Artificial Intelligence

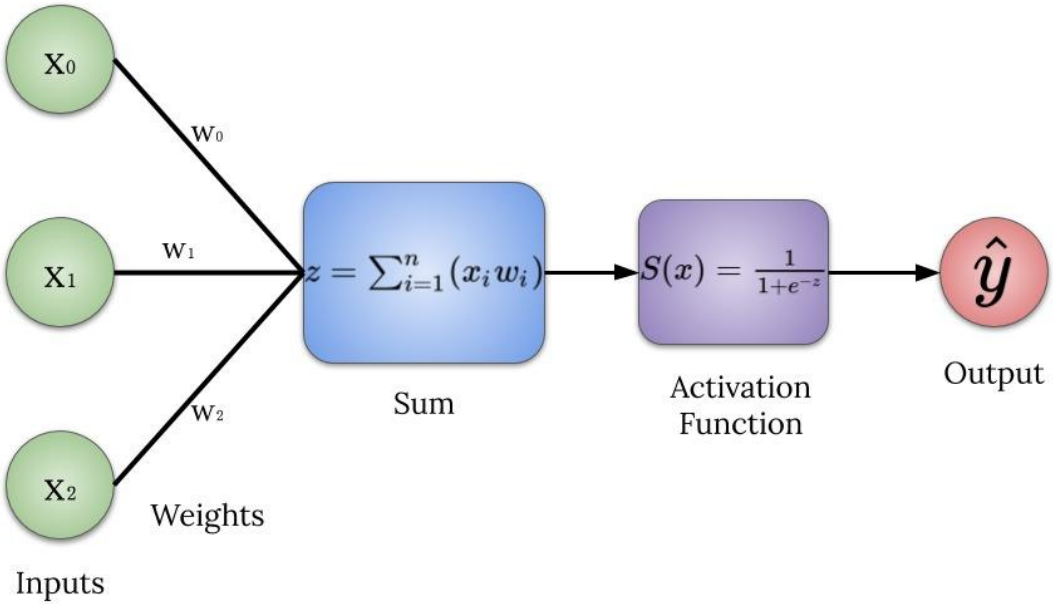
BS (CS) _Spring_2025

Lab_15 Manual

Learning Objectives:

1. Neural Network

Artificial Neural Networks (ANN)



Training ML Classifiers:

- Start with labeled data (e.g., reviews with correct labels).
- Feed data into the classifier during training.
- Model predicts a label; compare it with the actual label.
- Compute loss (error) and update model parameters using it.
- Repeat to improve model performance.

Traditional ML:

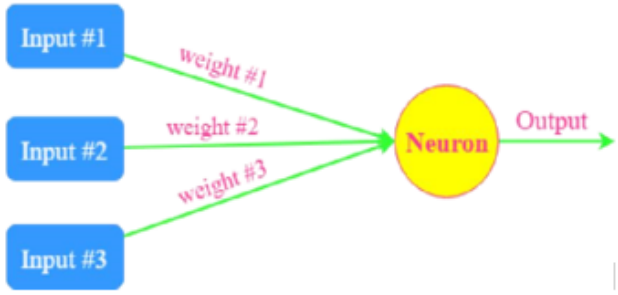
- Requires **manual feature selection** by experts.
- You choose which data features are important for the model.

Representation Learning (e.g., Neural Networks):

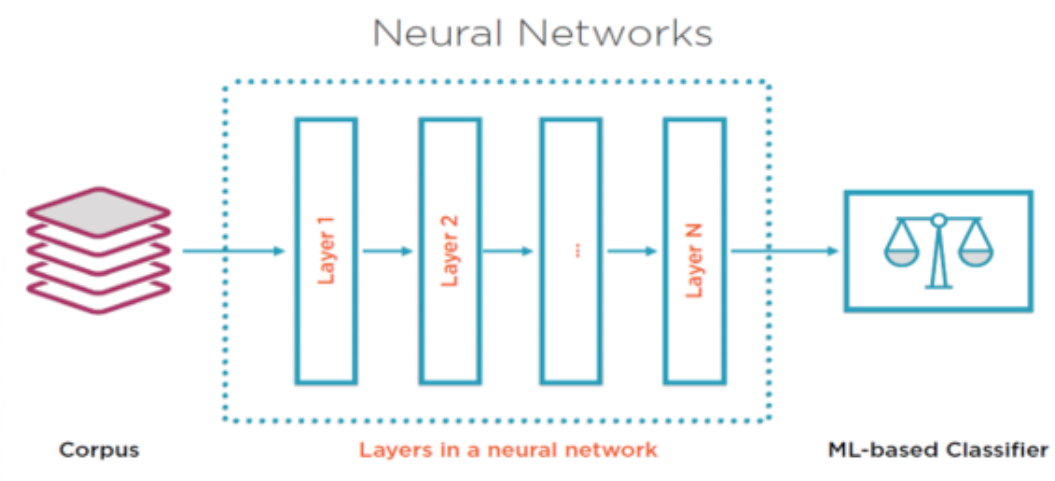
- Learns features **automatically** from raw data.
- No need for manual feature engineering.
- Neural networks are key examples of this approach

Components of a Neural Network

The fundamental building block of all neural networks we use today is the **neuron**. These are simple building blocks. Neurons are the active learning units in your neural networks that actually learn from the training data that you feed in. Now neural networks are capable of identifying patterns in very complex data sets, such as images or even videos.

