# AI Essentials

## Deep Learning & Artificial Neural Networks

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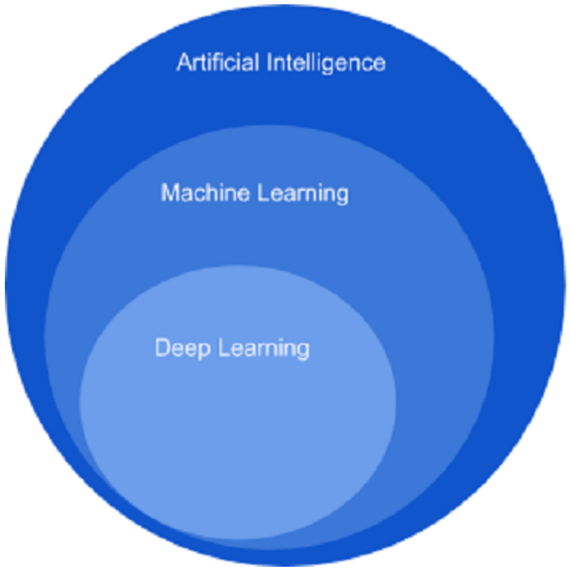
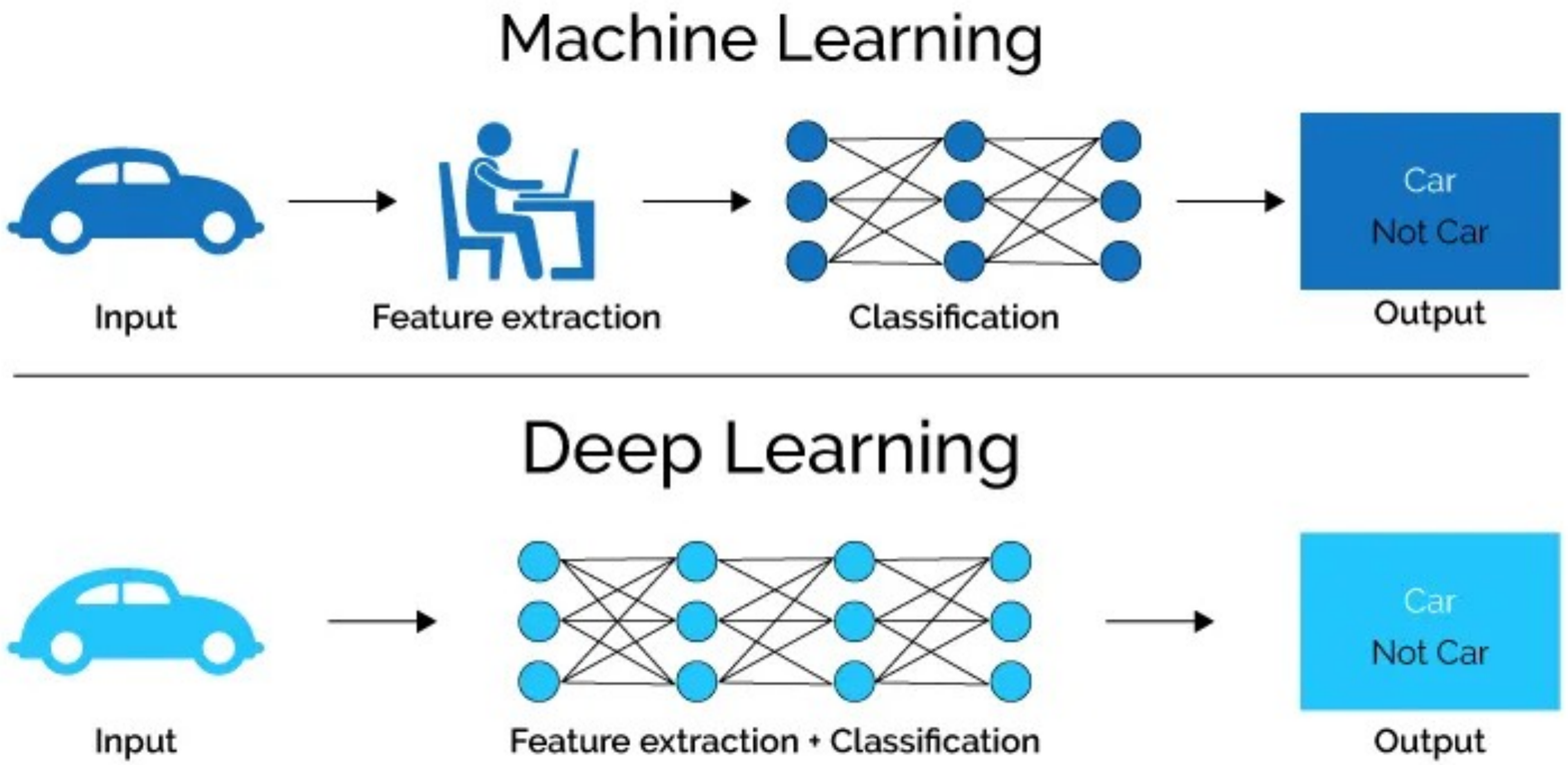
# Deep Learning

