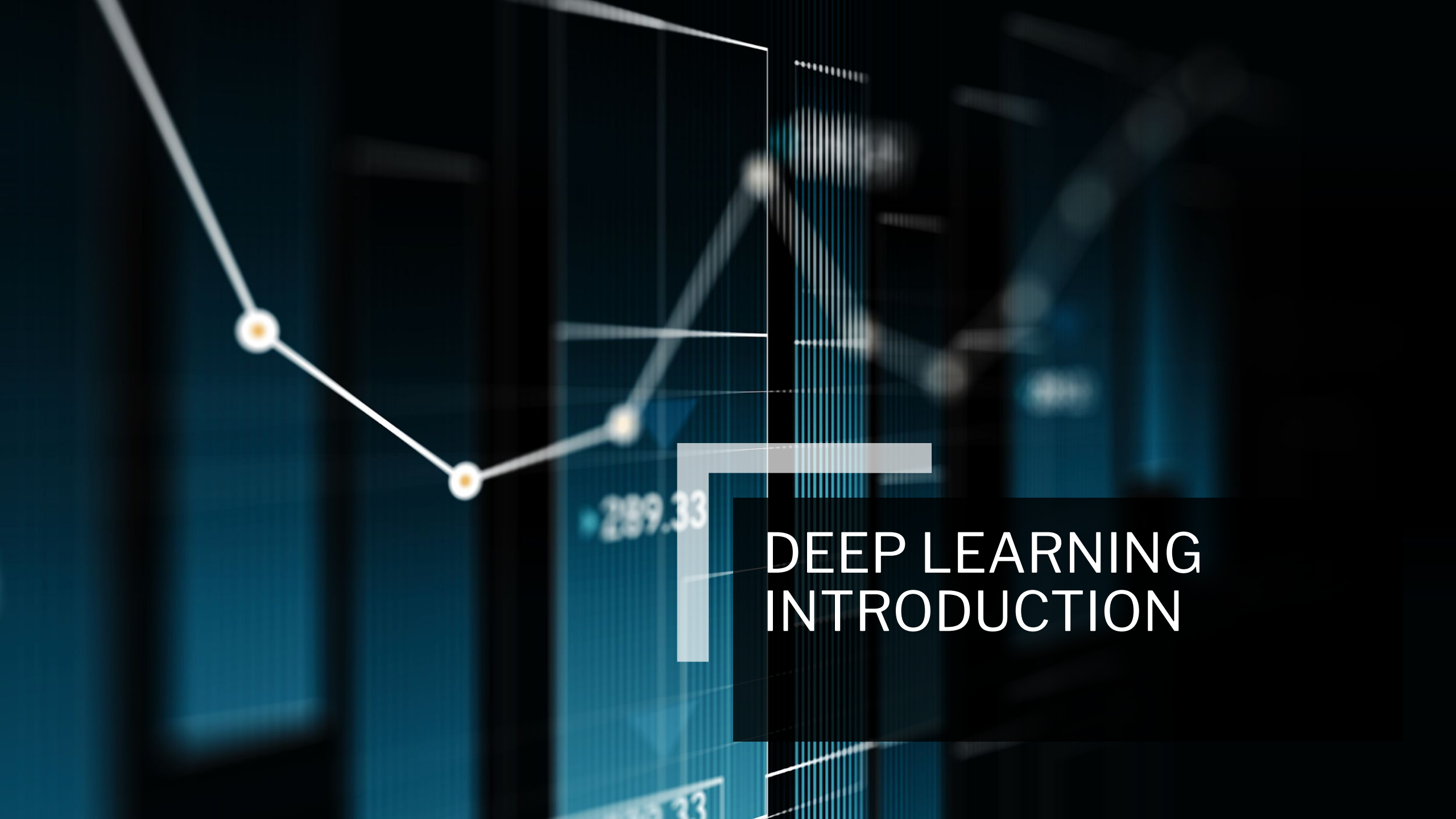


DEEP LEARNING INTRODUCTION

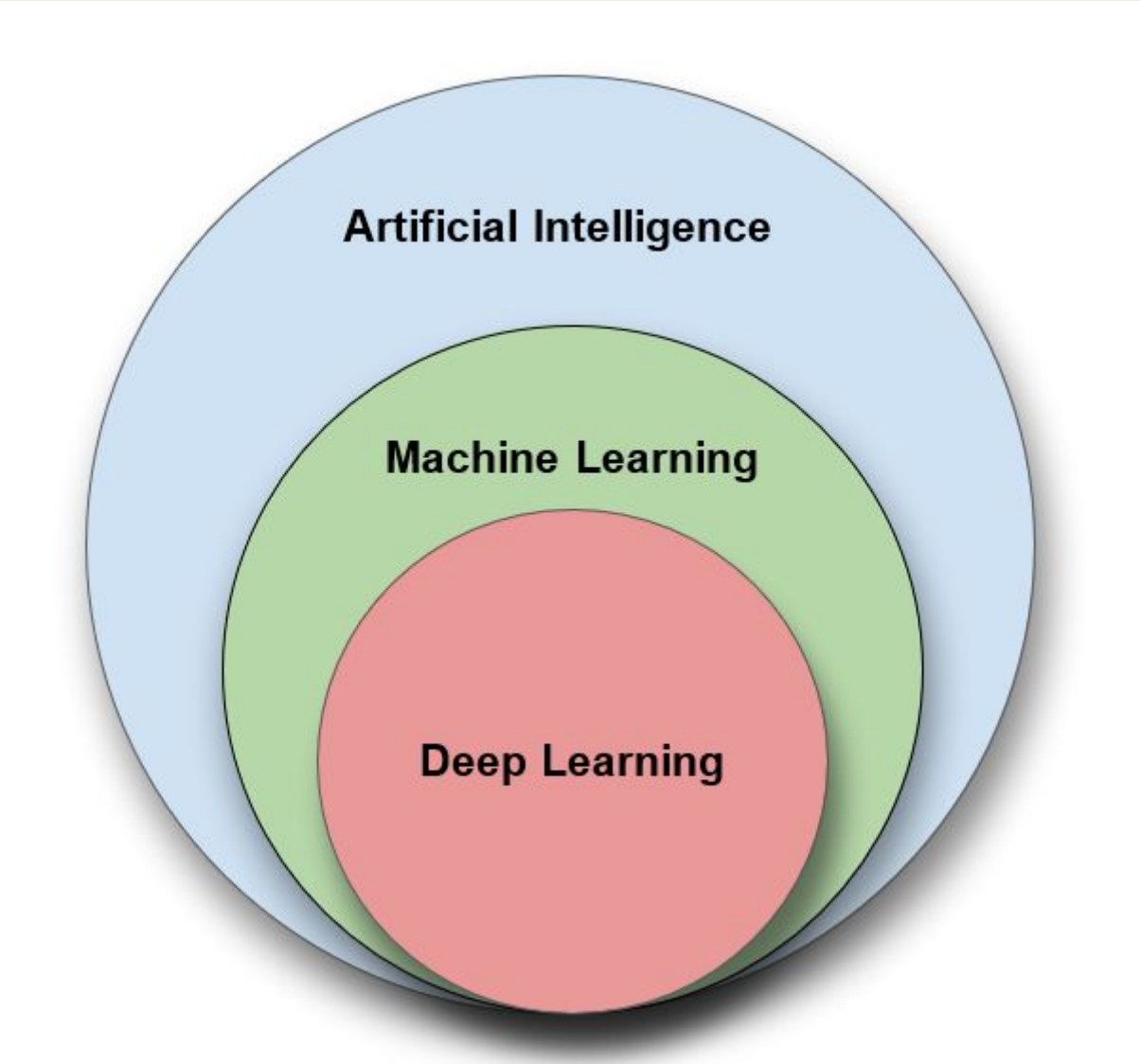
Artificial Intelligence (AI), Machine Learning (ML), and Deep Learning (DL)

AI is intelligence demonstrated by machines, as opposed to natural intelligence displayed by animals including humans.

ML is the study of computer algorithms that can improve automatically through experience and using data. It is seen as a part of artificial intelligence.

DL is part of a broader family of machine learning methods based on artificial neural networks.

Relationship of AI, ML and DL



- **Artificial Intelligence (AI)** is anything about man-made intelligence exhibited by machines.
- **Machine Learning (ML)** is an approach to achieve **AI**.
- **Deep Learning (DL)** is one technique to implement **ML**.

