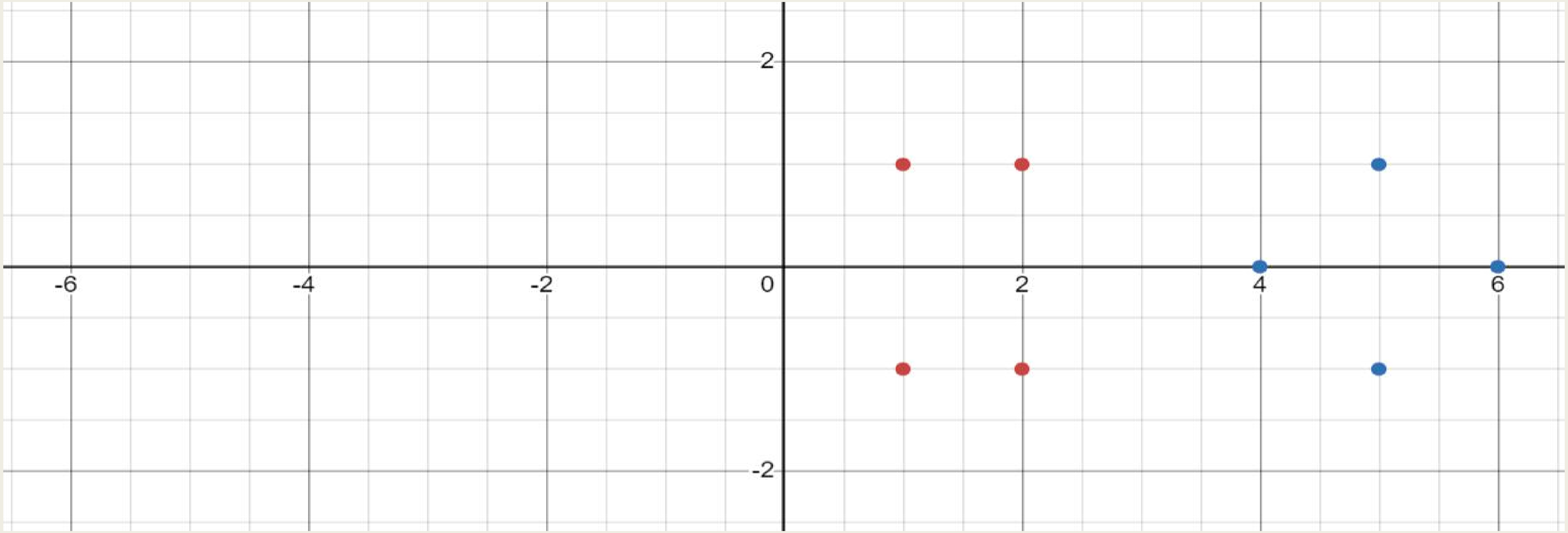
ML
LECTURE-28

BY
Dr. Ramesh Kumar Thakur
Assistant Professor (II)
School Of Computer Engineering

Previous Year Question (SVM)

- 1. Plot a hyper plane for the given data set (1,1) (2,1) (1,-1) (2,-1) (4,0) (5,1) (5,-1) (6,0) by using SVM.

- **Ans: First we plot the data points on a 2-D plane as below:-**



- $S1 = \begin{pmatrix} \mathbf{2} \\ \mathbf{1} \end{pmatrix}$, $S2 = \begin{pmatrix} \mathbf{2} \\ \mathbf{-1} \end{pmatrix}$, $S3 = \begin{pmatrix} \mathbf{4} \\ \mathbf{0} \end{pmatrix}$,

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- **Step2:- Augment each vector with 1 as bias input:**
- $\widetilde{S1} = \begin{pmatrix} 2 \\ 1 \\ 1 \end{pmatrix}, \widetilde{S2} = \begin{pmatrix} 2 \\ -1 \\ 1 \end{pmatrix}, \widetilde{S3} = \begin{pmatrix} 4 \\ 0 \\ 1 \end{pmatrix}$
- **Step3:- Our task is to find values for the α_i such that**

