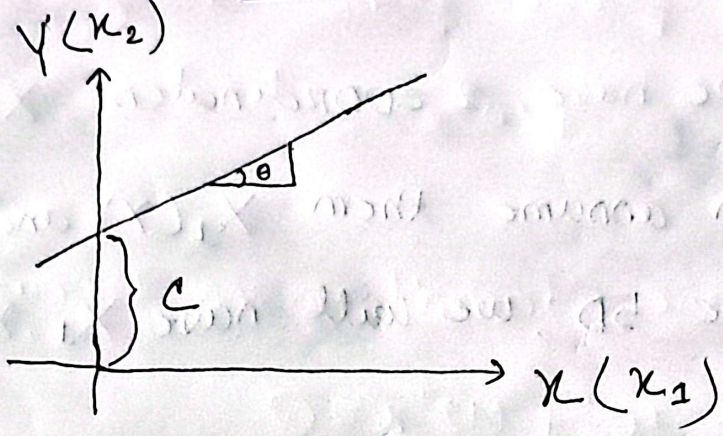
Hyper plane bor N Dimension



The equation ob that line,

$$Y = mx + c \quad \text{——— (0)}$$

m = slope ob the line

c = distance brom origin on Y axis

The general borm ob this equation is,

$$ax + by + c = 0 \quad \text{——— (1)}$$

$$\Rightarrow by = -ax - c$$

$$\therefore y = -\frac{a}{b}x - \frac{c}{b} \quad \text{——— (2)}$$

Ib we compare the equation (2) with (0) we get

$$m = -\frac{a}{b}, \quad c = -\frac{c}{b}$$

For 2D, we have 2 coordinates, X and Y, or we can assume them $X_1(X)$ and $X_2(Y)$.
If we have 5D, we will have $X_1, X_2 \cdots X_5$.

(1) $\Rightarrow$ $ax + by + c = 0$

$\Rightarrow w_1 x_1 + w_2 y_2 + w_0 = 0$

$\Rightarrow w_1 x_1 + w_2 y_2 + w_3 y_3 + \ldots + w_n y_n +$

$w_0 = 0$

Assume
$a = w_1$
$b = w_2$.
$\boxed{c = w_0}$

$$\Rightarrow \sum_{i=1}^{N} w_i x_i + w_0 = 0$$

$$\Rightarrow w_0 + \sum_{i=1}^{N} w_i x_i = 0$$

$$\Rightarrow w_0 + \underbrace{[w_1, w_2, w_3 \cdots w_n]}_{w_{1\times n}} \underbrace{\begin{bmatrix} x_1 \\ x_2 \\ x_3 \\ \cdots \\ x_n \end{bmatrix}}_{x_{n\times 1}} = 0 \quad -(3)$$

$w \cdot x = w^T x$

w, x = vector

By default vectors are column vector.

Means, $w = w_{n\times 1} = \begin{bmatrix} w_1 \\ w_2 \\ w_3 \\ \cdots \\ w_n \end{bmatrix}$; $X = X_{n\times 1} = \begin{bmatrix} x_1 \\ x_2 \\ x_3 \\ \cdots \\ x_n \end{bmatrix}$

For Dot Matrix, $w.x = w^T x$. Means, $[w_1, w_2 \ldots w_n] = w^T$.

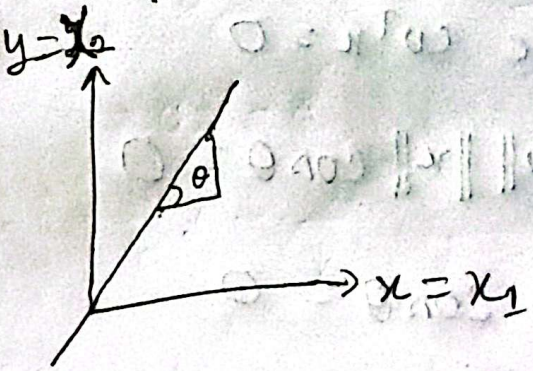
↳ Dot Product sign

∴ Equation (3) =>

$$w_0 + w^T x = 0 \quad \text{---------- (4)}$$

↳ Hyperplane equation for any n Dimensions.

But what if:



Here the slope went through center / origin.

$\therefore c = 0$

since $c = w_0$, equation (4) =>

$$0 + w^T x = 0$$

$$\therefore w^T x = 0$$

∴ If a plane pass through origin,

$w^T x = 0$

If a plane doesn't pass through origin

$w_0 + w^T x = 0$

Question: What is w?

$w^T x = w.x = \|w\| \|x\| \cos\theta$

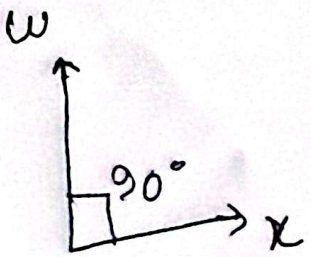
Since $w^T x = 0$

$\therefore \|w\| \|x\| \cos\theta = 0$

$\Rightarrow \cos\theta = 0$

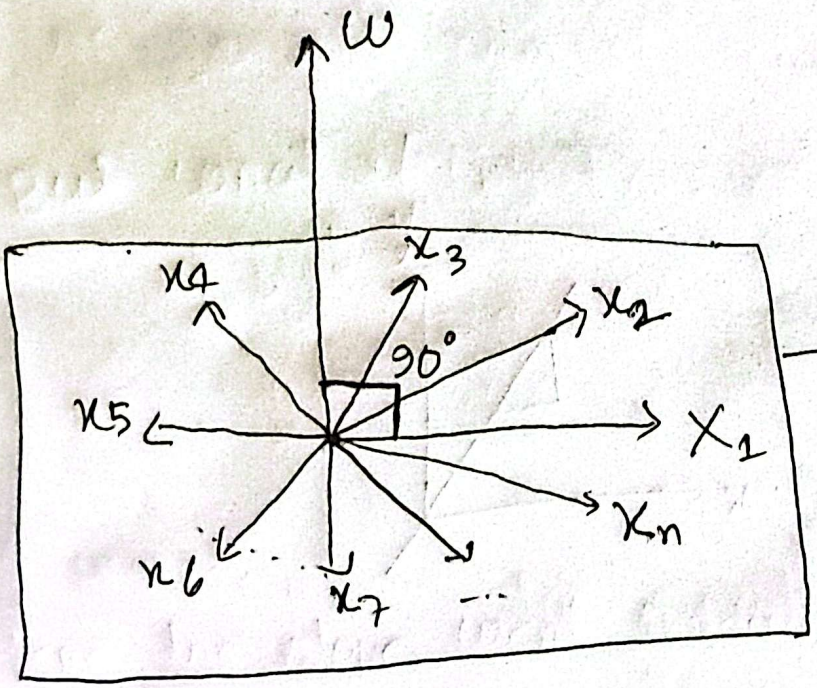
$\therefore \theta = \cos^{-1}(0) = 90°$

$\therefore \|w\| \|x\| \cos\theta$ will be 0 if θ between w and x is 90°.



$w \perp x$

Here w and x are vectors. $w = [w_1, w_2 \dots w_n]$ and $x = [x_1, x_2 \dots x_n]$. So x is the coordinates / axes of N Dimension and since $w \perp x$, w is perpendicular of all the axis of N Dimension.



→ plane, where X lies.

More general image: