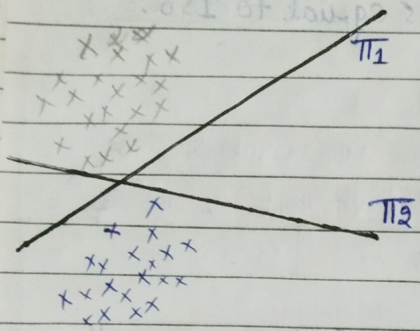
Support Vector Machines Where Kernel ⇒ Linear

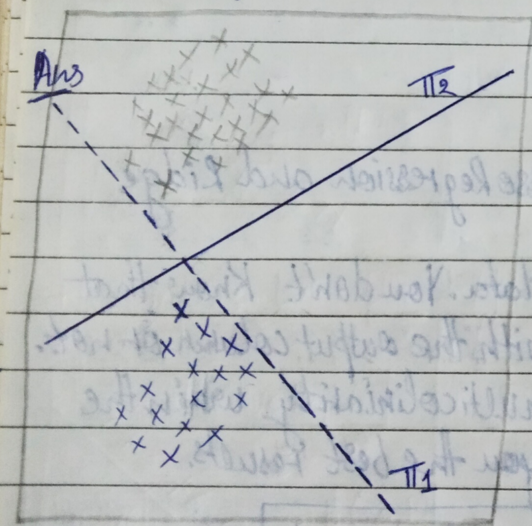


- According to the given Graph, which hyperplane "π_1" or "π_2" is more fitted plane or bestly divided the data?

- The answer to this question is "π_1" because the wideness between the plane and data points should be more. So that the input should be properly classified.

Q How SVM or Support Vector Machines decide, that which plane is best suitable ??

Ans



Graph "A"

- According to the Graph "A" given, we have ~~to find~~, which plane bestly classified the points.

- Step 1 ⇒ Select an plane.

- Step 2 ⇒ Calculate the margin maximising hyperplane.

1. SVMs are robust with outliers.
2. SVMs also works on Non-Linear data, with the help of $\boxed{\text{Kernels}}$.

$\boxed{\text{Kernals}}$ ⇒ This will helps to solve the problem when the data is non-Linear in nature.

3. SVMs are applied in both Regressions as well as Classification Problems.!

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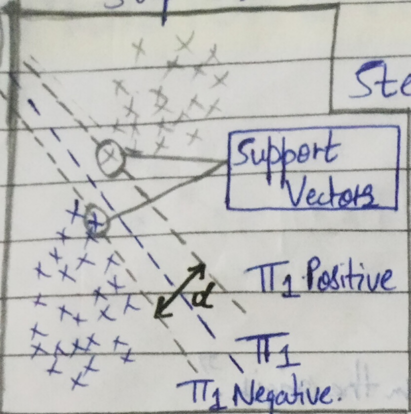
Step-1:- let's say I have selected π_1 plane.



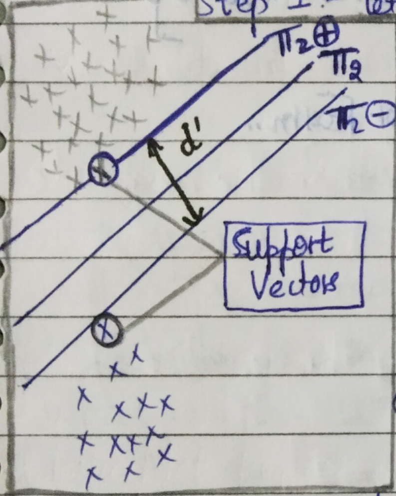
Step2:- Calculate the margins, just by moving the plane in upward direction till you got your Support Vectors [data points].

Graph "A"

Step3:- Now Calculate the Margin. which is the shortest distance between the $\pi_1 \oplus$ and $\pi_1 \ominus$. and it is denoted with 'd'.

$d \Rightarrow (1)$

Step-1:- let's say now I have selected π_2 plane.



Step2:- We have calculated or designed our planes, "π_2 Positive" and "π_2 Negative" just by identifying the support vectors.

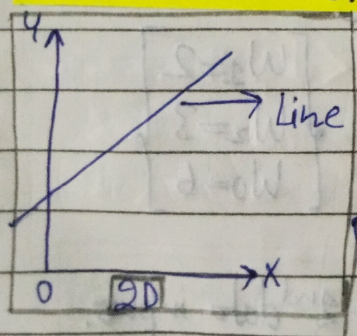
Step3:- Calculated the shortest distance between the $\pi_2 \oplus$ and $\pi_2 \ominus$. which is termed as margin.

