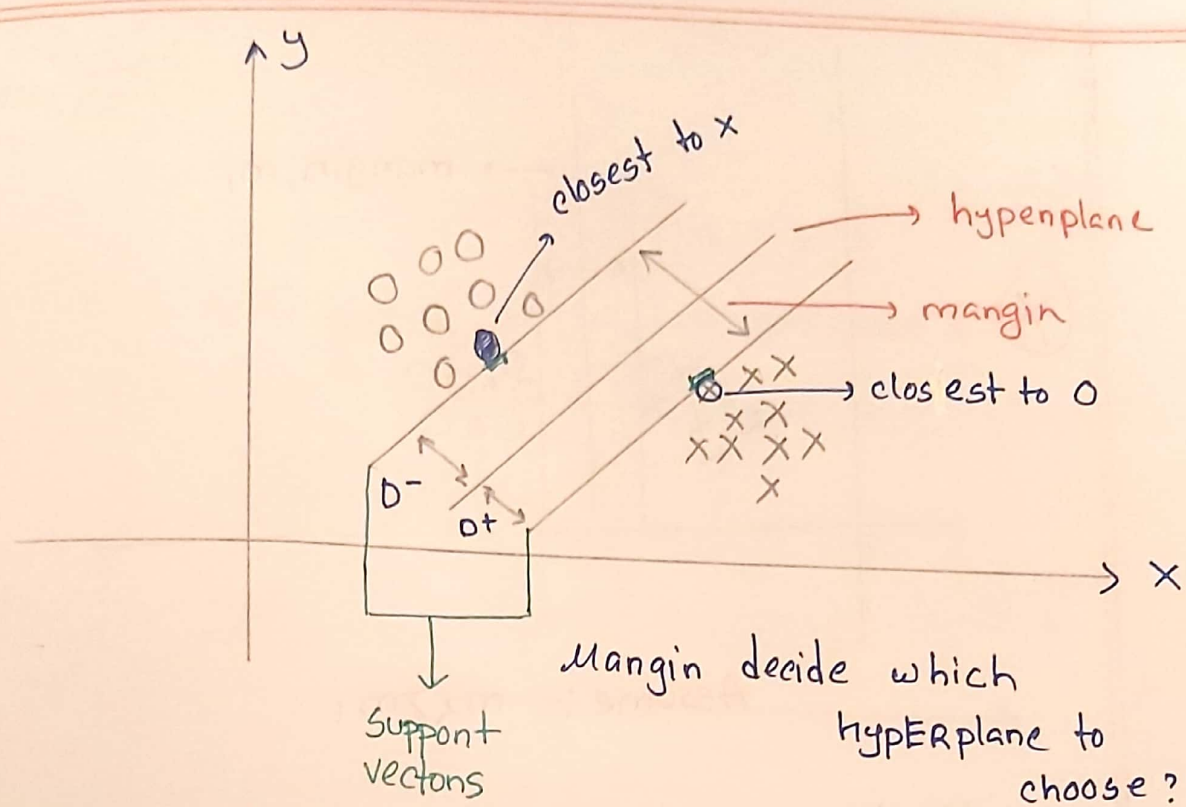
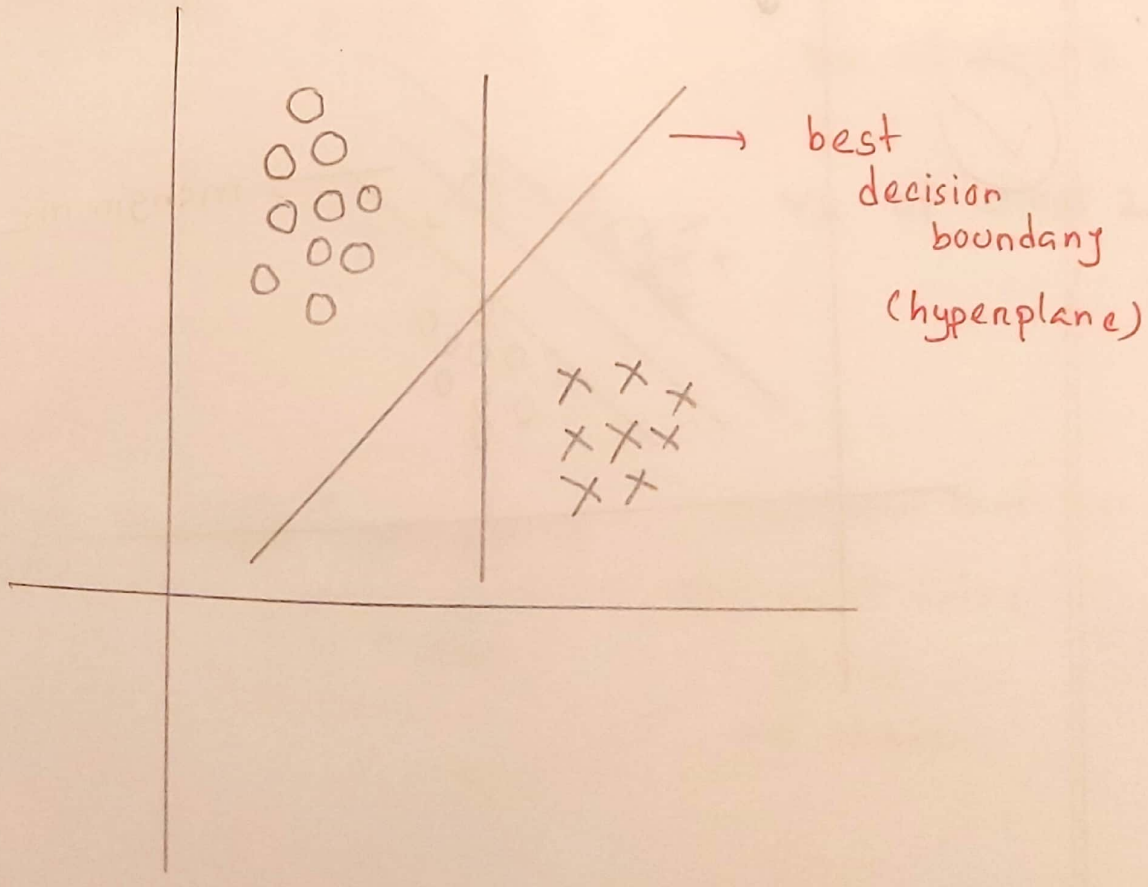