What is Deep Learning?

- Deep learning is a class of machine learning algorithms that:
- use a cascade of multiple layers of nonlinear processing units for feature extraction and transformation. Each successive layer uses the output from the previous layer as input.
- learn in supervised (e.g., classification) and/or unsupervised (e.g., pattern analysis) manners.
- learn multiple levels of representations that correspond to different levels of abstraction; the levels form a hierarchy of concepts.

Why Deep Learning?

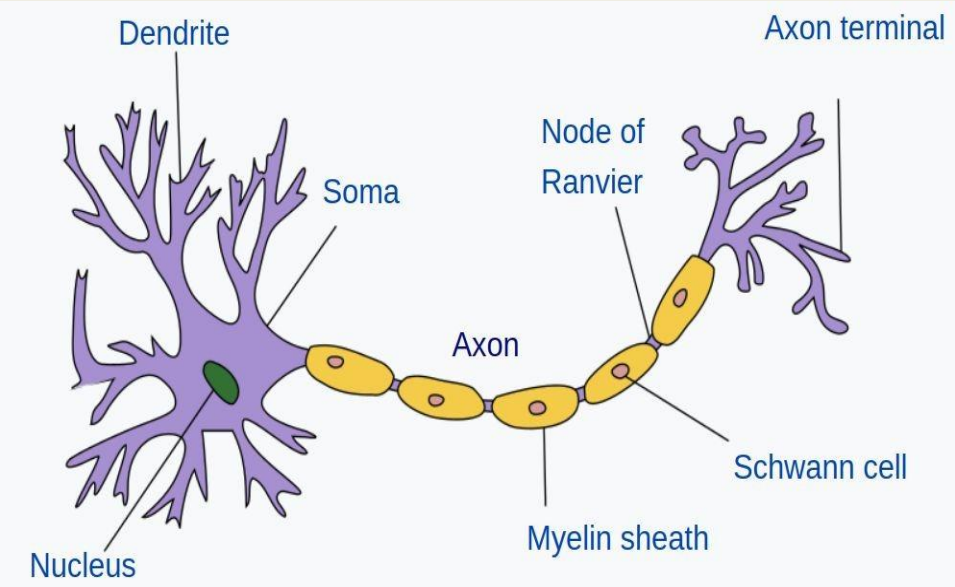
- Limitations of traditional machine learning algorithms

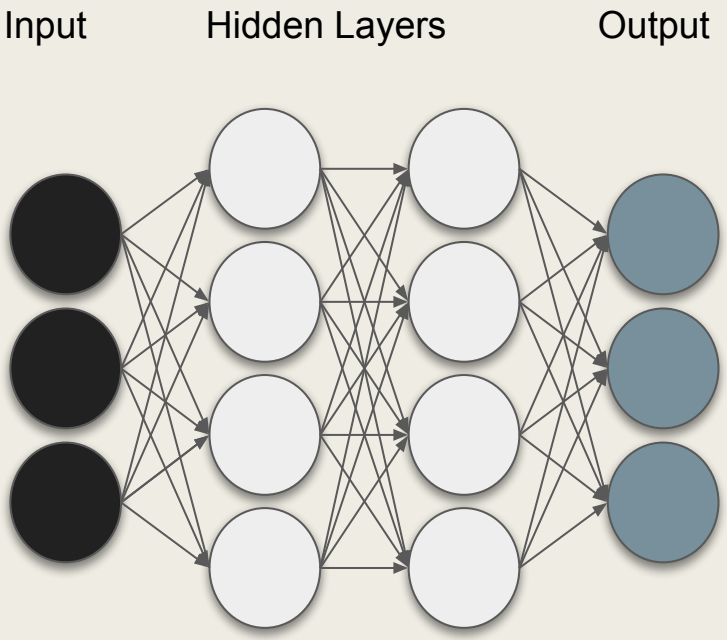
  not good at handling high dimensional data.

  difficult to do feature extraction and object recognition.

