Linear Algebra for Machine Learning:

* **Vectors:**

**Has 2 components: direction and length/magnitude.**

**Eg. =[3,1] where x = 3 and y = 1 component.**

**=[-2,3] where x = -2 and y = 3 components**

**Length of the vector in 2d:**

**||v||2  = 32+12  = 9+1 =**

**V =**

**Vector Addition:**

**V = [3,2]**

**U = [1,4]**

**V+U = [3+1 , 2+4] = [4,6]**

**U+V = [1+3 , 4+2] = [4,6]**

**Thus v+u = u+v = [4,6].**

* **Thus Vector addition is commutative**

Vector multiplication using scalar

V = [1,4]

2V = [2,8]. = Two times the size and magnitude as V.

-V = -1 X [2,8] = [-2 , -8] -> Completely changes the direction of the vector direction.

Vector Subtraction:

V = [3,3]

U = [4,1]

V-U = V + (-U) 🡪 Here we can see from the above that v-u is the same as v+(-u).

Thus:

V-U = [3,3] + [-4 , -1]

* V-U = [-1,2]

Vector with 3 components:

V = [1,4,3] = x = 1, y = 4, z = 3

Hence we need to plot it in 3d plane.

Fun point: The way 3d plane is shown as represented because, we always look at the plane from top-down approach. Hence when z is added we get depth and looks different.

Length of the 3-D Vector:

V = [1,-6,4]

||V|| = [12,-62,32] => 🡺

**Common equation = sq\_root(x12+x22+x32+…..xn2]**

Definition of Rn.

V = [v1 , v2] belongs to Rn i.e 🡪 R2

U=[u1 , u2 , u3] belongs to Rn 🡪 R3

W = [w1,w2,w3…wn] belongs to Rn 🡪 Rn

Rn  is the set of all n-tuples of real numbers.

**PROOF THAT VECTOR ADDITION IS COMMUTATIVE AND ASSOCIATIVE.**

**Commutative**

A=[A1,A2,...,An]

B=[B1,B2,...,Bn]

A+B=[A1+B1,A2+B2,...,An+Bn]

A+B=[B1+A1,B2+A2,...,Bn+An]

* B+A.

∴[A+B]=[B+A]

**Associative:**

A =[ a₁ + a₂]  
B =[ b₁+ b₂]  
C = [c₁ + c₂]  
so  
(A + B) + C =  (a₁ + a₂ + b₁ + b₂ )+ c₁+ c₂   .............................i  
again  
A + (B + C) = a₁ + a₂ +( b₁ + b₂ + c₁+ c₂ )   .............................ii  
so i = ii  
so (A + B) + C =  A + (B + C)

**Algebric properties of vectors:**

### Commutative (vector) P + Q = Q + P

### Associative (vector) (P + Q) + R = P + (Q + R)

### Additive : (P + 0) = P = (0 + P) = P

### Additive inverse P + (-P) = 0

### Distributive (vector) r(P + Q) = rP + rQ

### Distributive (scalar) (r + s) P = rP + sP

### Associative (scalar) r(sP) = (rs)P

**Definition of dot products:**

U = [u1+u2+u3+…un]

V = [vi+v2+v3v…vn]

U.V = u1v1 + u2v2 + u3v3 + …..UnVn.

Hence it returns a single NUMERIC [eg 15] value. Hence it is also known as scalar product.

Angle between two vectors.

----🡪 θ=cos−1a⃗ .b⃗ /|a⃗ ||b⃗ |

Orthagonal vectors.

cosθ= a⃗ .b⃗ /|a⃗ ||b⃗ |

cos 90 = a⃗ .b⃗ /|a⃗ ||b⃗ | => 0. [cos90 is 0]

thus a⃗ .b⃗ = 0.

**Two vectors a⃗ .b⃗ are orthogonal if and only if**

a⃗ .b⃗ = 0.