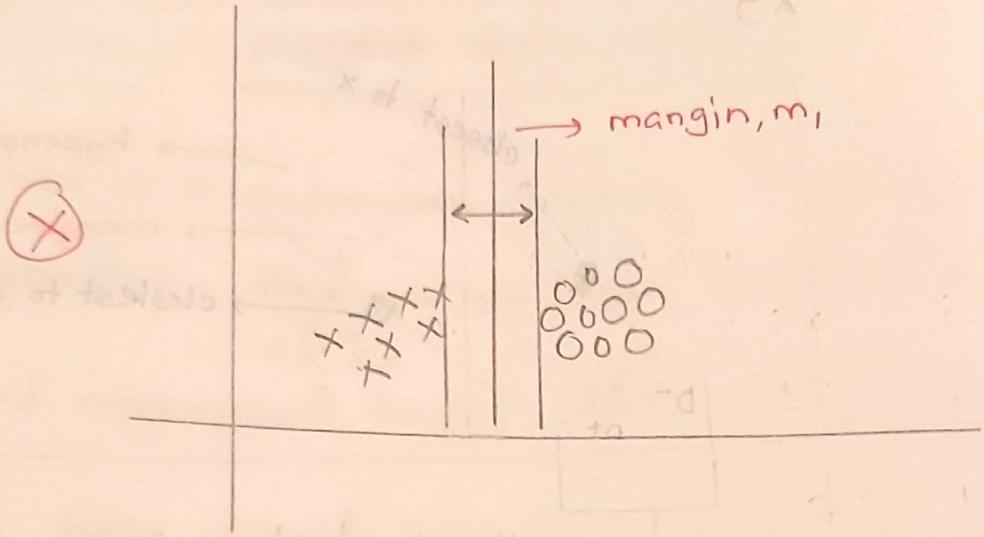
Support Vector Machine

