3 = 3.5$



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		C
	hyperplane $\tilde{w} = \frac{2}{3} \times \frac{3}{5}$ = -3.25 $\times \frac{2}{1}$ + 3.5 $\times \frac{4}{1}$	C
	(2) (4)	•
,	= -3.25 2 -1 + 3.5 0	(
		(
	2 ( )	(
	2 (1)	- (
So	Humps of once egg	
	Hyperplane eq <sup>n</sup> $y = wx + b$ with $w = (0)$ and offset $b = -3$	
	2 3 4 5 6	
i		
	the human alams	
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