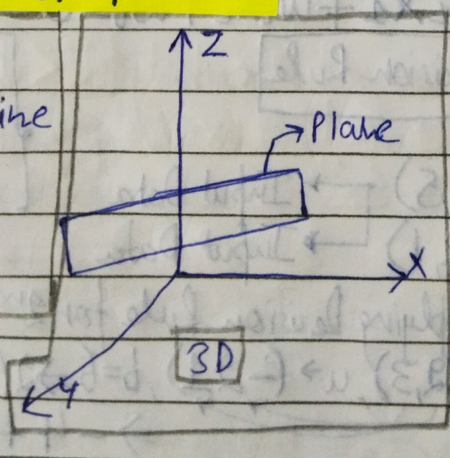
Graph 'A'. d'.

$d' \Rightarrow (2)$

$\therefore$ From (1) and (2), we can observe that $\boxed{d' > d}$. Thus it means "π_2" Plane is more efficient for classification. This is how the SVM selects a plane. Our goal is to Maximise the distance in the Margins.

Equation of a Hyperplane...





- But in 4D, 5D, 6D...n'D, they are termed as HyperPlane..
- Note:- In Higher Dimensions these hyperplanes are symbolised with "π" pi sign.

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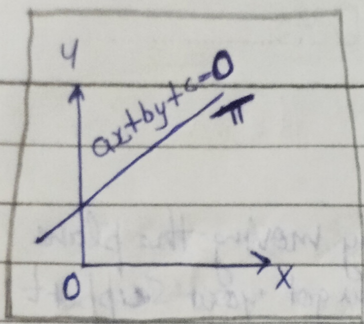


① General Equation

$$\boxed{ax+by+c=0}$$

$$\downarrow$$

$$ax_1+bx_2+c=0$$

$$\downarrow$$

Standard Equation. $\boxed{Wx_1+Wx_2+W_0=0}$

For 'n' dimensions $\Rightarrow \boxed{W\cdot X=0}$

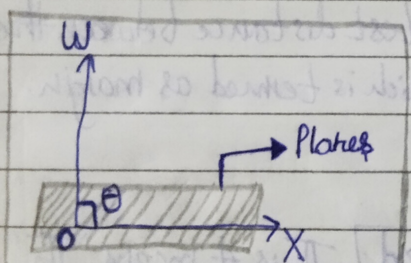
"Assumption that the Hyper plane is passing from the origin."

It means $\boxed{b=0 \text{ or } W_0=0}$

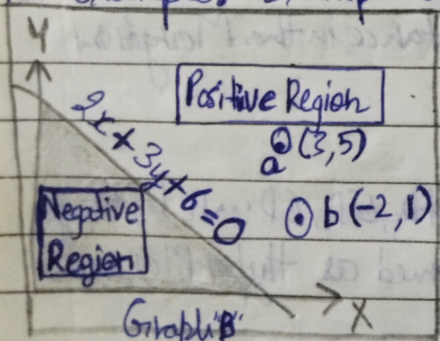
So, in matrics form it is written as:- $\boxed{W^TX=0}$ {Where $W_0=0$}

$$\boxed{W^TX=W\cdot X=\|W\|\cdot\|X\|\cdot \cos\theta=0}$$ In Vector Form..

Now $\cos\theta=0$ when $\theta=90^\circ$



For example:- Example of Applying Decision Rule in '2d' data.



- As per the Graph "B", Equation of Line $\Rightarrow 2x+3y+6=0$

$\Rightarrow W_1X_1+W_2X_2+W_0=0$

$\boxed{\text{Decision Rule}}$

$$\begin{bmatrix} W_1=2 \\ W_2=3 \\ W_0=6 \end{bmatrix}$$

① $a=(3,5) \rightarrow$ Input Data

② $b=(-2,1) \rightarrow$ Input Data

Applying Decision Rule

① $w^{\to} \Rightarrow (2,3)$, $u^{\to}(3,5)$, $b=6$

$w^{\to}\cdot u^{\to}+b \geq 0$

$2(3)+3(5)+6 \geq 0$

$33 \Rightarrow$ $\boxed{\text{Positive region}}$

② Applying Decision Rule for 2nd data input.

$w^{\to}(2,3)$, $u^{\to}(-2,1)$, $b=6 \Rightarrow 2(-2)+3(1)+6 \geq 0$

$\Rightarrow -4+9 \geq 0$

$\boxed{\text{Positive Region}}$ 5

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