# SVM AND SVR Algorithms:

① CLASSIFICATION AND REGRESSION PROBLEMS.

$\boxed{\text{ML Breadth}}$

⇓

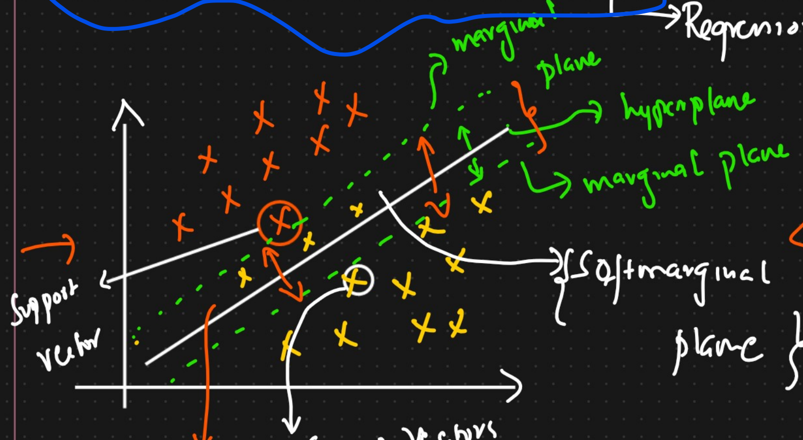
SVM

{AIM}

Support Vector Machine → CLASSIFICATION → SVC

Support Vector Machine → Regression → SVR

Hard marginal plane

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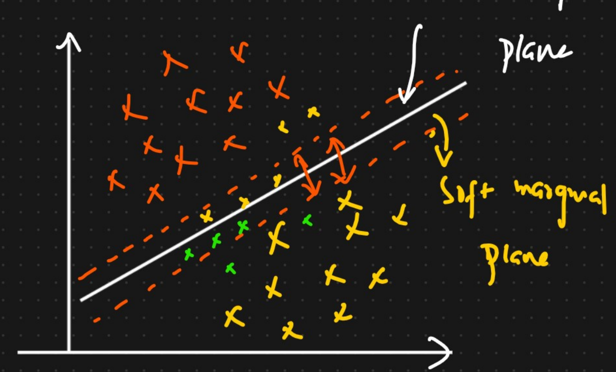



{Hard marginal plane}

$y = mx + c$

$y = \theta_0 + \theta_1 x$

$y = \beta_0 + \beta_1 x$

⇓

$\boxed{y = w^T x + b}$

$\boxed{ax + by + c = 0}$ → Equation of a Straight line

$by = -ax - c$

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

$-\frac{a}{b}$ → coefficient

$-\frac{c}{b}$ → intercept

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

$\boxed{y = w^T x + b}$

{Matrix multiplication}

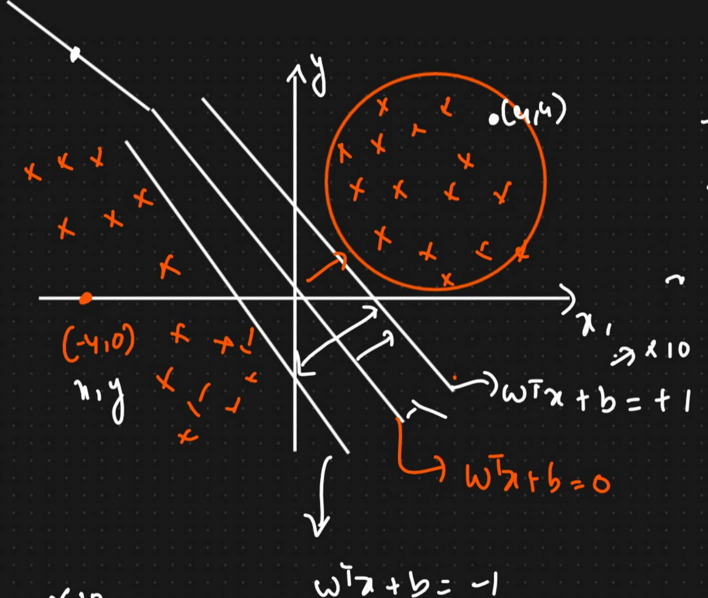
$$\begin{bmatrix} w_1 \\ w_2 \\ w_3 \end{bmatrix} \begin{bmatrix} x_1 & x_2 & x_3 \end{bmatrix}$$

