Linear Algebra
Gilbert Strang - Lecture

Why Linear Algebra? — Math of Multivariate

- Data will be represented as vectors and matrices
- Visual Statements Training can be written as matrix operations (Matrix Multiplication)
- Ways to make matrix decomposition suitable higher order tensor decomposition

Gilbert Strang (Linear Algebra) (Learning from Data) Insight

$\begin{bmatrix} \Sigma V^T u \end{bmatrix}$

Topics
- Vectors & Matrices
- Dot product
- Matrix vector, matrix matrix multiplication
- Rank, null space, row and column spaces
- Matrix Decomposition

Vectors
- Usually will represent a data point for example a house, an image, a document
- $\begin{bmatrix} x_1 \\ x_2 \end{bmatrix}$ may represent
- number with sign, weight or height of an x_1 x_2 will be in $\mathbb{R}^2$

$\mathbb{R}^n$

- Usually a vector with n coordinates (using real values) is said to be in $\mathbb{R}^n$
- The coordinates may not stay in orthogonality
- The real numbers at least upto 3 dimensions

I am confused for not me

Modelling

$\begin{bmatrix} x_1 \\ x_2 \end{bmatrix} \in \mathbb{R}^2$

$a = \begin{bmatrix} x \\ y \end{bmatrix}$

$= \begin{bmatrix} 2 \\ 3 \end{bmatrix}$

- can be added overlapped

Matrix
- Represent full data
- May represent weights of
- Hidden layers / Map
- Linear transformation

Matrix can represent full training data

$\begin{bmatrix} 1 & 2 \\ 3 & 4 \end{bmatrix}$

$\begin{bmatrix} x & y \\ z & w \end{bmatrix}$

$a^T b$

AB

$Rank(A)$

Matrices of same dimension can be added

$\begin{bmatrix} 1 & 2 \\ 3 & 4 \end{bmatrix} + \begin{bmatrix} x & y \\ z & w \end{bmatrix} = \begin{bmatrix} 1+x & 2+y \\ 3+z & 4+w \end{bmatrix}$

Frobenius Norm

$\|A\|_F$

For $A = \begin{bmatrix} 1 & 3 \\ 2 & 4 \end{bmatrix}$

$\|A\|_F = \sqrt{1^2 + 2^2 + 3^2 + 4^2}$

Dot Product

$a = \begin{bmatrix} 1 \\ 2 \end{bmatrix}$ $b = \begin{bmatrix} 3 \\ 4 \end{bmatrix}$

$a \cdot b = \begin{bmatrix} 1 & 2 \end{bmatrix} \begin{bmatrix} 3 \\ 4 \end{bmatrix}$

$a \cdot b = a^T b$

$a \cdot b = 0 \Rightarrow$ Orthogonal

$\begin{bmatrix} 1 & 2 \end{bmatrix} \begin{bmatrix} 3 \\ 4 \end{bmatrix} = 1 \times 3 + 2 \times 4$

$\begin{bmatrix} 1 & 2 \end{bmatrix} \begin{bmatrix} 3 \\ 4 \end{bmatrix} = 11$

$\begin{bmatrix} 1 & 2 \end{bmatrix} \begin{bmatrix} 3 \\ 4 \end{bmatrix} = 0$

$\begin{bmatrix} 1 & 2 \end{bmatrix} \begin{bmatrix} 3 \\ 4 \end{bmatrix} = 1 \times 3 + 2 \times 4