$\alpha 1.\ \widetilde{S1}.\widetilde{S1} + \alpha 2.\ \widetilde{S2}.\widetilde{S1} + \alpha 3.\ \widetilde{S3}.\widetilde{S1} = -1$

$\alpha 1.\ \widetilde{S1}.\widetilde{S2} + \alpha 2.\ \widetilde{S2}.\widetilde{S2} + \alpha 3.\ \widetilde{S3}.\widetilde{S2} = -1$

$\alpha 1.\ \widetilde{S1}.\widetilde{S3} + \alpha 2.\ \widetilde{S2}.\widetilde{S3} + \alpha 3.\ \widetilde{S3}.\widetilde{S3} = 1$

$$\alpha 1.\begin{pmatrix} 2 \\ 1 \\ 1 \end{pmatrix}.\begin{pmatrix} 2 \\ 1 \\ 1 \end{pmatrix} + \alpha 2.\begin{pmatrix} 2 \\ -1 \\ 1 \end{pmatrix}.\begin{pmatrix} 2 \\ 1 \\ 1 \end{pmatrix} + \alpha 3.\begin{pmatrix} 4 \\ 0 \\ 1 \end{pmatrix}.\begin{pmatrix} 2 \\ 1 \\ 1 \end{pmatrix} = -1$$

$$\alpha 1.\begin{pmatrix} 2 \\ 1 \\ 1 \end{pmatrix}.\begin{pmatrix} 2 \\ -1 \\ 1 \end{pmatrix} + \alpha 2.\begin{pmatrix} 2 \\ -1 \\ 1 \end{pmatrix}.\begin{pmatrix} 2 \\ -1 \\ 1 \end{pmatrix} + \alpha 3.\begin{pmatrix} 4 \\ 0 \\ 1 \end{pmatrix}.\begin{pmatrix} 2 \\ -1 \\ 1 \end{pmatrix} = -1$$

$$\alpha 1.\begin{pmatrix} 2 \\ 1 \\ 1 \end{pmatrix}.\begin{pmatrix} 4 \\ 0 \\ 1 \end{pmatrix} + \alpha 2.\begin{pmatrix} 2 \\ -1 \\ 1 \end{pmatrix}.\begin{pmatrix} 4 \\ 0 \\ 1 \end{pmatrix} + \alpha 3.\begin{pmatrix} 4 \\ 0 \\ 1 \end{pmatrix}.\begin{pmatrix} 4 \\ 0 \\ 1 \end{pmatrix} = 1$$

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$\alpha 1(4+1+1) + \alpha 2(4-1+1) + \alpha 3(8+0+1) = -1$

$\alpha 1(4-1+1) + \alpha 2(4+1+1) + \alpha 3(8+0+1) = -1$

$\alpha 1(8+0+1) + \alpha 2(8+0+1) + \alpha 3(16+0+1) = 1$

$6\alpha 1 + 4\alpha 2 + 9\alpha 3 = -1$

$4\alpha 1 + 6\alpha 2 + 9\alpha 3 = -1$

$9\alpha 1 + 9\alpha 2 + 17\alpha 3 = 1$

By solving above eqn we get,

$\alpha 1 = -3.25$

$\alpha 2 = -3.25$

$\alpha 3 = 3.5$

$\widetilde{w} = \alpha 1.\widetilde{S1} + \alpha 2.\widetilde{S2} + \alpha 3.\widetilde{S3}$

$$= -3.25 \begin{pmatrix} 2 \\ 1 \\ 1 \end{pmatrix} + -3.25 \begin{pmatrix} 2 \\ -1 \\ 1 \end{pmatrix} + 3.5 \begin{pmatrix} 4 \\ 0 \\ 1 \end{pmatrix} = \begin{pmatrix} 1 \\ 0 \\ -3 \end{pmatrix}$$