SVM is a supervised machine learning algorithm that is used for classification and and regression tasks. It is primary task is to help classify / predict outcomes by finding the best possible line / Hyperplane in a N dimensional space (N = number of feature) that separates data points of different classes.


y
closest to x
hypenplane
mangin
closest to o
d-
d+
x
Support vectors
Mangin decide which hypERplane to choose ?

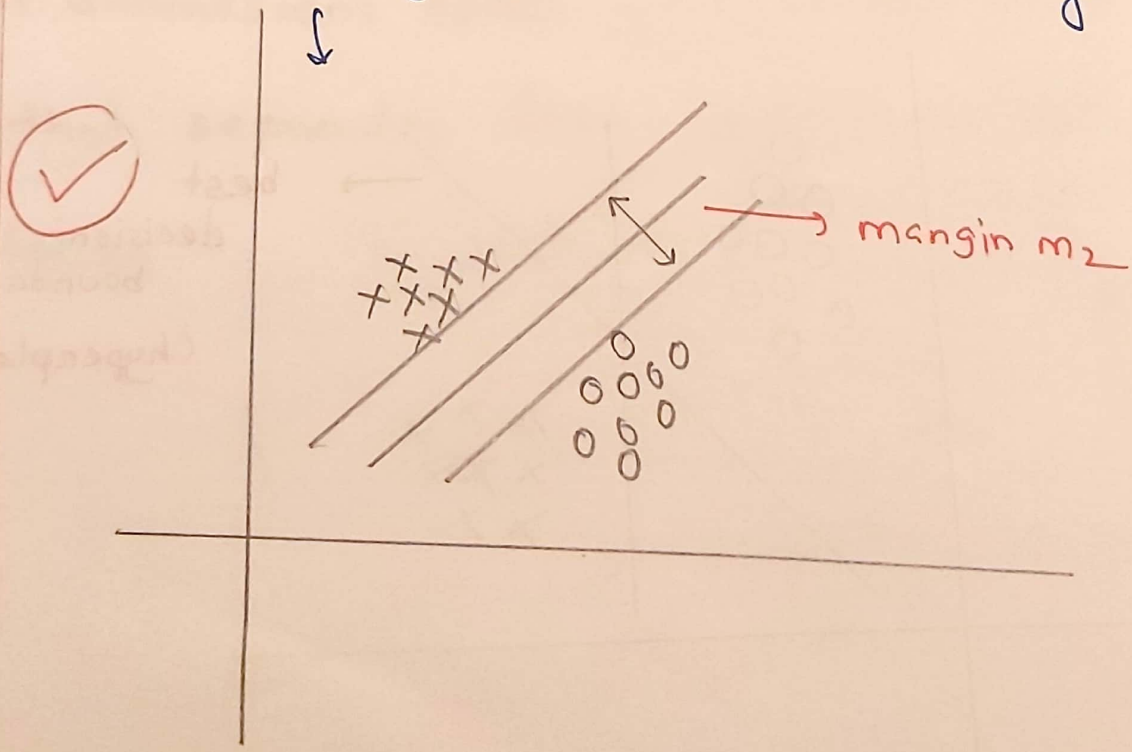

best decision boundary (hyperplane)