- Advantages of deep learning
  1. DL is computationally expensive, but it is capable of handling high dimensional data.
  2. *feature extraction is done automatically.*

Artificial Neural Network



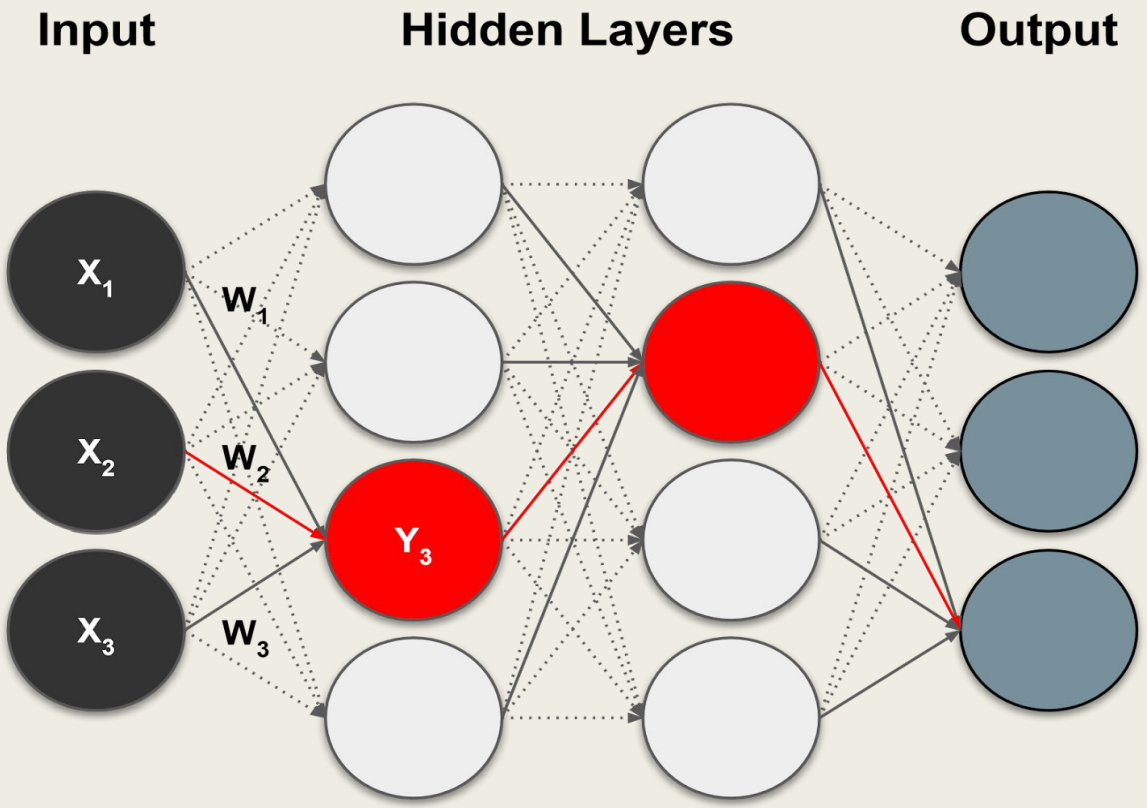


Supervised Deep Learning with Neural Networks

From one layer to the next

$$Y_j = f\left(\sum_i W_i X_i + b_i\right)$$

f is the activation function, W_i is the weight, and b_i is the bias.



Activation function, Bias.

- **Definition**:

  Activation functions introduce non-linearity into the neural network, enabling it to learn complex patterns.

- **Purpose**:

  Transform the weighted sum of inputs into an output.
  Decide whether a neuron should be activated or not.
  Enable the network to solve non-linear problems.

- **Key Idea**:

  Without activation functions, a neural network would behave like a linear regression model.

•**Linear Activation Function**: Output = Weighted Input (used rarely).

•**Non-linear Activation Functions**:

Sigmoid: Compresses output between 0 and 1.
Tanh: Compresses output between -1 and 1.
ReLU (Rectified Linear Unit): Output = max(0, input), helps with sparse activation.
Leaky ReLU: Allows small gradient for negative inputs.
Softmax: Used for multi-class classification problems.

Bias:

Definition: Bias is an additional parameter added to the weighted sum of inputs to shift the activation function.

Purpose:Allows the model to better fit the data.

Enables the network to learn patterns that do not pass through the origin.

Helps avoid symmetry issues in neurons.

- Mathematically: $Z=W \cdot X+BZ$ where: W: Weights , X: Input , B: Bias

Problem.