Recap

29 October 2025 20:30

What does the perceptron do ?

Update weights => better boundary / Move boundary

How does it start ?

Random weights => Random boundary

How does it Move forward ?

Visits every point.

Misclassification or not

update the weight

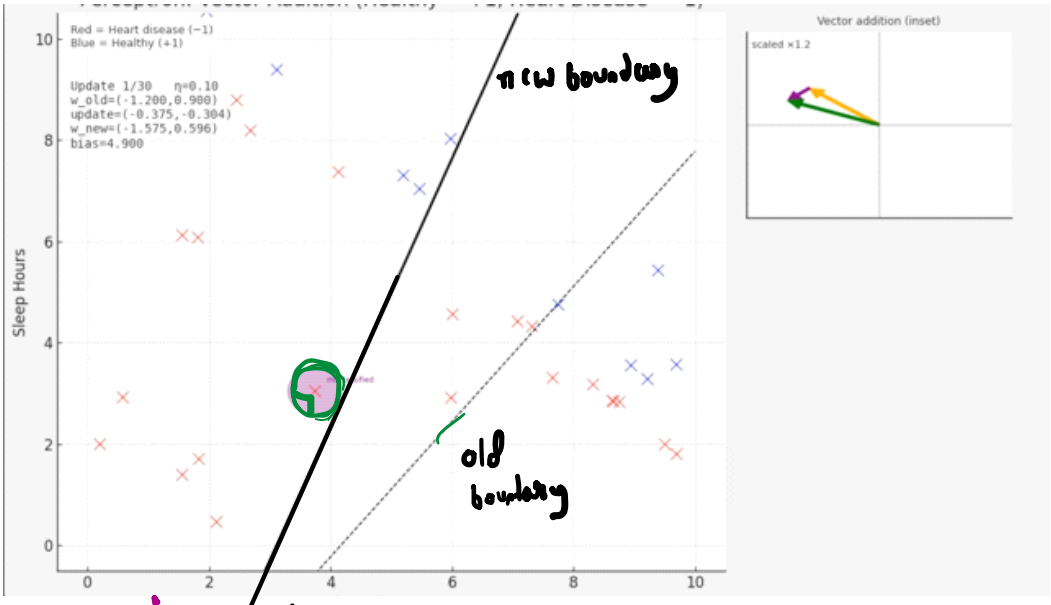
nothing. ignore

Move forward

$W_{new} = W_{old} + \lambda x_i y_i$

Move forward

$w_{new} = w_{old} + x_i y_i$

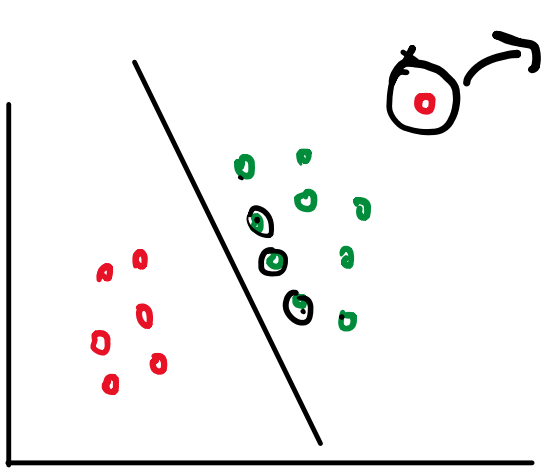


$w_{new} = w_{old} + x_i y_i$

Perceptron Drawbacks

30 August 2025 23:23

(Few Major drawbacks of the Perceptron:) Interview ✡



i) Extremely sensitive to outliers.

Multiple attempts to get a good result

ii) Higher confidence ⇒ distance.