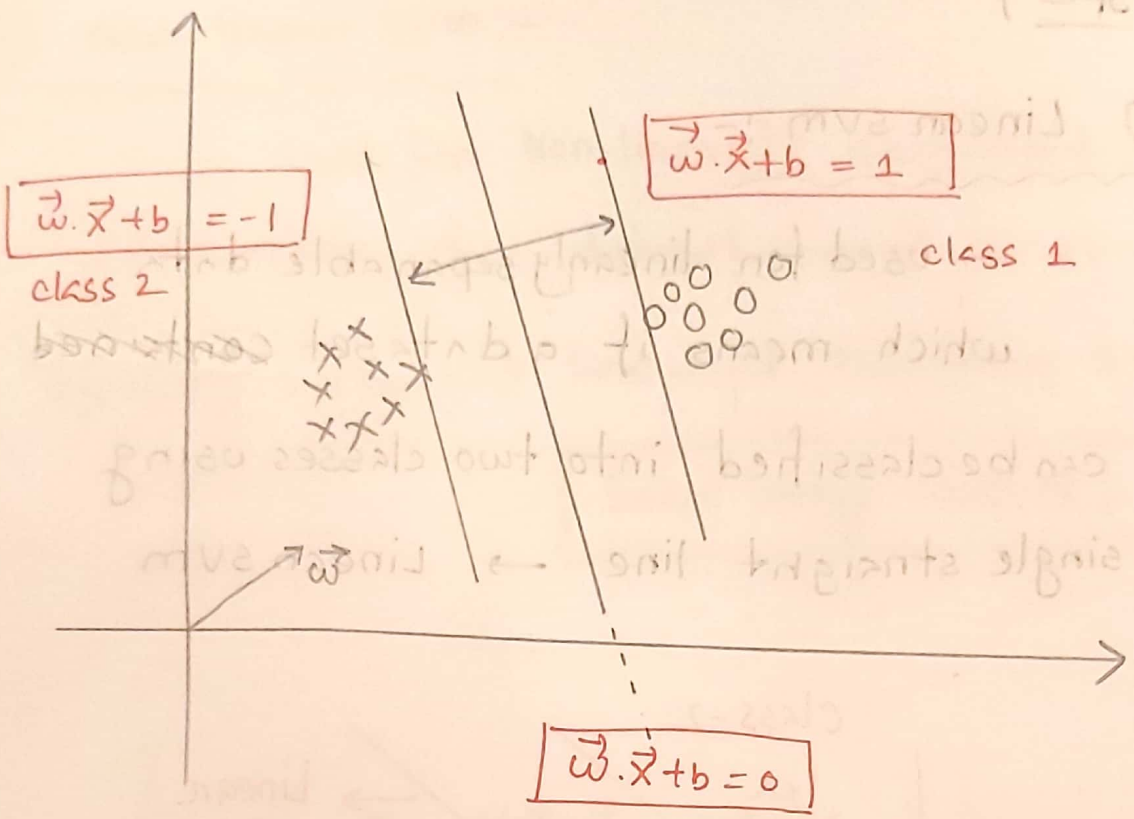
which hypERplane to choose ?



