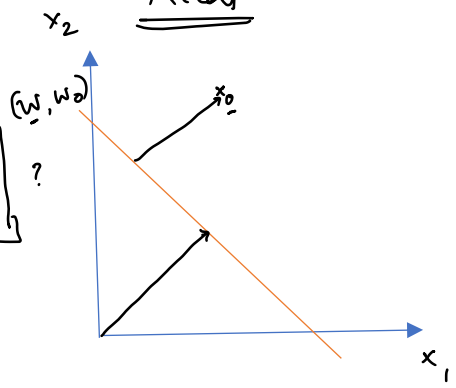
Decision Boundary

→ Error Minimization ✓
→ Unit vector
→ Vector projection
→ Vector Addition

Recap

$$d = \frac{w^T x_0 + w_0}{\|w\|} \quad ?$$



Origin DB : $\frac{-w_0}{\|w\|}$ ✓

Half Space

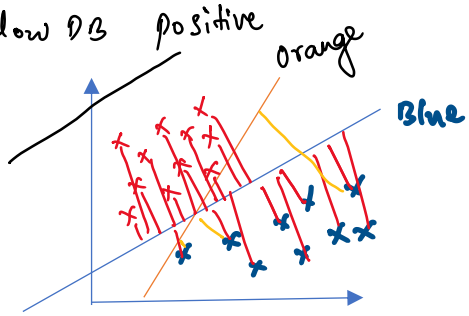
$w^T \cdot x + w_0 > 0$ +ve Space

$w^T \cdot x + w_0 < 0$ −ve Space

→ Which one is Positive half Space? Which is Negative half Space

① Top(above DB) +ve Space, below(DB) Negative

② Top(above DB) −ve Space, below DB positive



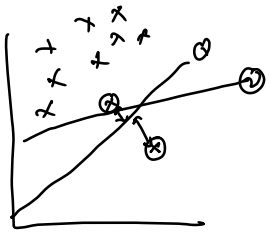
Classification (Binary classification)

→ Which one is a better DB ?

→ Sum of distances of all points to the Boundaries (Maximum) ✓

Blue → 100 ✓
Orange → less 80 ✓

} Which one is better



→ Avg distance (mean distance) max ↑

→ max (Min distance b/w one positive and one Negative point)

$$\sum_{i=1}^{n} \frac{w^T \cdot x + w_0}{\|w\|} \quad (d)$$

d +ve or −ve

EMI, Monthly Salary

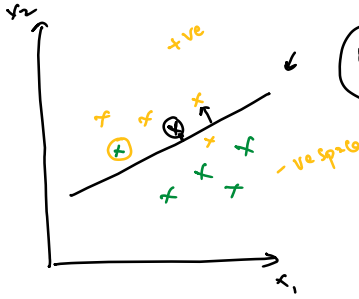
n - # of obs

f_1	f_2	Target	
10	20	0	−1
15	16	1	+1 ✓

Mean distance & target $= \sum \frac{w^T \cdot x + w_0}{\|w\|} \times T \quad +1$

x -1

x $+1$



+ve ⊗ $w^T \cdot x + w_0 > 0$

⊗ $w^T \cdot x + w_0 < 0$

$$\max \sum_{i=1}^{n} \frac{w^T x + w_0}{\|w\|} \times t$$

↑ 2000

→ 1800

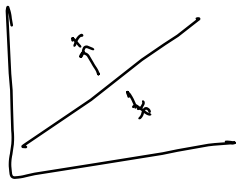
$$\sum_{i=1}^{n} \frac{w^T x + w_0}{\|w\|} \cdot t$$

↑

Loss (Error)

(Max mean distance)

(L.R)



Max (Min distance on both Sides)

(SVM)

→ Distance b/w two planes (Parallel)

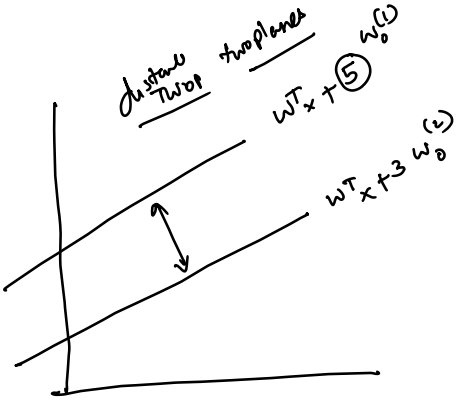
→

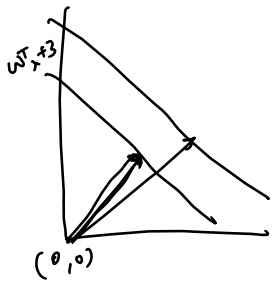
→ If two planes are Parallel.