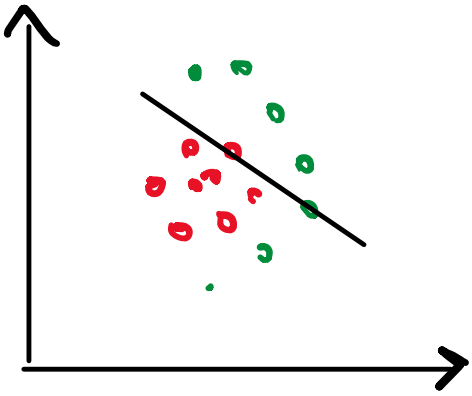
Perceptron does not consider distance

We cannot get a confidence score

iii) [No loss Function. We are not Minimizing anything.

iv) Does not handle non linearity

[Maximize distance]



Additional Discussion - Perceptron

29 October 2025 16:56

Age	Daily Exercise (mins)	Health Status	Model Prediction
25	60	+1	+1
30	30	+1	+1
45	10	-1	-1
50	5	-1	-1
28	20	+1	-1
35	50	+1	+1
40	15	-1	-1

Misclassified.

$-1 \times 28 + 1 \times 20 + 5.8 = -28 + 20 + 5.8$

$= -8 + 5.8$

$= -2.2$

$y = -x_1 + x_2 + 5.8$ Boundary equation at a particular time

or equivalently,

$y = (-1) \times \text{Age} + (1) \times \text{Exercise} + 5.8$

When the perceptron approaches a point, does it know that the point is misclassified.?

Before coding

29 October 2025 21:02

$$w_1 x_1 + w_2 x_2 + w_0 = 0$$

$$\begin{bmatrix} w_1 & w_2 \end{bmatrix} \begin{bmatrix} x_1 \\ x_2 \end{bmatrix} + w_0 = 0$$

$$\Downarrow$$

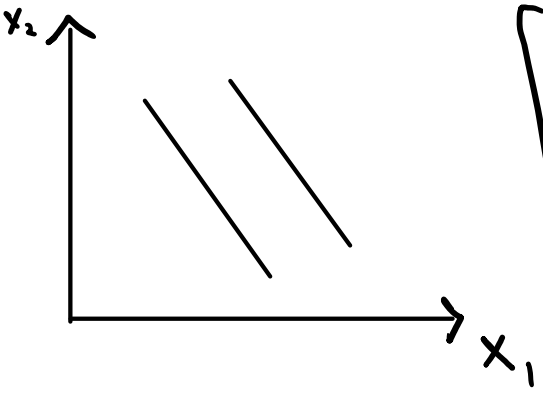
$$\left\{ \begin{bmatrix} w_1 & w_2 & w_0 \end{bmatrix} \begin{bmatrix} x_1 \\ x_2 \\ 1 \end{bmatrix} = 0 \right\} \text{ coding}$$

$$\begin{bmatrix} w_1, w_2 \end{bmatrix} \begin{bmatrix} x_1 \\ x_2 \end{bmatrix} + w_0$$

$$\left[w_{0_{new}} = w_{0_{old}} + x_i \lambda y_i \right]$$

Distance between two lines

23 August 2025 17:51



Using formulas we learnt before, can derive the formula for distance b/w two lines?

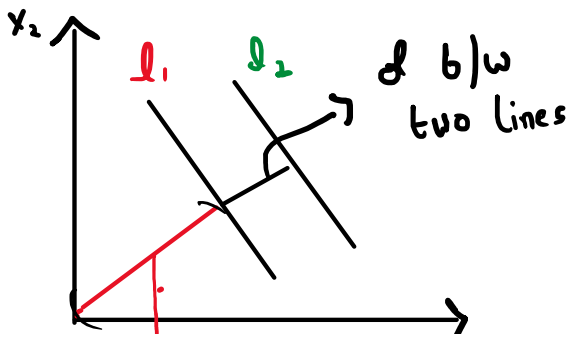
[d b/w point and line ?] [$d = \frac{|w^t x + w_0|}{\|w\|}$]

d b/w (0,0) and line $= \frac{|w_0|}{\|w\|}$

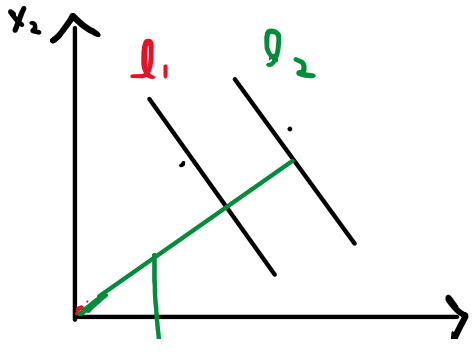
[distance of a line from origin $= \frac{|w_0|}{\sqrt{w_1^2 + w_2^2}}$]