Assume :- $m_2 > m_1$

Maximum mangin Hyperplane → best decision boundary





$f_{w,b} = 1$

$(w.x + b) \geq 1$; $\forall x$ of class 1

$(w.x + b) \leq -1$: $\forall x$ of class 2

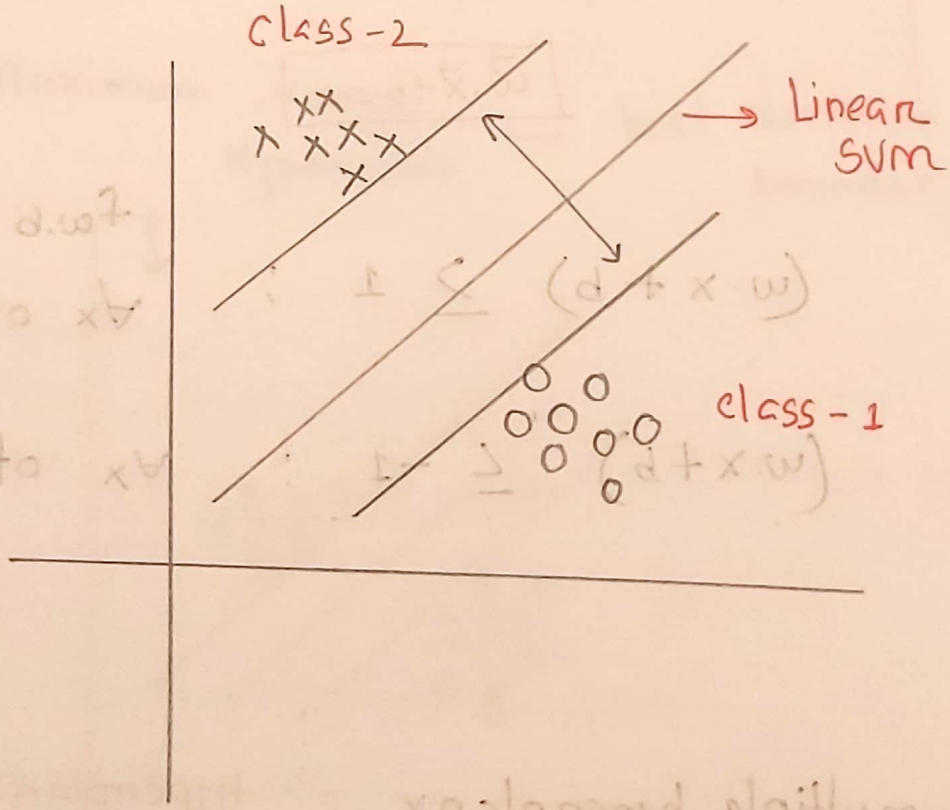
∴ if multiple hyperplanx

$= \frac{2}{\|w\|}$ → hyperplan that has maximum value of this will choosen

Types

(1) Linear SVM :-

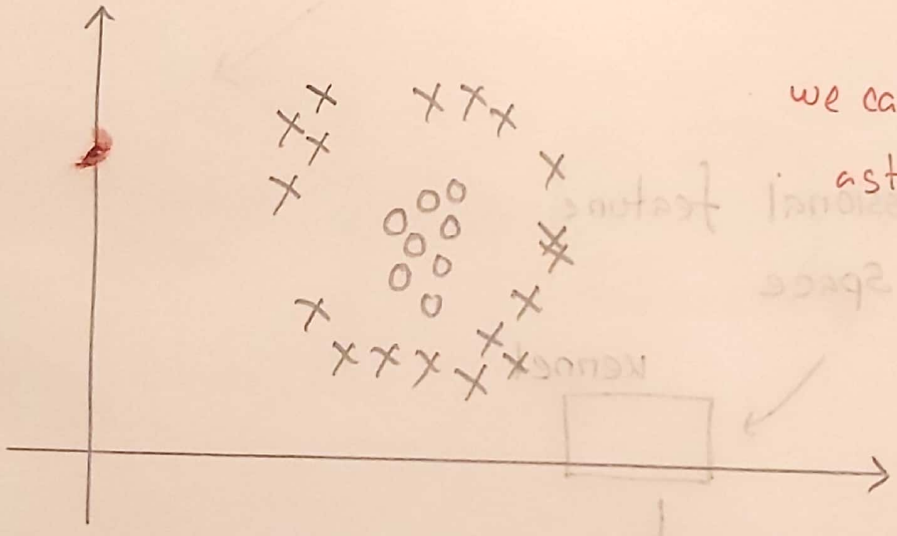
→ used for linearly separable data which means if a dataset can be classified into two classes using a single straight line → Linear SVM



