# Support Vector Machine [SVM]
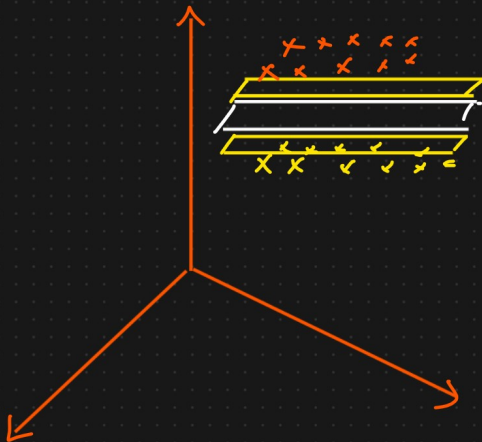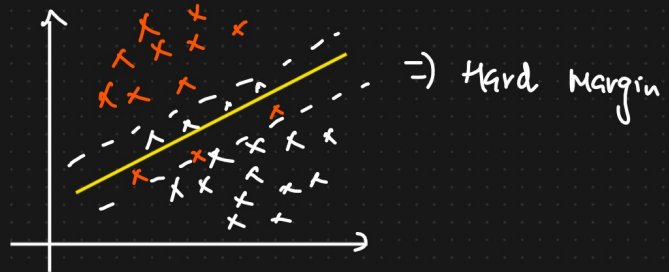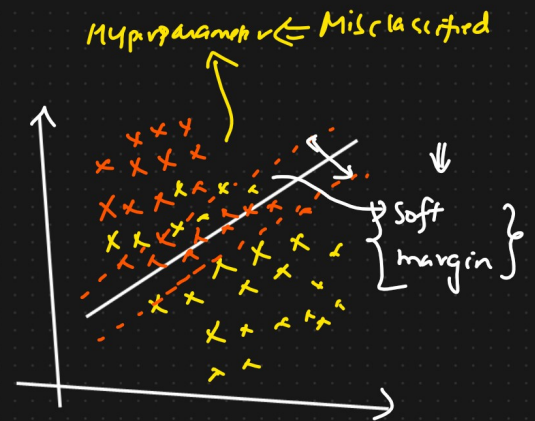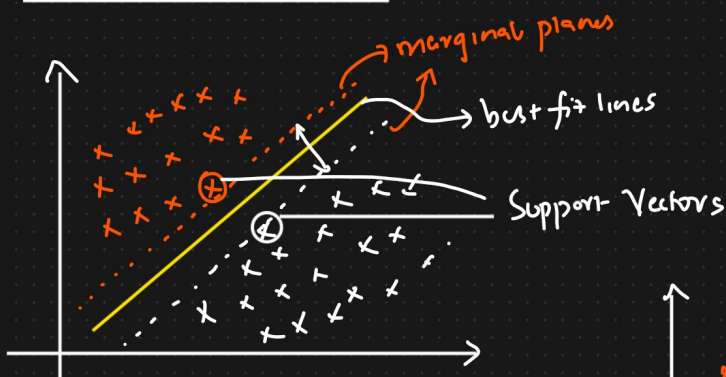
① Classification (SVC) ⇒ Support Vector Classifier

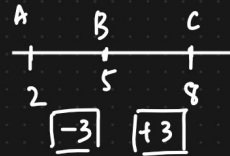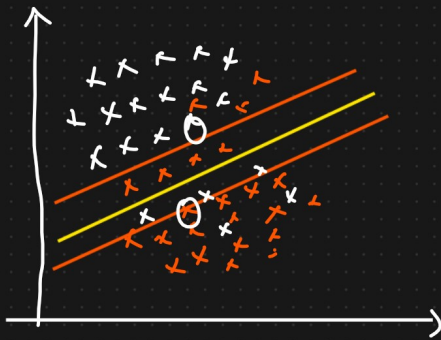② Regression (SVR) ⟶ Support Vector Regression