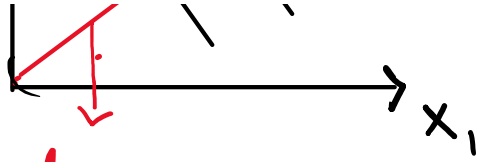
$l_1 \Rightarrow w_{a1} x_{a1} + w_{a2} x_{a2} + w_{a0} = 0$

$l_2 \Rightarrow w_{b1} x_{b1} + w_{b2} x_{b2} + w_{b0}$



d b/w two lines





{ perp distance b/w origin and L_1 $= d_1$ }

{ perpendicular dist b/w origin and L_2 $= d_2$ }

$$d_2 - d_1$$

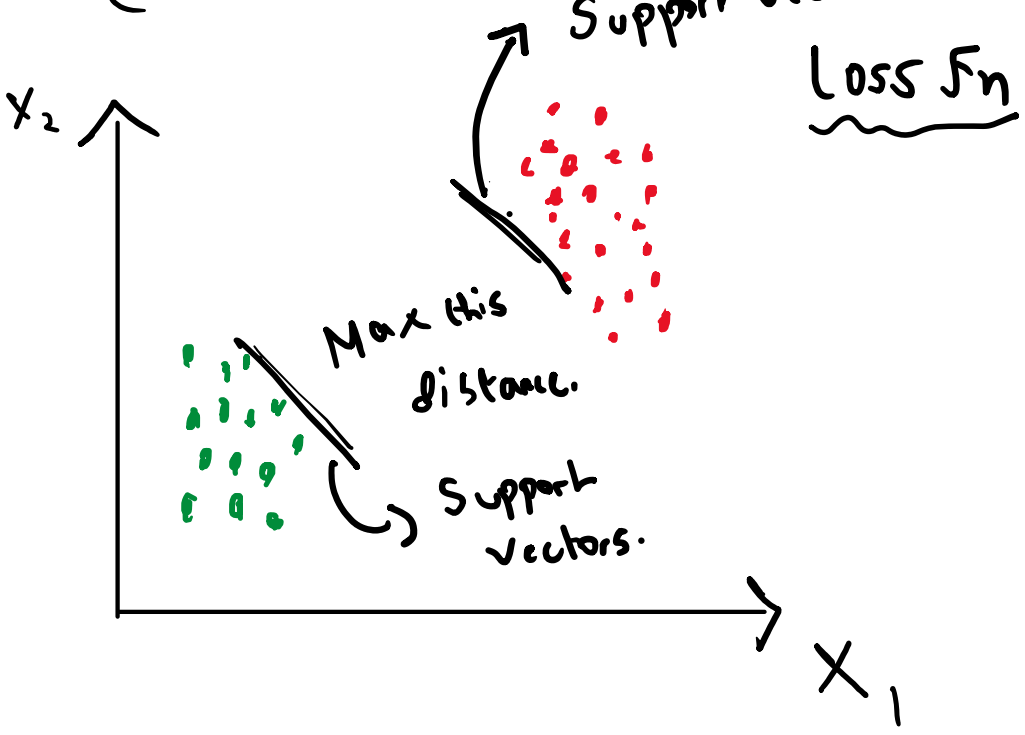
[Both lines have same w_1 and w_2]

$$\frac{|w_{02}|}{\sqrt{w_1^2+w_2^2}} - \frac{|w_{01}|}{\sqrt{w_1^2+w_2^2}}$$

$$\left[\frac{|w_{02}-w_{01}|}{\sqrt{w_1^2+w_2^2}} \right] \Rightarrow \text{distance b/w parallel lines.}$$

Link to SVM:

[Support Vector Machines]