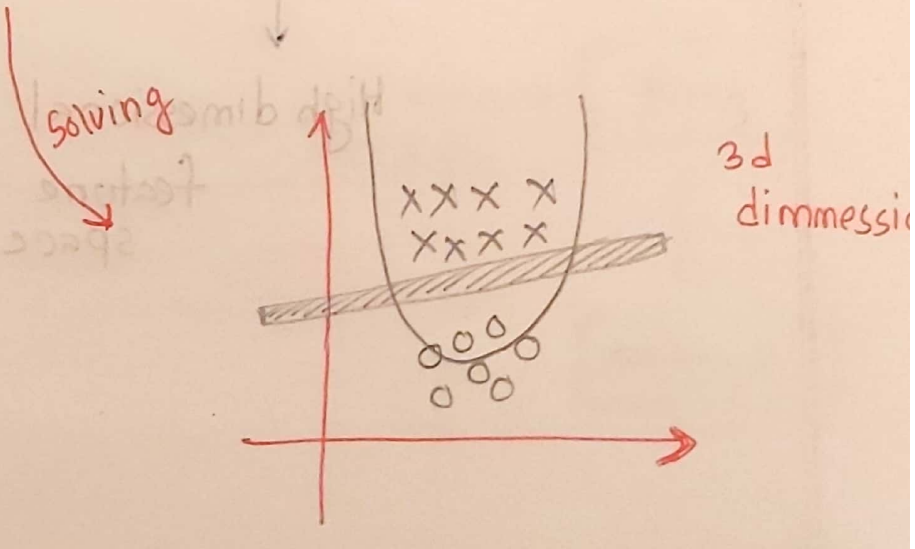
(3) Non-linear SVM :-

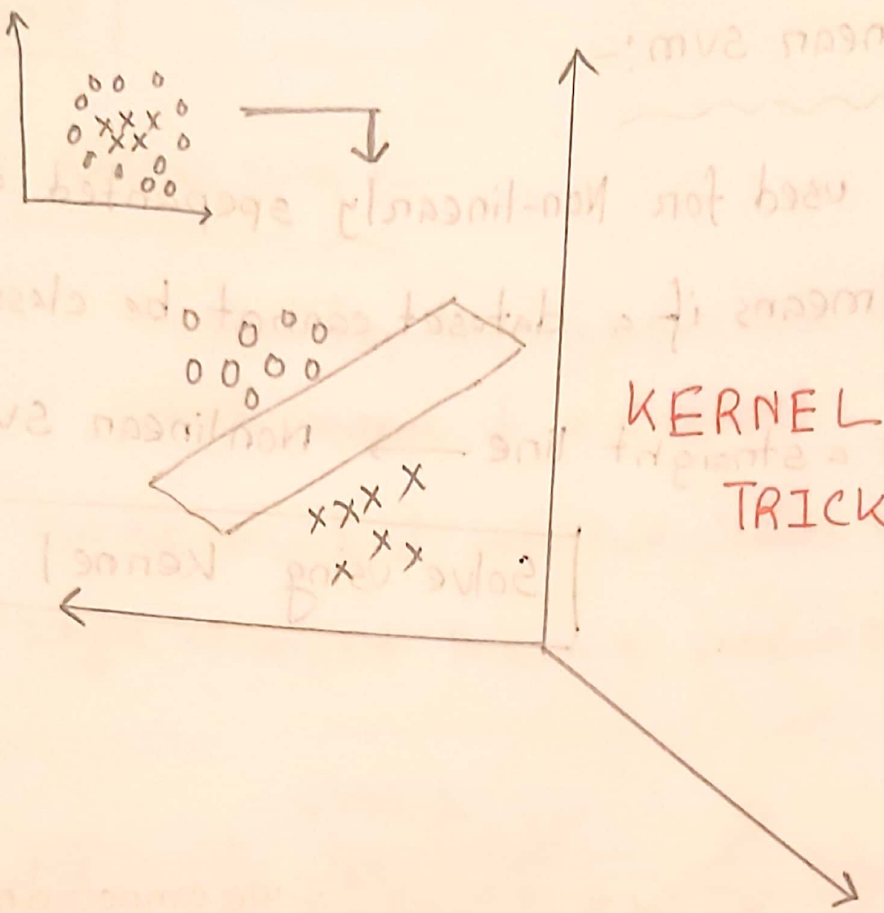
used for Non-linearly spepanted data which means if a dataset cannot be classified by using a straight line ⟶ Nonlinear SVM

Solve using Kernel

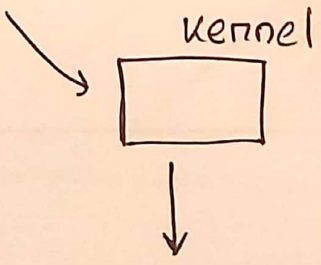


we cannot draw astraight line to separate data.





