
# Artificial Neural Network

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# ARTIFICIAL NEURAL NETWORK

## Introductory Class-0

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# Artifical Neural Network

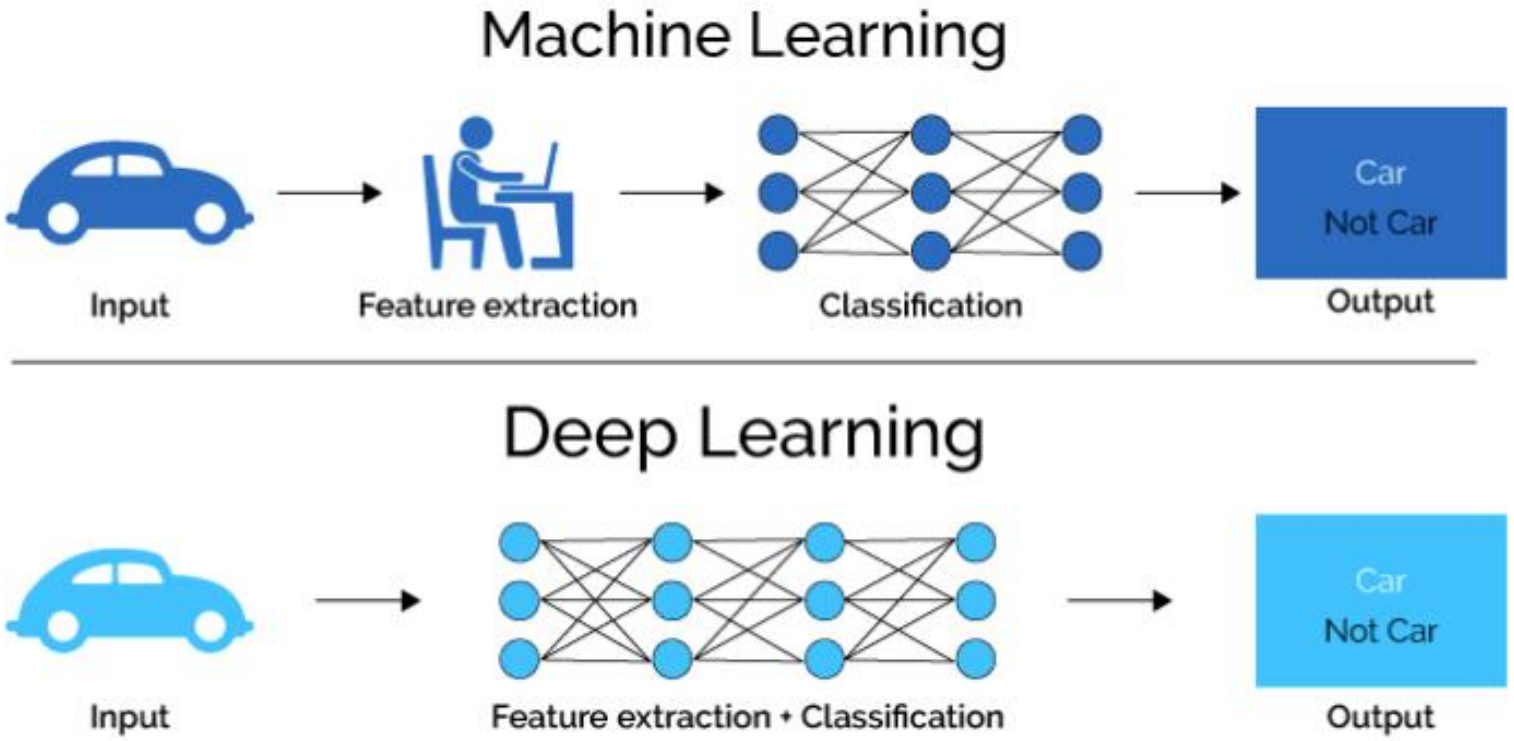
## Content

1. Motivation
2. Math required for Unit-1

# Motivation

Why Neural Network?

# Motivation-ANN



## Math Concept required

### Differentiating a function with respect to vector:

Let $a, b \in \mathbb{R}^n$ be 2 vector, then

$$\frac{\partial(a^T b)}{\partial b} = \frac{\partial(b^T a)}{\partial b} \triangleq \begin{pmatrix} \frac{\partial(b^T a)}{\partial a_1} \\ \dots \\ \frac{\partial(b^T a)}{\partial a_n} \end{pmatrix} = \begin{pmatrix} a1 \\ \dots \\ a_n \end{pmatrix} = a$$

And Let P = $P^T \in \mathbb{R}^{nxn}$

$$\frac{\partial(a^T P a)}{\partial a} = 2Pa$$

## Math Concept required

### Differentiating a function with respect to vector:


Condition Number:

If A is a square matrix, then it's condition number is defined as a ratio of maximum to minimum Eigen value of A matrix.

$$\kappa(A) = \left|\frac{\lambda_{max}}{\lambda_{min}}\right|$$

## Math Concept required

### Differentiating a function with respect to vector:

Pseudo-Inverse:

- Consider a rectangular matrix A of size MxN, the Pseudo-inverse is defined in two ways as follows:
- If the column of a matrix A are linearly independent, So $A^T$A is invertible and we obtain the following formula for Pseudo inverse:

$$A^{\dagger} = (A^T \cdot A)^{-1} A^T$$

Here, $A^{\dagger}$ is a left inverse of A.

## Math Concept required

### Differentiating a function with respect to vector:


Pseudo-Inverse:

- If the row of a matrix A are linearly independent, So A$A^T$ is invertible and we obtain the following formula for Pseudo inverse:

$$A^{\dagger} = A^T(A^T \cdot A)^{-1}$$

Here, $A^{\dagger}$ is a right inverse of A.

- If both the columns and the rows of the matrix are linearly independent, then the matrix is invertible and the pseudo inverse is equal to the inverse of the matrix.

## Math Concept required

### Differentiating a function with respect to vector:


Semi-definite:

- The Matrix A is positive semidefinite iff,
    - A is symmetric.
    - $v^T Av \geq 0$ for all $v$
- If the matrix is Symmetric and $v^T Av > 0 \; \forall \; v$ , then matrix A is called as positive definite matrix

# References


- Neural Networks: A Comprehensive Foundation S. Haykin, 2ndEdition, Prentice Hall of India, 2003.
- Google. Com
- MatheAss – Pseudoinverse
- Wikipedia


# THANK YOU

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