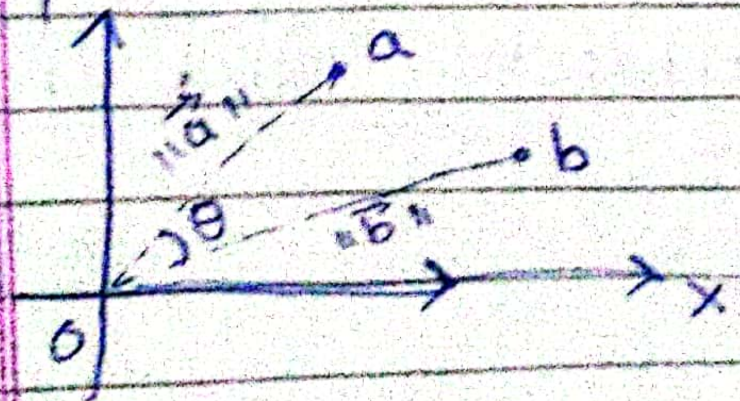
→ Dot Product of 2 vector

$$\vec{a} \cdot \vec{b} \Rightarrow a_1 * b_2 + a_2 * b_2 + \cdots + a_n * b_n$$

$$\Rightarrow [a_1, a_2, a_3 \cdots a_n]_{1\times n} * \begin{bmatrix} b_1 \\ b_2 \\ b_3 \\ \vdots \\ b_n \end{bmatrix}_{n\times 1}$$

∴ its a matrix multiplication conversion

$$\vec{a} \cdot \vec{b} \Rightarrow a^T * b = \sum_{i=1}^{n} a_i b_i = \|\vec{a}\| * \|\vec{b}\| * \cos\theta$$



$$\vec{a} \cdot \vec{b} = \|\vec{a}\| * \|\vec{b}\| * \cos\theta$$

Note:- $\|\vec{a}\|$ is magnitude of a i.e. distance of point a from the origin

So, ~~where~~, $\cos\theta = \dfrac{\vec{a}\cdot b}{\|\vec a\|\,\|\vec b\|} = \dfrac{\sum_{i=1}^{n} a_i b_i}{\sqrt{\sum_{i=1}^{n} a_i^2} + \sqrt{\sum_{i=1}^{n} b_i^2}}$

So, 2D → $\cos\theta = \dfrac{a_1 b_1 + a_2 b_2}{\sqrt{a_1^2+a_2^2} * \sqrt{b_1^2+b_2^2}}$

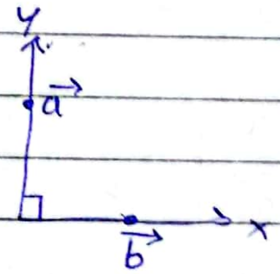
$$\vec a \cdot \vec b = [a_1\ a_2 \cdots a_n] * \begin{bmatrix} b_1 \\ b_2 \\ \vdots \\ b_n \end{bmatrix} = a^T b$$

$$\theta = \cos^{-1}\left[\frac{\sum_{i=1}^{n} a_i b_i}{\sqrt{\sum_{i=1}^{n} a_i^2} + \sqrt{\sum_{i=1}^{n} b_i^2}}\right]$$

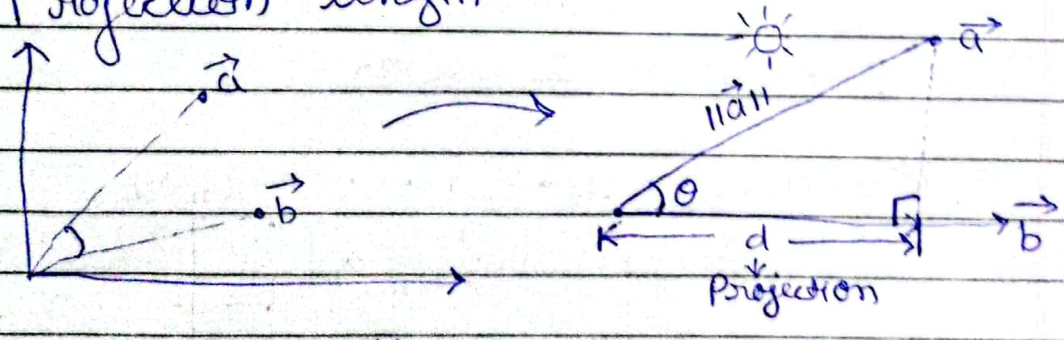
if,

$a\cdot b = 0$ → angle $= 90°$

$a\cdot b = \underbrace{\|a\|}_{(+ve)}\ \underbrace{\|b\|}_{(+)ve}\ \underbrace{\cos\theta}_{0}$



→ Projection length



So, $\cos\theta = \dfrac{adj}{hyp} = \dfrac{d}{\|\vec a\|}$

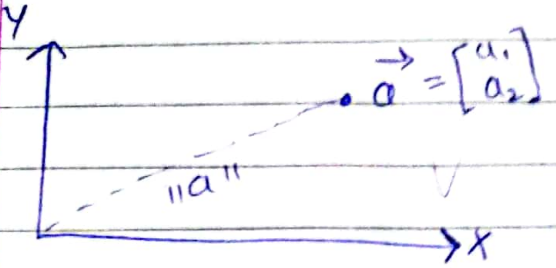
ie→ $d = \|a\| \cdot \cos$

now, multiply & divide by $\|\vec b\|$

$$d = \frac{\|\vec a\|\,\|\vec b\|\cos\theta}{\|b\|}$$

$d = \dfrac{a\cdot b}{\|b\|}$ = lengeth of projection of b in a

→ Unit Vector ($\hat{a}$) i.e. direction of the vec



$$\Rightarrow \frac{\vec{a}}{\|\vec{a}\|} = \hat{a}$$

$\hat{a}$ is in same direction as $\vec{a}$

vector represent magnitude & direction i.e.
$\|\vec{a}\|$ $\hat{a}$

$$\Rightarrow \vec{a} = \|\vec{a}\| \times \hat{a}$$

→ Projection vector

Projection length, $d = \frac{a \cdot b}{\|b\|}$ i.e. magnitude

direction will be $\vec{b} \Rightarrow \hat{b} = \frac{\vec{b}}{\|b\|}$

So, projection of vect a on vect b ⇒

$$\Rightarrow Proj_{\vec{a}} \vec{b} = \frac{a \cdot b}{\|\vec{b}\|} * \frac{\vec{b}}{\|\vec{b}\|}$$

Note :- Logistic regression :- uses Dot product

ML algo :-> Logistic regression, linear regression
→ Support vector machine

NLP :-> BOW (Bag of words), ~~tfidf (Term~~
→ tfidf : Term frequency inverse doc freq.

Dimensionality reduction → PCA : Principal Component Analysis
→ Tsne : T-distributed stochastic neighborhood embedding