Chapter Two: Mathematical fundamental for studying ANN

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Vector and Matrix foundamentals

- Matrices, vectors and vector function provide framework for visualization and computation
- Many concepts involve visualization of points in d-dimensional space
- Its easy if d is less than or equal to 3 but for d>3 its hard

Elementary matrices

- A $n \times m$ dimensional matrix arranges mn entities in an array of n rows each with m elements

$$A = [a_{ij}] \quad i=1,2....n \quad j=1,2,...m$$

Properties

- If m=n—square matrix
- If m=1---column vector
- If n=1---- row vector
- Vectors are represented by underline e.g $\underline{x}$, length of vector is also called dimension in vector space within which the vector resides
- If m=n=1 the matrix is scalar
- Transpose of A denoted by A^T is $[a_{ji}]$ j =1,2....m and i=1,2,...n
- If A= A^T matrix is called symmetric and A must be square for that

- Matrix partition

$$\begin{bmatrix} \underset{A1}{pxq} & \underset{A2}{px(m-q)} \\ \underset{A3}{(n-p)} & \underset{A4}{(n-p)(m-q)} \end{bmatrix}$$

p and *q* are real and positive integer

Matrix A of order *mxn* is partitioned as above. Such partition is useful for visualization and computation

- A column vector most important partition of a matrix is into an array of column vectors as

$$A = [\underline{a}_1 , \underline{a}_2 , \ldots\ldots.. \underline{a}_m]$$

here a_i *is a nx1 dimensional column vector*

Elementary matrix operation

- Addition (subtraction)
- Multiplication
- Scaling

C= A **X** B A is *mxn* and B is *nxp* order matrix

For this $c_{ij} = \sum a_{ik}b_{kj}$ k runs from 1 to n

Vectors

- For any positive integer 'd' let R^d represents set of all ordered n tuples of the form

$$\{x_1, x_2, \ldots\ldots\ldots x_d\}$$

- They can be viewed as the co-ordinates of a point x in d – dimensional space- and it is necessary that the co-ordinate system is specified
- A x_i co-ordinate can be represented using vector as

$$x = \begin{Bmatrix} x_1 \\ x_2 \\ . \\ x_d \end{Bmatrix}$$

Linearity

- If a mapping function holds superposition then it is said to be linear

  $x = ax_1 + bx2$ implies that $f(x) = f(x1) + f(x2)$

- Vector Matrix equation

  $$\underset{A}{\text{nxd}} \quad \underset{x}{\text{dx1}} \quad = \quad \underset{y}{\text{nx1}}$$

  - Multiple interpretation of this equations