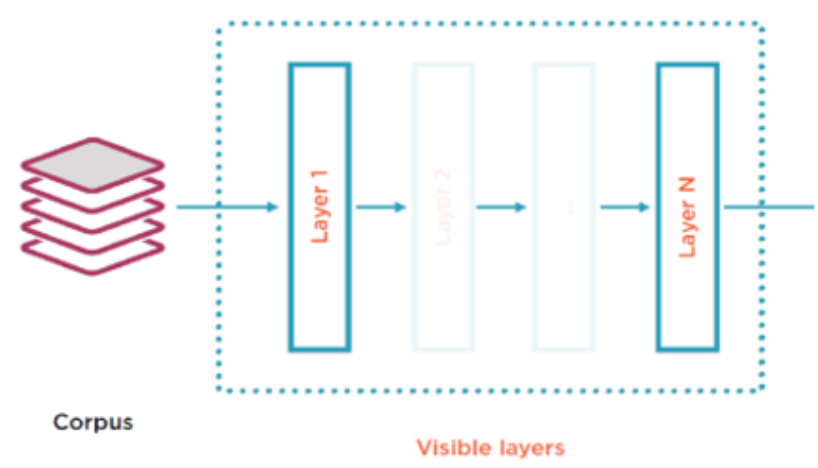


The corpus of training data is fed into and within the neural network, and within this neural network there are different layers and all of these layers share responsibility for understanding patterns and data. Different layers are responsible for understanding different details in the given data.



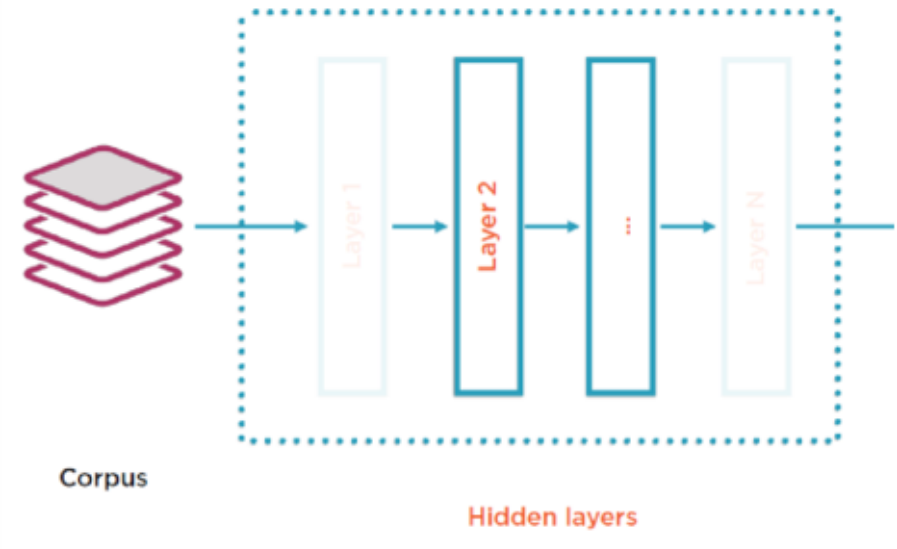
Layers that are closer to the input focus on extracting more granular details from the data. Layers feed other layers and higher-level layers are responsible for piecing these granular details together in order to understand higher-level abstractions.

The simplest way to imagine this is that each layer has its own set of patterns to identify and piece together. If you're thinking of an image classification system, the first layer, say Layer 1, will be responsible for looking at pixels. Layer 2 might pieces pixels together to find edges and corners. Layer 3 might piece edges and corners together to identify objects. And Layer 4 might piece objects together to identify features, such as a nose or a face. The layers with which we interact directly are called visible layers of a neural network.



This is the input layer where we feed in the training data and instances for prediction, and the output layer, which outputs the prediction of the neural network. This can be a classification label or a regression prediction.

The layers that we as developers do not interact with directly are termed hidden layers on the neural network. These are the layers that are responsible for extracting granular detail from the input, finding patterns, and piecing these patterns into higher-level abstractions.



Neural Network Layers:

- Each layer is made up of **neurons** (active learning units).
- Neurons are **interconnected** to pass information between layers.
- A single layer can contain **thousands of neurons**.

Example: Neural Network for AND Gate

The AND gate is a logic gate that takes two binary inputs and outputs a single binary output based on the following truth table:

Input 1	Input 2	Output
0	0	0
0	1	0
1	0	0
1	1	1

To design a neural network for the AND gate, we'll create a model that takes two inputs and outputs a single output. As AND gate is linearly separable, we'll use a simple feed-forward neural network with one hidden layer and one output layer.