⇕

$y = m_1 x_1 + m_2 x_2 + m_3 x_3 + c$

$\boxed{y = m^T x + c}$

$$\begin{bmatrix} m_1 \\ m_2 \\ m_3 \end{bmatrix} \begin{bmatrix} x_1 & x_2 & x_3 \end{bmatrix}$$




$\boxed{k=1}$

+1

-1

$$\boxed{3x+2y+4=0}$$

$3(-4)+2(0)+4=0$

$\boxed{-8} \Rightarrow$ -ve value

$3x+2y+4=0$

$3(4)+2(4)+4=0$

$12+8+4$

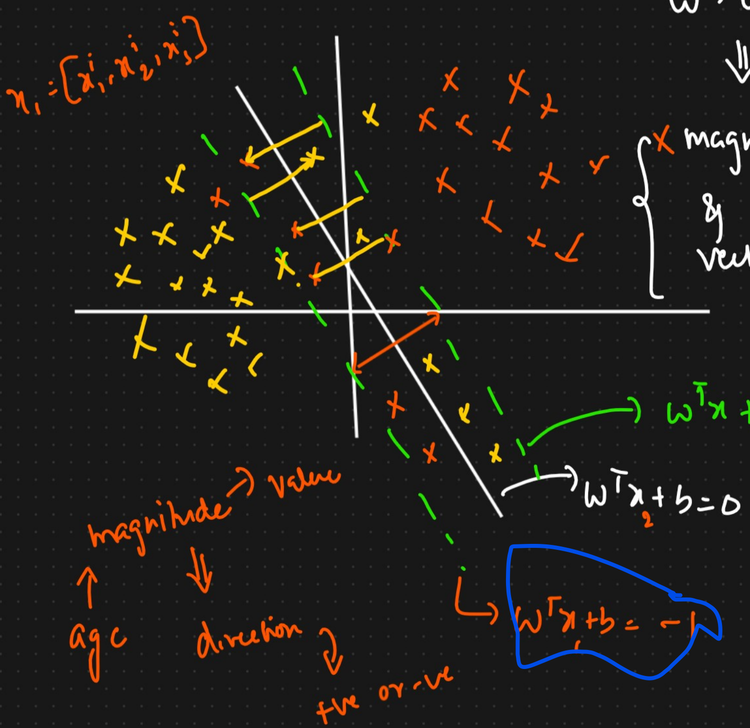
$\Rightarrow 24 \Rightarrow$ +ve

$\alpha 10$

$w \Rightarrow$ coefficient

$\Downarrow$

magnitude & vector




$w^Tx_1+b=+1$

$w^Tx_2+b=-1$

(-) (-) (+)

$\vec{w}$

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

$\boxed{\text{Marginal Error}}$

Maximize $(w,b)$ $\dfrac{2}{\|w\|} \Rightarrow$ Marginal plane ✓

Constraint

Truth O/P

Such that $y_i \begin{cases} +1 & w^Tx+b \geq 1 \text{ correct} \\ -1 & w^Tx+b \leq -1 \rightarrow \text{+ve} \end{cases}$

For all correct points

Constraint $\rightarrow$ $\boxed{y_i * (w^T x_i + b) \geq 1}$

$\boxed{\underset{(w,b)}{\text{Maximize}} \ \frac{2}{||w||}}$ $\Leftrightarrow$ $\underset{(w,b)}{\text{Min}} \ \frac{||w||}{2}$

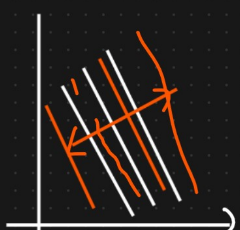
Linear Regression

Cost function : $\underset{(w,b)}{\text{Min}} \ \frac{||w||}{2} + C_i \sum_{i=1}^{n} \xi_i$ $\rightarrow$ {Hinge Loss} Summation of the distance of the wrong data points from the marginal plane

Hyperparameter

ETA

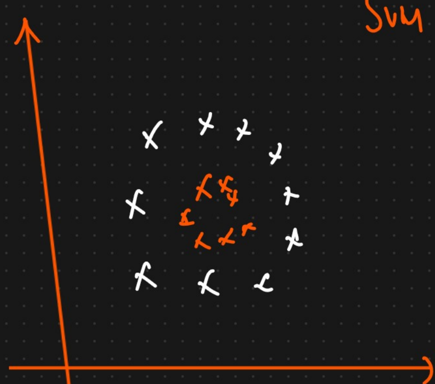
$\Downarrow$

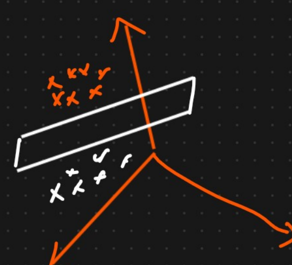


{ Hard marginal plane } { How many points we want to avoid misclassification. }

SVM

SVM Kernels (Kernel Trick)



