Vector

vector can be represented as a **one-dimensional array**, either as a column vector (vertical array) or a row vector (horizontal array) [02:01].

It represent direction & length(also called Magnitude).
V1 =(x1, x2,x3...xn).   V2 =(y1, y2,y3...yn)

V1=[1,2,3]   v2 =[4,5,6]

V1 **+** v2 = [5,7,9]

V1 **-** v2 =[3,3,3]

Addition & subtraction

V1+_V2= (x1+-y1,x2+-y2,.....xn+-yn)

Dot product (multiplication)

V1**.**V2 =x1*y1+x2*y2+x3*y3.....xn*yn). $\sum_i^n xi *$yi

V1**.**V2= v1*v2= [4,10,18]=4+10+18=32

Vector Algebra

$v_1 = (x_1, x_2, \cdots, x_n) \in \mathbb{R}^n$

$v_2 = (y_1, y_2, \cdots, y_n) \in \mathbb{R}^n$

$v_1 \bullet v_2 = x_1 y_1 + x_2 y_2 + \cdots + x_n y_n$

$= \sum_{i=1}^{n} x_i y_i$

- Addition/Subtraction
- Dot Product
- Length/Magnitude
- Angle between two vectors

Length (Magnitude)$\overrightarrow{v1}$

Length v1 =squreroot[1,2,3] = 1*1+2*2+3*3 =1+4+9=squreroot(14)

<u>Length</u>:- $\vec{v} = (x_1, x_2, \cdots, x_n)$

$|\vec{v}| = v = \sqrt{\vec{v} \cdot \vec{v}} = \sqrt{x_1^2 + x_2^2 + \cdots + x_n^2}$

<u>Ex</u>: $\vec{v} = (1, -1, 2)$

$|\vec{v}| = \sqrt{1^2 + (-1)^2 + 2^2}$

$= \sqrt{1+1+4}$

$= \sqrt{6}$

Angle between 2 vector

<u>Angle</u>: $\vec{v}_1, \vec{v}_2 \in \mathbb{R}^n$ $\theta = \cos^{-1}\left(\frac{\vec{v}_1 \cdot \vec{v}_2}{|\vec{v}_1||\vec{v}_2|}\right)$

linear combination of vectors:

Example:

If you have two vectors, v_1 = and v_2 =, and scalars $c_1 = 2$ and $c_2 = -1$, the linear combination would be:

- **v_1 = [2, 1]**
- **v_2 = [-1, 3]**

2 *v1 + (-1) *v2 = 2(2,1)+ -1(-1,3) =(4+1,2-3) =[5,-1]

linearly independent(LI): if linear combination(Addition) of vectors is equal to Zero (2v1+(-1)v2 =0, if and if c1, c2 scalar(2, -1) should zero.
Ex. C1V1[1,2], c2V2 [-1,-2]. =0 but c1, c2 not zero , So, vector linear dependent.

linearly dependent(LD): if linear combination of vectors is equal to non-Zero (2v1+(-1)v2 =[5,-1]

Orthogonal Vector : if vector **v1, v2 . There dot product is zero .**

V1 . V2 = 0 v1 *v2 =0

if **u = (u1, u2, ..., un)** and **v = (v1, v2, ..., vn)**, the dot product is: u·v=u1v1+u2v2+...+unvn=0

Orthnormal vector : 1. if vector is orthogonal i.e . dot product is zero. And
2, length or magnitude is 1.

Example in $\mathbb{R}^2$

u=[1,0],**v**=[0,1]

- **Dot product**:

u·**v**=(1)(0)+(0)(1)=0+0=0

- **Magnitudes**:

‖**u**‖=‖**v**‖=1 ,
Ex, u = squrroot (1^2+0^2) = 1

V = squrroot (0^2+1^2) = 1

- **u = (1, 0)**
- **v = (0, 1)**

Check Orthogonality:

- Dot product: $u \cdot v = 1 \cdot 0 + 0 \cdot 1 = 0$. They are orthogonal.

Check Norm (Magnitude):

- For **u**: $||u|| = \sqrt{1^2 + 0^2} = \sqrt{1} = 1$
- For **v**: $||v|| = \sqrt{0^2 + 1^2} = \sqrt{1} = 1$

Both vectors have a magnitude of 1 and are orthogonal, so **{(1, 0), (0, 1)}** is an orthonormal set.

LI & orthogonal : -

LI is addition is zero & in orthogonal dot product is zero

Exercise:

https://colab.research.google.com/.

```
import numpy as np



v=np.array([1,-1,2])

u=np.array([2,5,2])



print("add two vector",v+u)

print("subtract two vector",v-u)

print("dot product:",np.dot(v,u))



#scalar product

print("scalar product",3*v)



#find magnitude(length of vector)

print("length of vector :",np.linalg.norm(v), " u:",np.linalg.norm(u))
```