① Support Vector Classifier

marginal planes
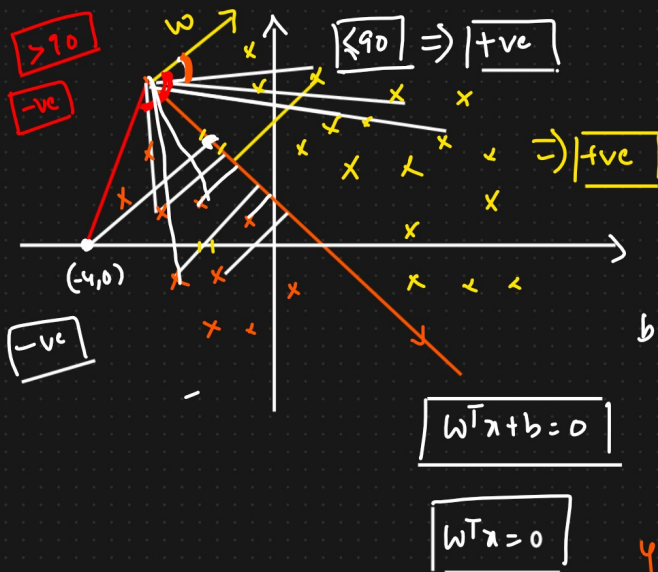
best fit lines

Support Vectors

Hyperparameter ⟸ Misclassified
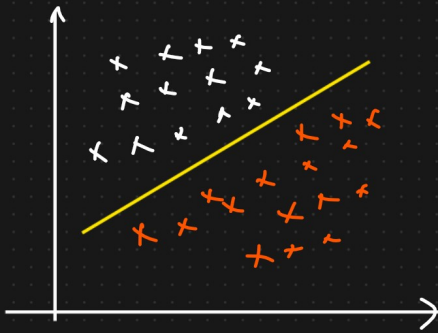
Soft margin

⇒ Hard Margin

# Soft Margin And Hard Margin In SVC



A ————— B ————— C

2      5      8

$\boxed{-3}$  $\boxed{+3}$

## ① SVC Maths Intuition



$\boxed{>70}$

$-ve$

$\boxed{<90} \Rightarrow \boxed{+ve}$

$\Rightarrow \boxed{+ve}$

$\boxed{-ve}$

$(-4,0)$

If the angle between the vector and the points is greater than 90, then distance — — is $\boxed{-ve}$

$b=0$

$\boxed{W^T x + b = 0}$

$\boxed{W^T x = 0}$

### Equation of a straight line

$y = mx + c \quad \Rightarrow \quad ax + by + c = 0$

$h_\theta(x) = \theta_0 + \theta_1 x$

$by = -ax - c$

$y = \boxed{\dfrac{-a}{b}} x - \boxed{\dfrac{c}{b}}$

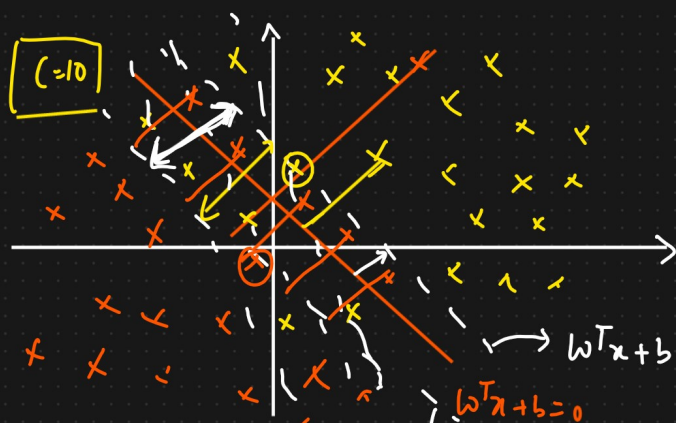$\Downarrow \qquad\qquad \Downarrow$

$y = m x + -c$

$y = \theta_0 + \theta_1 x_1 + \theta_2 x_2 + \theta_3 x_3$

$y = b + w_1 x_1 + w_2 x_2 + w_3 x_3$

$w = \begin{bmatrix} w_1 \\ w_2 \\ w_3 \end{bmatrix} \qquad x = \begin{bmatrix} x_1 \\ x_2 \\ x_3 \end{bmatrix}$

$w^T = \begin{bmatrix} w_1 & w_2 & w_3 \end{bmatrix} \qquad x = \begin{bmatrix} x_1 \\ x_2 \\ x_3 \end{bmatrix}$
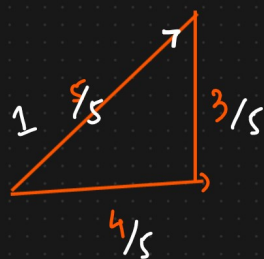
$\boxed{y = w^T x + b}$

$[C=10]$

$$w^T x_1 + b = +1$$
$$w^T x_2 + b = -1$$
$$(-) \quad (-) \quad (+)$$

$$\vec{w} \leftarrow \frac{w^T (x_1 - x_2)}{\|w\|} = \boxed{\frac{2}{\|w\|}} \uparrow\uparrow \Rightarrow Maximum$$

$$w^T x + b = +1$$
$$w^T x + b = 0$$
$$w^T x + b = -1$$

$1 \quad 4/5 \quad 3/5$

$4/5$

$\boxed{|v|}$

unit vector $= |\vec{v}| = \boxed{1}$

## Cost function

$\underset{w,b}{\text{Maximimize}} \quad \boxed{\dfrac{2}{\|w\|}} \Rightarrow$ Distance between marginal planes.