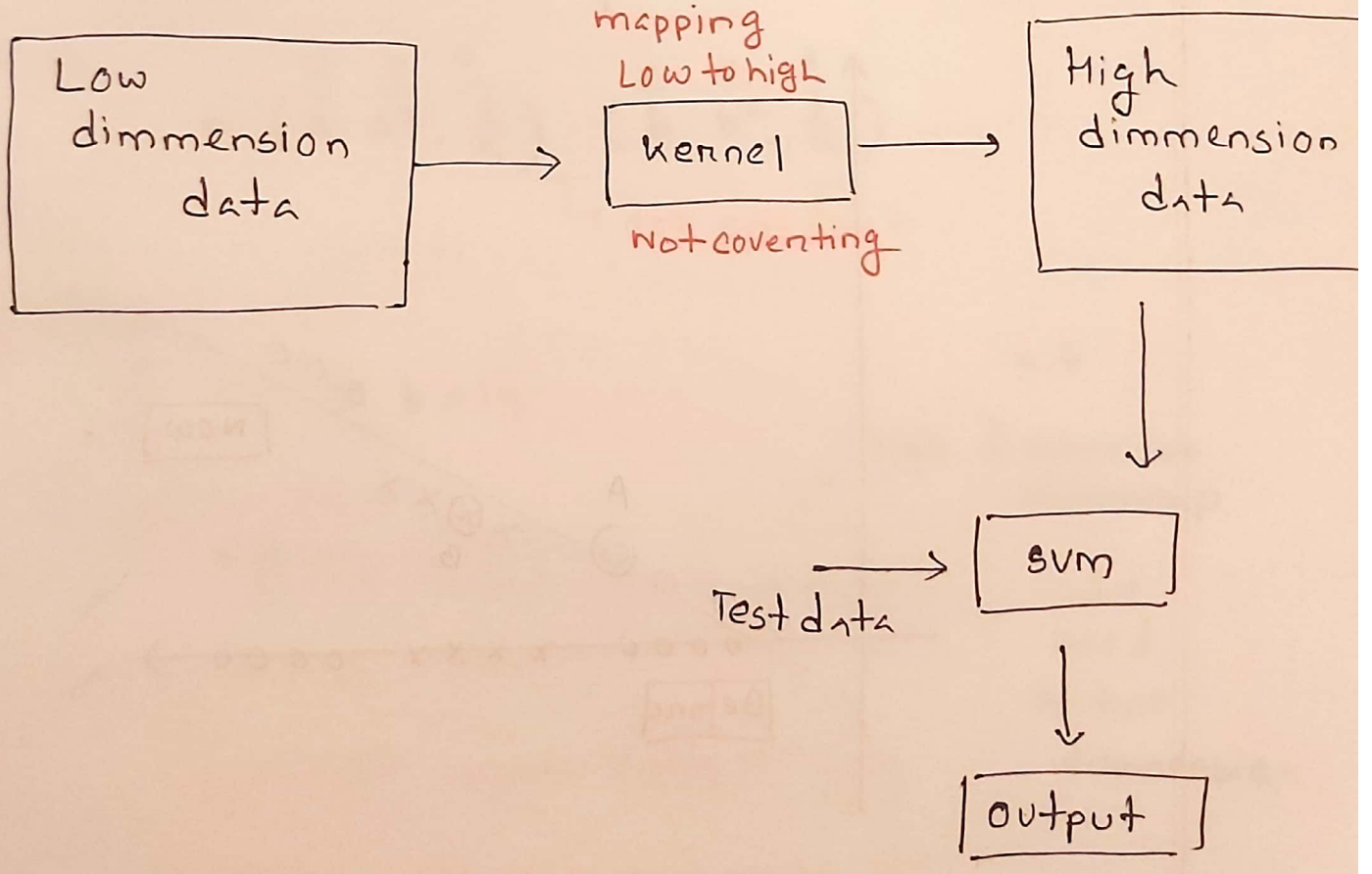
Low Dimessional featune
Space



High dimessional
featune
space

Kernel Trick

→ Kernel are a set of functions used to transform data from lower dimmension to higher dimmession and to manipulate data using dot product at higher dimmension.