- So the line eqn is
- 1.x + 0.y - 3 = 0 or **x-3 = 0**

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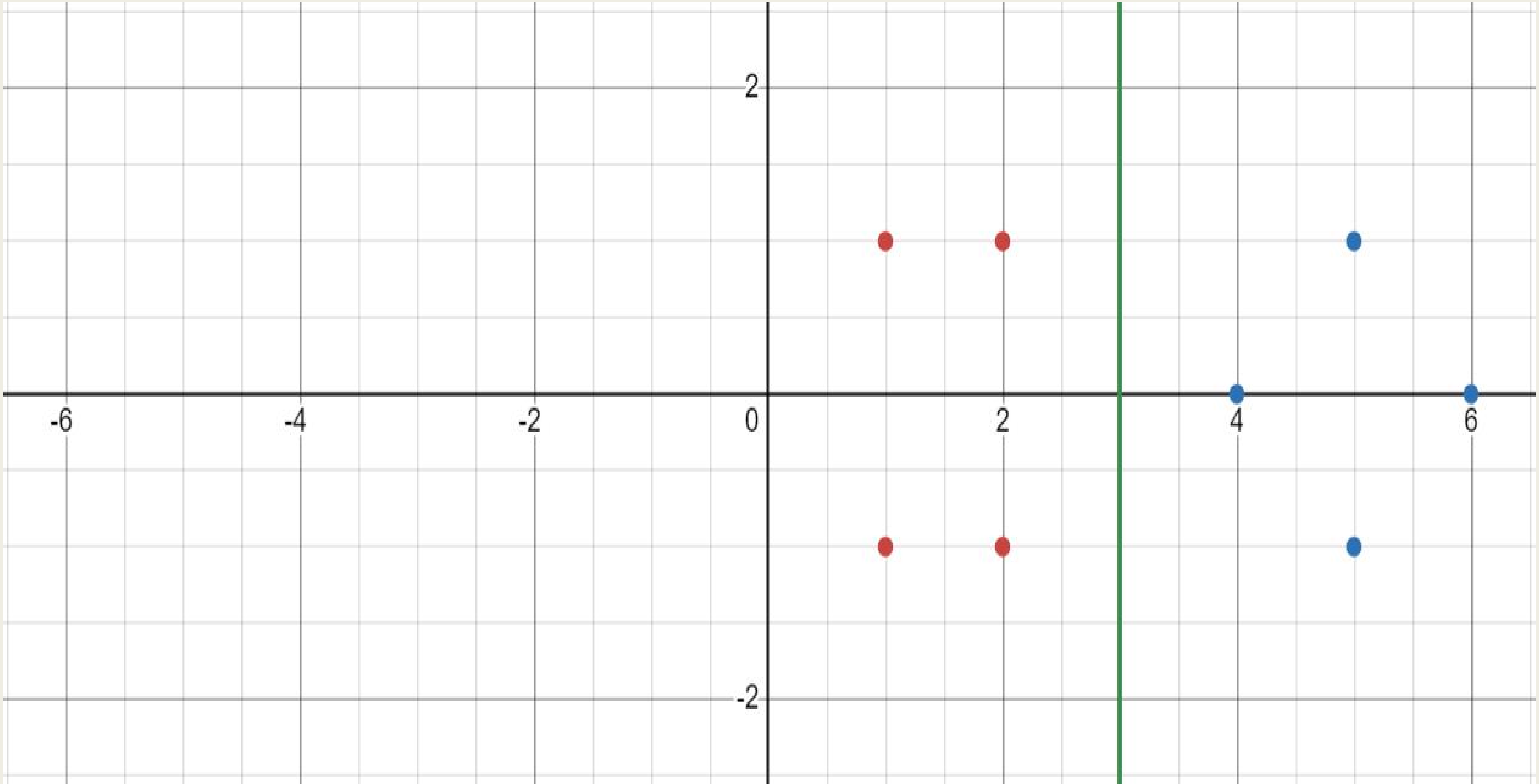
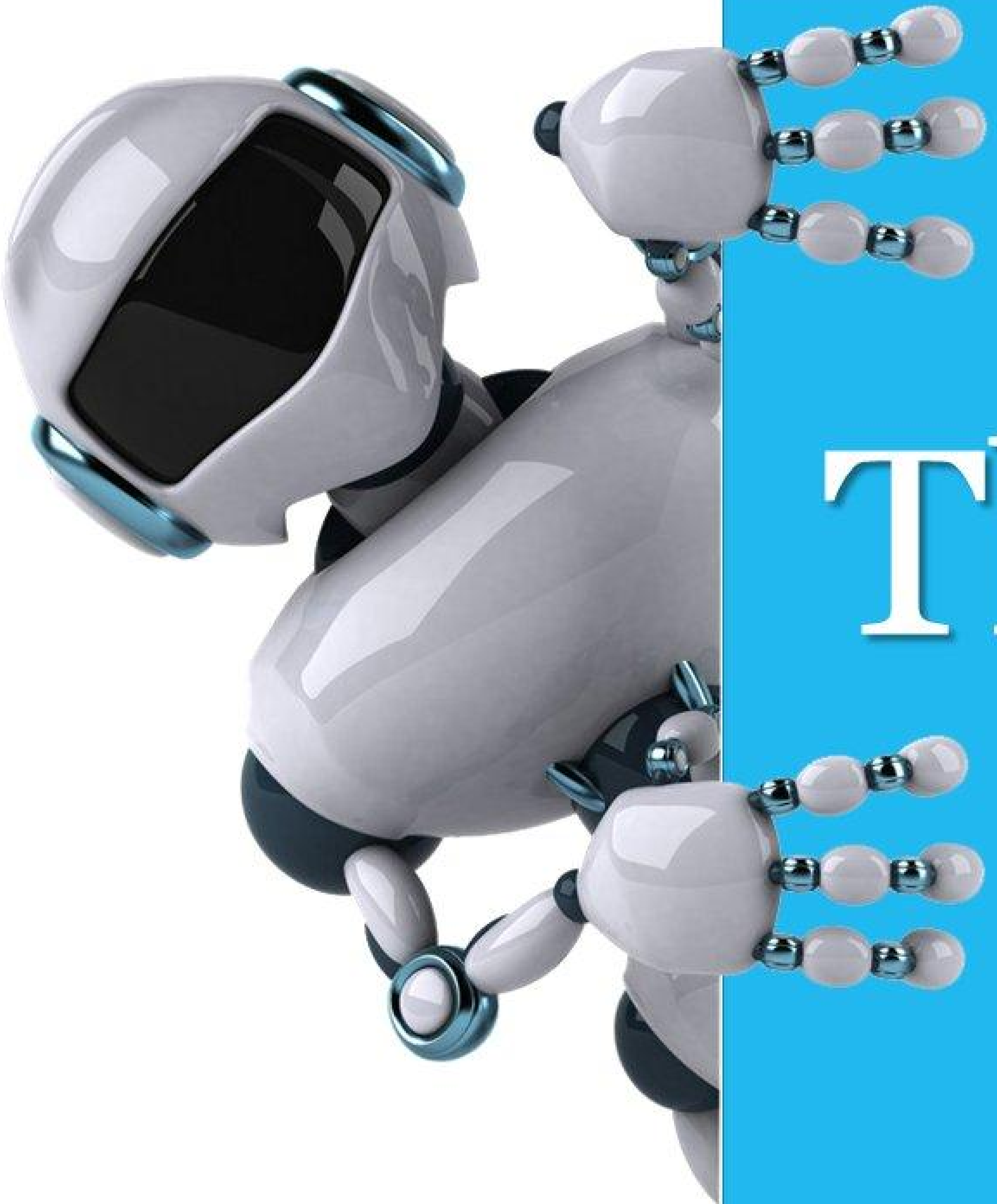
❖ **The optimum hyperplane is shown below:-**





Thank you