

1 Vector: 3 perspectives - Physics, Math, CS

$$\begin{bmatrix} 7 & 8 & 6 \\ 6 & 8 & 4 \\ 7 & 5 & 4 \end{bmatrix}$$

1.1 physics

- vectors are arrows in space with length and direction
- so vectors can be moved around in space without any issues

1.2 cs

- vectors are ordered lists of numbers

1.3 math

- seeks to generalize both of these views and defines vector operations such as addition and multiplication

1.4 In linear algebra

- graham suggests to view vector as arrow with tail always fixed at origin
- maybe i can imagine a vector as a operation of shifting the origin
- thus when we do vector addition we will start the second vector from the start of first vector, since the origin has been shifted by the first vector
- Note: "but" it could really be shifting of all the points in the coordinate system (as told by graham)

1.5 Scalars

- The numbers that we multiply the vector with to scale the vector in its original direction
- since it's used frequently it just interchangeable with number

2 Linear Combinations, Spans, Basis Vectors

2.1 Vector Coordinates

- vector coordinates are the number numbers present in a vector
- Each of the vector coordinates is also a scalar that scales the basis vectors of the coordinate system \hat{i}, \hat{j}

2.2 Span

Span of \vec{v} and \vec{w} are the set of all of their linear combinations

$$a\vec{v} + b\vec{w}$$

Note: Its common to think a collection of vectors as points, due to clustering/noise

2.3 Linearly dependent Vectors

- If the third vector can be formed by linear combination of the other vectors then the vectors are said to be linearly dependent
- If we cannot get a vector by linear combination of other vectors then then those vectors are called as linearly independent

2.4 Basis

- basis of a vector space is a set of linearly independent vectors that span the full space

3 Linear Transformation and matrices

Transformations are just "functions" just suggests to visualize every function as a movement of coordinates(changing of basis vectors, thus changing of all of coordinate system)

3.1 Linear transformation in graph

- every lines will remain parallel
- and origin will remain at center

3.2 Matrix Transformation

- A 2 dimensional linear transformation of a coordinates system can be entirely described just 4 numbers (a 2d matrix)
- In a matrix each of the column is the final landing basis vector
- thus, matrix \implies transformation data

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$$\begin{bmatrix} a & b \\ c & d \end{bmatrix} \begin{bmatrix} x \\ y \end{bmatrix} = x \underbrace{\begin{bmatrix} a \\ c \end{bmatrix}}_{\text{intuition}} + y \begin{bmatrix} b \\ d \end{bmatrix} = \begin{bmatrix} ax + by \\ cx + dy \end{bmatrix}$$

Note:

- by summary: Matrix \implies set of transformed basis vectors
- thus giving transformation data of the space(coordinate system)

4 Matrix Multiplication as Composition

4.1 Composition matrix

- when a series of transformation occurs the "overall" transformation matrix is called as composition matrix
- this composition matrix is formed by matrix multiplication of each transformation matrix –from right to left
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$$\begin{array}{c}
 f(g(x)) \\
 \text{Read right to left} \\
 \leftarrow \underbrace{\begin{bmatrix} 1 & 1 \\ 0 & 1 \end{bmatrix}}_{\text{2nd transformation}} \underbrace{\begin{bmatrix} 0 & -1 \\ 1 & 0 \end{bmatrix}}_{\text{1st transformation}} = \begin{bmatrix} 1 & -1 \\ 1 & 0 \end{bmatrix}
 \end{array}$$