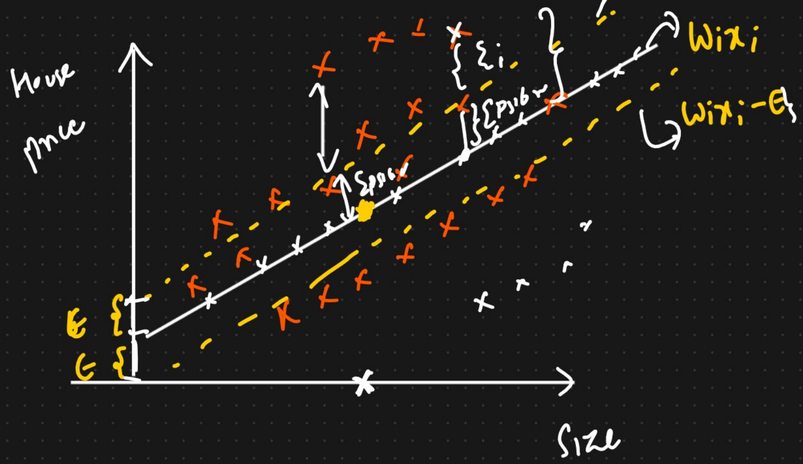


④ Support Vector Regression

$w_i x_i + b = +1$

$w_i x_i + b = -1$

$\rightarrow w_i x_i + \epsilon \}$




$$\min_{(w,b)} \frac{\|w\|}{2}$$

Constraint

$$|y_i - w_i x_i| \le \epsilon$$

$\hat{y}$

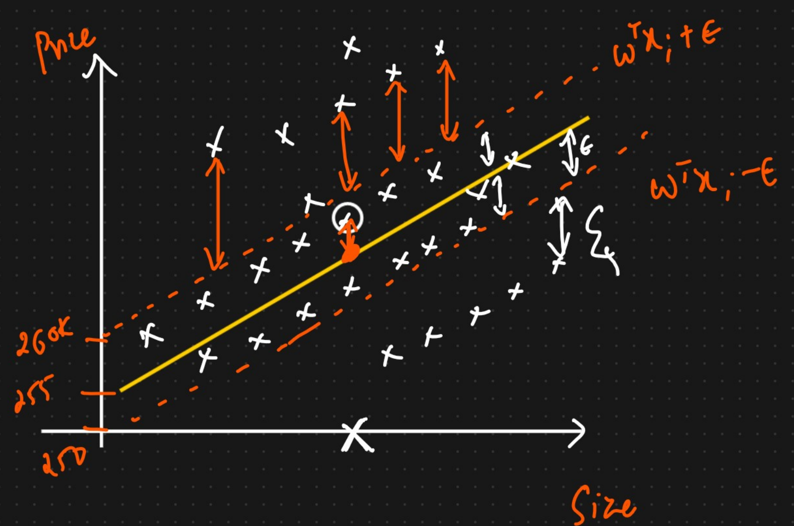
## Cost function

$$\min_{(w,b)} \frac{\|w\|}{2} + C \sum_{i=1}^{n} |\xi_i|$$

Constraint

$$|y_i - w x_i| \le \underbrace{\epsilon}_{\text{Epsilon}} + |\xi_i|$$

distance of the points that are away from the Epsilon line




Hyperparameter

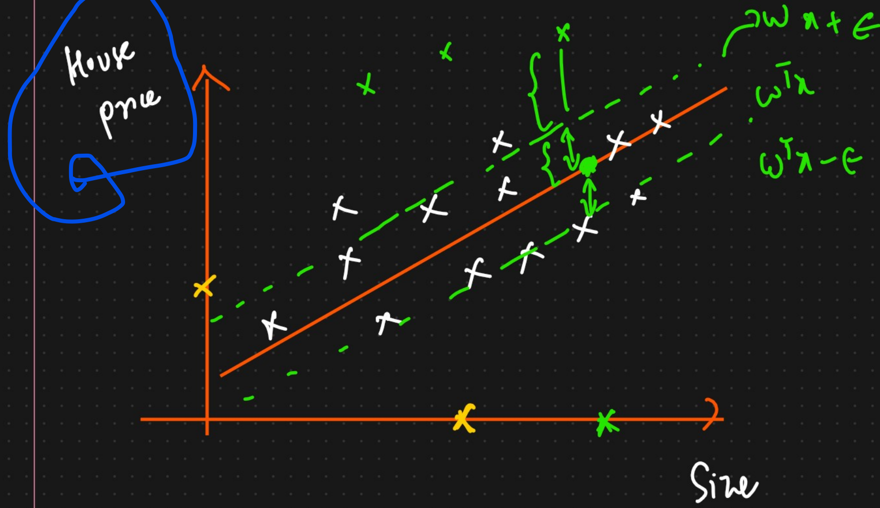
$$\min_{(w,b)} \frac{\|w\|}{2} + C \sum_{i=1}^{n} \xi_i$$

Constraint

$$\boxed{|y_i - w^T x_i| \le \epsilon + \xi_i}$$

Truth point

Predicted point




$|y_i - w^T x_i| \le \epsilon + |\xi_i|$

$\downarrow$

$\hat{y}$

$\{ \underline{C \text{ \& Slope}} \}$

$\hat{y}_i$, $w^T x + b$

$$\text{Cost function} = \frac{1}{2n}\sum_{i=1}^{n}(y_i - \hat{y}_i)^2 + \lambda \sum_{i=1}^{n}(\text{Slope})^2 \rightarrow L2$$

Actual value — predicted value

$$\lambda \sum_{i=1}^{n} |\text{Slope}| \rightarrow L1$$

Regularization parameter