Problem 1

25 August 2025 18:37

Given 2 lines which are parallel to each other find the distance between them

- $L1 = w_1^T \bar{x} + w_{01}$
- $L2 = w_2^T \bar{x} + w_{02}$

Where:

- w_1=$[4, 3]^T$
- w_2=$[16, 12]^T$
- w_{01}=3
- w_{02}=7

$L1 \rightarrow [4,3] \cdot x + 3$

$L2 \rightarrow [16,12] \cdot x + 7$

$$\begin{bmatrix} 4x_1 + 3x_2 + 3 = 0 \\ 16x_1 + 12x_2 + 7 = 0 \end{bmatrix}$$

$$\frac{|w_{01} - w_{02}|}{\sqrt{w_1^2 + w_2^2}}$$

$$\begin{pmatrix} 4x_1 + 3x_2 + 3 = 0 \\ \frac{16x_1}{4} + \frac{12x_2}{4} + \frac{7}{4} = \frac{0}{4} \end{pmatrix}$$

$$\left(4x_1 + 3x_2 + \frac{7}{4} = 0 \right)$$

$$\frac{|3 - 7/4|}{\sqrt{16 + 9}} = \left(\frac{3 - 7/4}{5} \right)$$

Problem 2

25 August 2025 18:32

suppose we have two vectors

vector x =[2,1,-3]

vector y=[5,8,6]

[• What is the length of the projection of x onto y?]

$[2, 1, -3]$

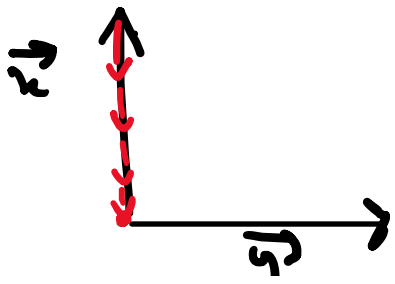
$[5, 8, 6]$

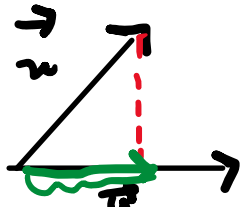
$\Rightarrow 10 + 8 - 18 = 0$

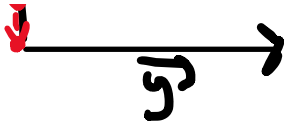
Projection $\Rightarrow$ dot product

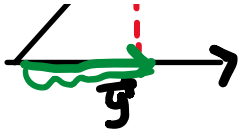
Length of projection $= \frac{[x \cdot y]}{\|y\|} \cdot \frac{0}{\|y\|} = 0$

Does a projection exist? No!!









Problem 3

25 August 2025 18:37

In the classification context we have two vectors x and w Define v=x+w

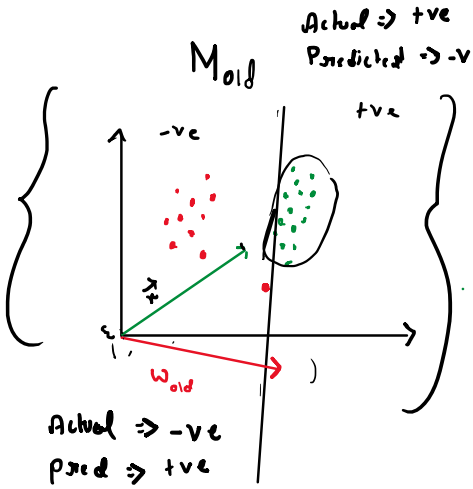
In which direction should we move w to reach v ,options are:

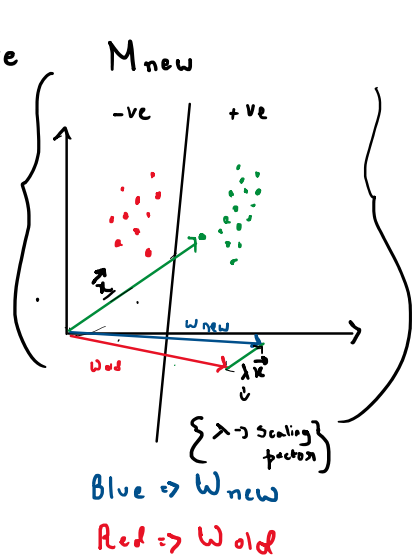
- clockwise
- anti-clockwise

$V = W_{new}$

$W_{new} = W_{old} + x$

Does boundary move clockwise or anti-clockwise?