computes Relationship
between pair of observation

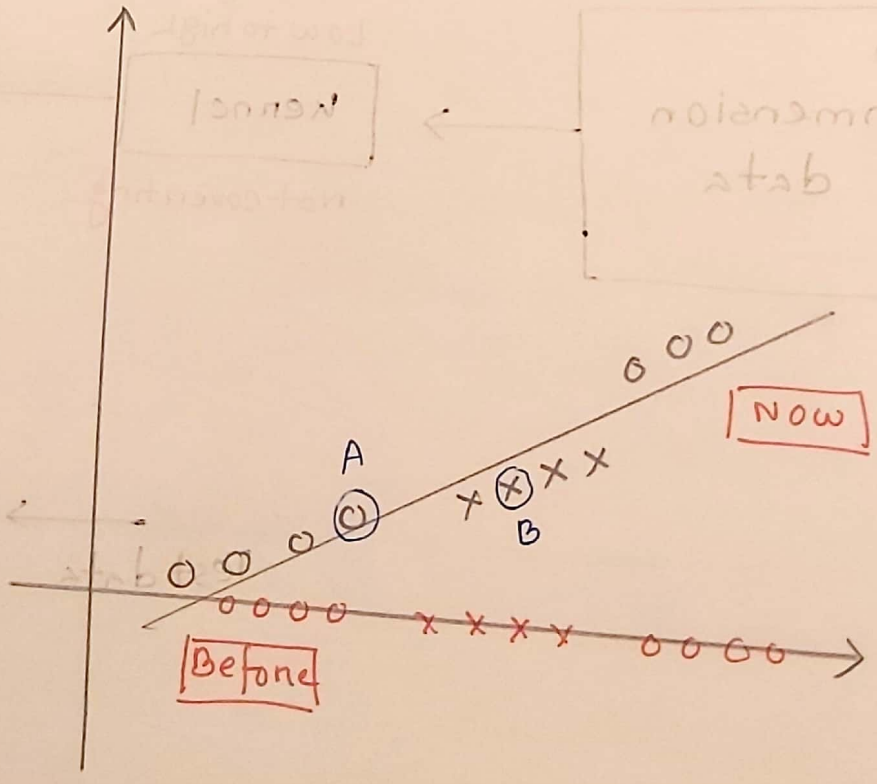
Polynomial kernel :-

$$= (a \times b + r)^d$$

a, b = refers to different observations in dataset

r = coefficient of polynomial

d = the degree of polynomial



Here,

$d = 2$

$r = \frac{1}{2}$

$= (a.b + \frac{1}{2})^2$

$= (a+b+\frac{1}{2})(ab+\frac{1}{2})$

$= a^2b2 + \frac{1}{2}ab + \frac{1}{2}ab + \frac{1}{4}$

$= ab + a^2b^2 + \frac{1}{4}$

$= (\frac{x}{a}, \frac{y}{a^2}, \frac{z}{\frac{1}{2}}) \cdot (\frac{x}{b}, \frac{y}{b^2}, \frac{z}{\frac{1}{2}})$

↳ dot product

∴ if $a = 9, b = 14$

a, b

high dimension Relationship

$= (9 \times 14 + \frac{1}{2})^2 = 16,002.25$

→ Solve need to two dimension

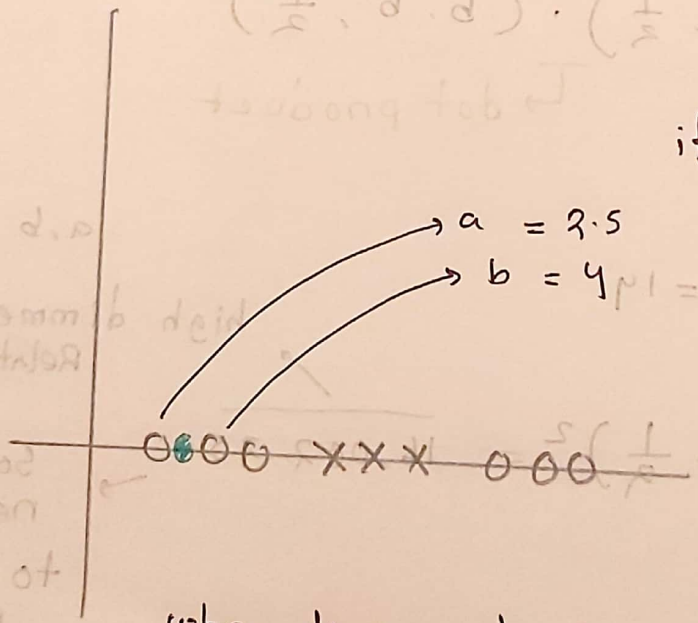
The Radial Kernel

$$RBF = e^{-\gamma(a-b)^2} = e^{-\gamma(a-b)^2}$$

Radial Bassis Function

a, b = two different obersration in dataset

γ = influence
= theamount of influence between two points



if $\gamma = 1$
RBF = 0.11

$\gamma = 2$
RBF = 0.01

when two point closen, RBF high

two point fan each othen, RBF low close to 0

$$RBF = e^{-\gamma(a-b)^2}$$

$$\gamma = \frac{1}{2}$$

$$RBF ; \quad e^{-\frac{1}{2}(a-b)^2}$$

$$= e^{-\frac{1}{2}(a^2-2ab+b^2)}$$

$$= e^{-\frac{1}{2}(a^2+b^2)} e^{ab}$$

$$e^{ab} = 1 + \frac{1}{1!}ab + \frac{1}{2!}(ab)^2 + \frac{1}{3!}(ab)^3 + \cdots$$

$$+ \frac{1}{\infty!}(ab)^{-\infty}$$

Infinite dimmension