① w and w_0 will be Same

② w is Same w_0 will change

③ both w and w_0 will change

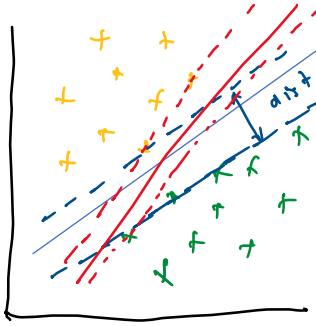




→ origin to plane = $\frac{-w_0}{\|w\|} = \frac{-3}{\|w\|}$ $\frac{-5}{\|w\|} = \frac{5}{\|w\|} - \frac{3}{\|w\|}$

$= \frac{2}{\|w\|}$

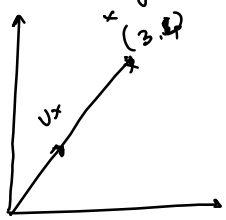
→ $\frac{w_0' - w_0^2}{\|w\|}$



✓ Max (Min of distance of nearest point on both Sides)

Svm

Unit vector → vector of magnitude '1'

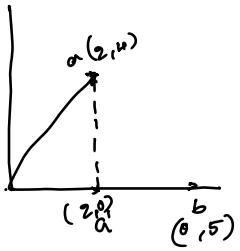


$\|x\| \to 1$

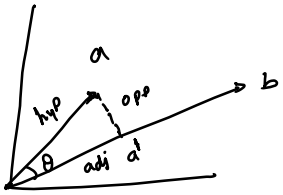
$\|x\| \to \sqrt{3^2+4^2} \to 5$

$ux = \left(\frac{3}{5}, \frac{4}{5}\right) \to \|ux\| \to 1$

Projection of a vector



a' is projection of a onto b vector



$\cos\theta = \frac{adj}{hyp} = \frac{a'}{\|a\|}$ $\quad a' = \|a\| \cdot \cos\theta$

→ hyp → $\|a\|$

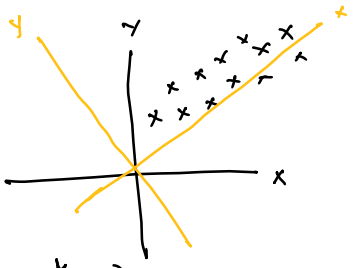
cosθ w.r.t two vectors a, b ? $\quad \cos\theta = \frac{a \cdot b}{\|a\| \|b\|}$ ✓ -②

$\cos\theta = \frac{w^T \cdot x}{\|w\| \|x\|}$

$a' = \|a\| \cdot \frac{a \cdot b}{\|a\| \|b\|}$

$$a' = \frac{a \cdot b}{\|b\|}$$

← Projection of vector a on b is calculated.



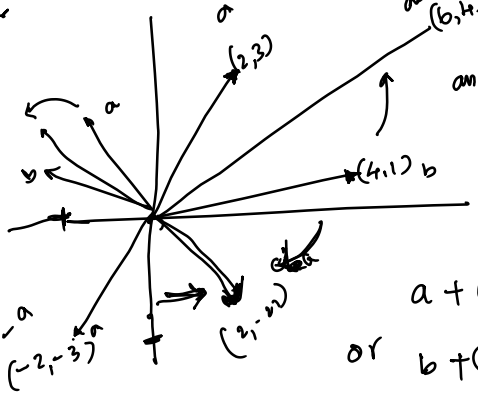
adding → anticlockwise

Sub → clockwise

Vector Additions

Can we Substract vectors ?

Given two vectors add them it moves in anti clockwise direction.



vectors

(a+b)

a	(2,3)
b	(4,1)
ab	(6,4)

$a + (-b)$

or $b + (-a)$

$a_4 = (a - b)$

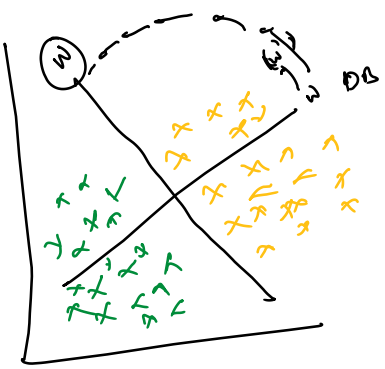
$b + (-a) =$

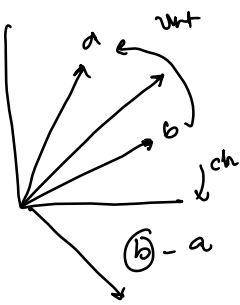
addition

Perceptron ←

shift, rotate

position (w)





DB, Hyperplanes

half spaces

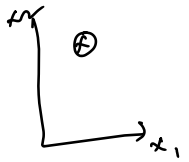
distance from origin to plane

distance of vector to plane

Sum / mean distance of all data points

avoid +ve and -ve distance

→ Maximize ↑ f(*) or Minimize f(*) ↓



Maximize or Minimize

$$\sum_{i=1} \frac{w^T \cdot x + w_0}{\|w\|} \quad x \in$$

(x) → data point

f(w, x) → f(w, w0, x)

the values of w and w0 such that

f(w, w0, x) taken max possible value

f(w, w0, x) taken Min possible value

→ Maximizing Sum / mean max (dist b/w the nearest

distance b/w two planes

Projection

Addition

elimination

9x + 2y + 3y − 10 = 0

2 9x + 20y − 100 = 0

iterative optimization:

Gauss Siedal

Newton-raphson methods

Gradient descent ↑ optimization

Calculus →

Newton → (w0, w)

0 = 10x1 + 20x2 + 30x3 + ... 10x10 + 90 = 0

Minimize error

Maximize distance of all points DB

→ Unit vector

→ projection

→ distance b/w parallel planes

→ vector additions