Blue => W_{new}

Red => W_{old}

$W_{new} = W_{old} + \lambda x_i$ (if Actual = +1 but predicted as -1) => Boundary moves Anticlockwise

Similarly, if (Actual = -1) and (predicted = +1) => other way round

$W_{new} = W_{old} - \lambda x_i$ => Boundary moves clockwise

Problem 4

25 August 2025 18:42

Problem 5

Suppose we have points with very little data points and the boundry is w with $w_o = 0$,

- will this be a good classifier? No
- in which direction should w rotate to make it better

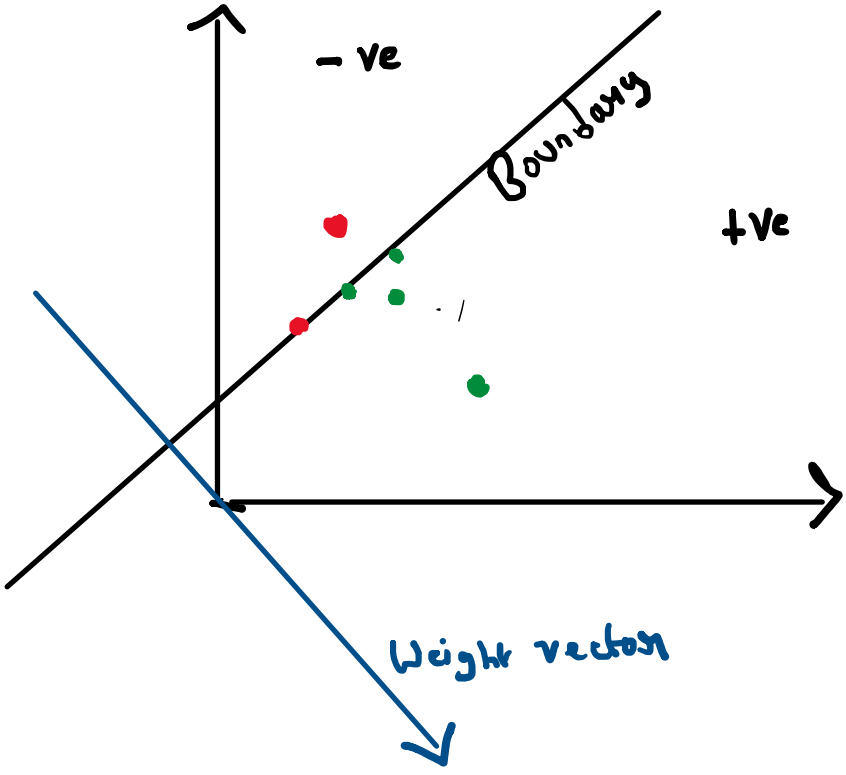
Enough data points to get a good classifier