$\{ L2, L1, \text{Elastic Net}, \text{Hinge Loss} \}$

Amazon: Relationship between $C$ & $\lambda$

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

Logistic Sklearn

Diff
Loss & cost function

1-datapoint

Entire dataset.

$$\text{Loss fn} = \frac{1}{2}(y-\hat{y})^2$$

$(\hat{y}-y)^2$

$\updownarrow$

$(y-\hat{y})^2$

$$\text{Cost funct} : \frac{1}{2n}\sum_{i=1}^{n}(y-\hat{y})^2$$

fit & fit_transform & transform.

Standard Scaler

⇓

Transforming the data??

↓

Changing the data.

| | f1 | f2 | f1 | f1-Standard |
|---|---|---|---|---|
| Train | 2 | | 2 | -1 |
| | 3 | | 3 | 0 ← $\boxed{\mu, \sigma}$ |
| | 4 | | 4 | 1 |
| Test | 5 | | | |
| | 6 | | | |

$$Z\text{-score} = \frac{x_i - \mu}{\sigma} \quad \mu = 3, \ \sigma = 1$$

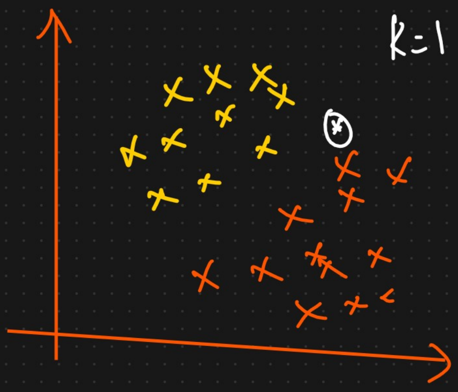
$$\frac{2+3+4}{3} = \frac{9}{3} = \boxed{3}$$

$\boxed{\text{fit \& transform.}}$

fit & $\boxed{\text{fit-transform}}$

Transform ↘ Test {5, 6}

$$\frac{5-3}{1} = 2 \quad \text{No}$$



K=1 bad accuracy.

K=2 $\boxed{K=\text{odd}}$

K=3

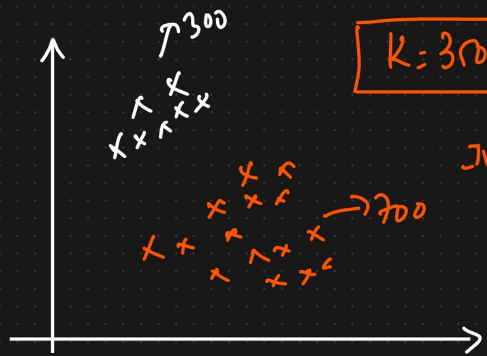
K=4

K=5

K=6

K↑ Accuracy↑

Error↓↓↓




$\boxed{K=300}$

Imbalanced

data points