# Linear Algebra- Coursera Class Notes

1. LA is a study of vectors, vector spaces and a mapping between vector spaces
2. It emerged from the system of linear equations.
3. Basically solving 2 types of problems
   1. Solving system of linear equations
   2. Fitting some data with an equation with some parameters

In Spatial terms, vectors can be thought of as describing directions along some axes in a coordinate space. A vector has 2 properties- a length and direction.

In other terms, vectors can be thought of as an ordered list- describing various components. It can be considered as an object that moves around in the space (physical or parameter space). It can used to describe data (considering that its elements are the attributes of the data).

Fundamental Operations with Vectors:

1. Vector Addition:
   1. Associative Property: a+(b+c) = (a+b)+c
   2. Commutative Property: a+b = b+a
2. Scalar Multiplication: 3a

**Dot Product:**

1. Commutative: r.s = s.r
2. Distributive over vector addition: r.(s+t) = r.s + r.t
3. Associative over scalar multiplication: r.(3s) = 3(r.s)
4. r.s = |r||s|cos(theta) => the dot product gives the extent to which the 2 vectors go in the same direction. For orthogonal/perpendicular vectors, the dot product will be 0
5. **Scalar Projection**: of a vector s over vector r, with an angle theta between them is given by |s|.cos(theta) = r.s/|r|
6. **Vector Projection**: of a vector s on vector r, in the direction of r is given by
7. Transforming a vector in one basis vector space to another basis vector space. This can be accomplished by finding vector projections of the vector in the new basis

**Basis:** It is a set of n vectors s.t.

1. They are linearly independent
2. Span the space

This would then give rise to a n-dimensional vector space.

They don’t necessarily have to be of unit length and orthogonal to each other. If they aren’t orthogonal, then transformation from one basis to another can’t be done using dot product