$$w_1 x_1 + w_2 x_2 + w_0 = 0$$

$$w_1 x_1 + w_2 x_2 = 0$$

$$x_1 - x_2 = 0$$

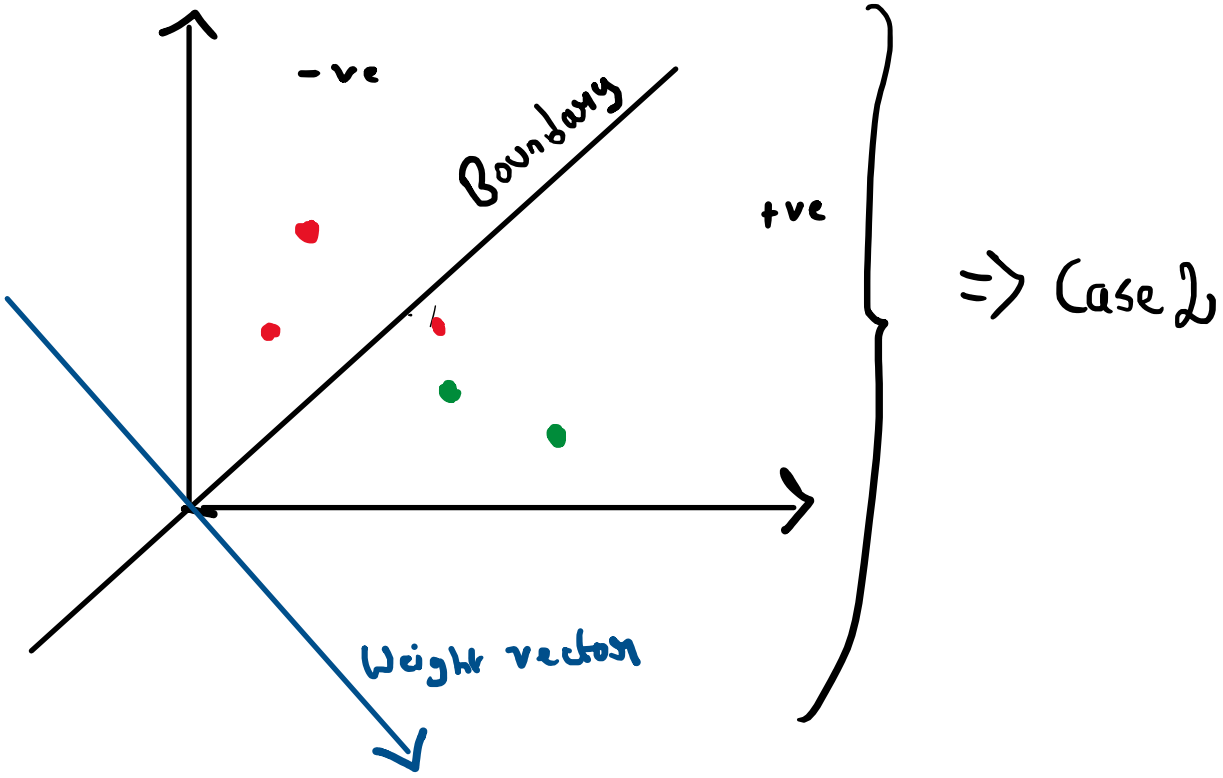
$(1, -1)$



$\Rightarrow$ Case 1

Actual :

Predicted :



=> Case 2

[Domain
(Algorithm]

Function ? in Math

Equation ✓

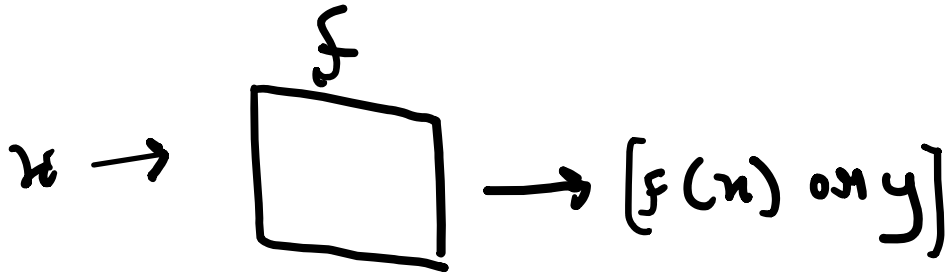
input => output. ✓

Calculation ✓

instructions ✓

transformations

operations



Domain ?

All possible inputs a fn can take

-1000 $f(x) = x + 3$ 100000

Domain $(-\infty \text{ to } +\infty)$

Range $(-\infty$ to $+\infty)$

Limited domain.

$f(x) = \frac{1}{x}$ Domain $\Rightarrow$ All real no. except 0

$f(x) = \sqrt{x}$ $[0, \infty]$

[Limited range

$\sin(x) =$

$x^2 \Rightarrow$ +ve

e^x] $(-1, 1)$