Constraint such that

$f_1 \quad f_2 \quad f_3 \quad \boxed{y}$

$$y_i \begin{cases} +1 & \text{if } w^T x + b \geq 1 \quad \Rightarrow +ve \\ -1 & \text{if } w^T x + b \leq -1 \Rightarrow +ve \end{cases}$$

For all correct classified data point

$$\boxed{y_i * [w^T x + b] \geq 1}$$

$$\boxed{\text{predicted point} \Rightarrow \hat{y}}$$

$$\boxed{y_i * \hat{y_i} \leq -1}$$

Incorrect Classification

# Modified Cost fn

$$\text{Max}_{w,b} \quad \frac{2}{||w||} \quad \Bigg\} \quad \Rightarrow \quad \boxed{\text{Min}_{w,b} \quad \frac{||w||}{2}}$$

## Constraint such that

$$y_i \begin{cases} +1 & \text{if } w^Tx + b \geqslant 1 \\ -1 & \text{if } w^Tx + b \leq -1 \end{cases}$$

$$\underline{\text{Cost fn}} = \boxed{\text{Min}_{w,b} \quad \frac{||w||}{2}} + \boxed{C_i \sum_{i=1}^{h} \xi_i} \quad \Rightarrow \quad \text{Hinge loss}$$

Eta

Hyperparameter

$\downarrow$

{How many points we can consider for misclassification}.

{Summation of the distance of incorrect data points from marginal plane}.



$\lambda_1 \quad \lambda_2$

$$\boxed{C = \frac{1}{\lambda}}$$
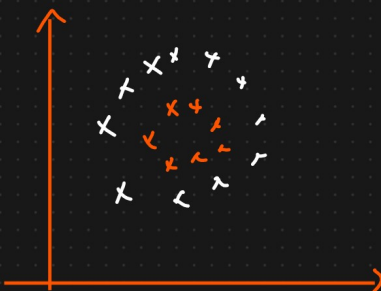


Kernels

$\Rightarrow \boxed{\text{linear SVC}} \quad \Rightarrow \quad RBf$
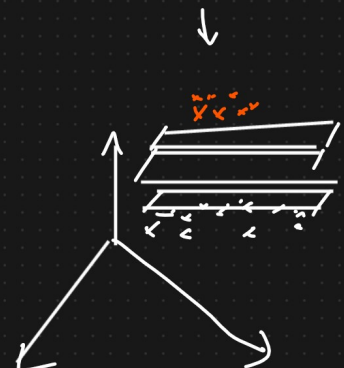
# Support Vector Regressor

$\epsilon \Rightarrow$ Marginal Error



$$\boxed{w^Tx + b + \epsilon}$$
$$\rightarrow w^Tx + b$$
$$\boxed{w^Tx + b - \epsilon}$$

Price

Size
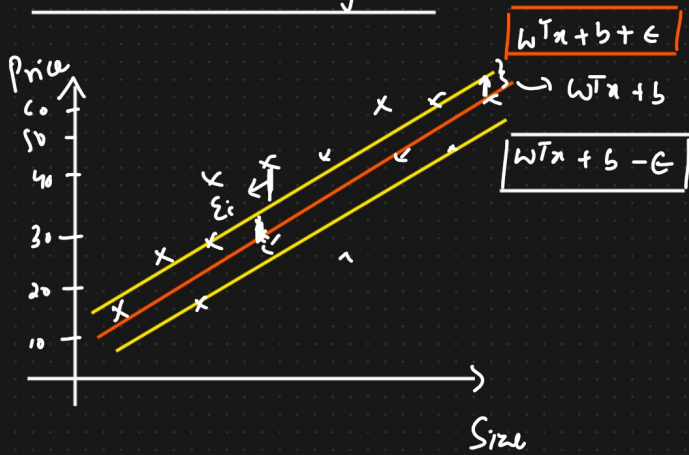
## Cost fn

$$\underset{w,b}{\text{Min}} \quad \frac{||w||}{2} \quad + \quad \boxed{C \sum_{i=1}^{n} \xi_i} \Rightarrow \text{Hinge Loss}$$

$\Downarrow$

Constraint

Error $\Rightarrow |y_i - w^Tx_i| \leq \epsilon + \xi_i$

$\epsilon \Rightarrow$ Marginal Error

$\xi_i \Rightarrow$ Error above or below the marginal plane.