## What is DL?

- A subset of machine learning (ML)
- DL Learns features and tasks directly from data such as images, text or sound
- DL is a ML technique that automatically extracts the useful pieces of information or makes decisions using neural networks



# Deep Learning



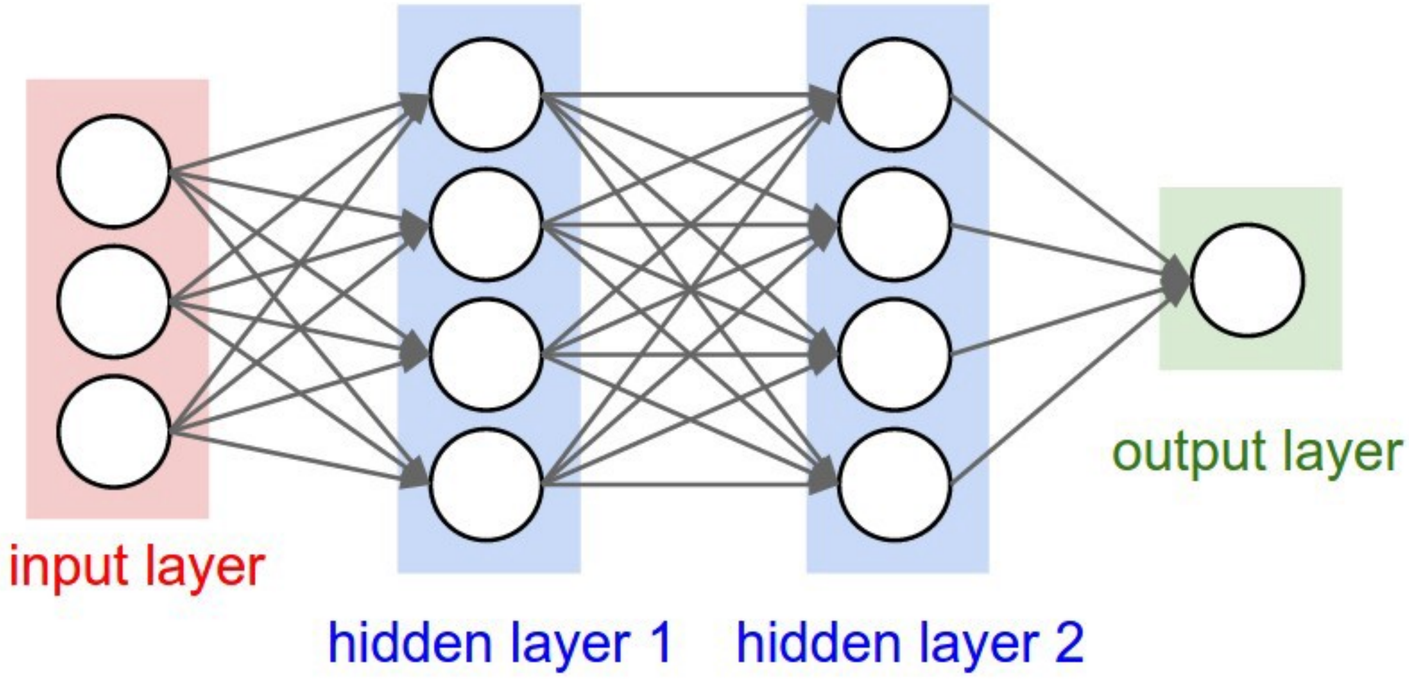
# Artificial Neural Networks

## ANN

- Inspired by the human brain
- ANNs imitates the human brain's behavior to solve complex data problems
- Technologies to solve problems in image, speech and pattern recognition
- Consists out of neurons, the building blocks of an ANN

# Artificial Neural Networks

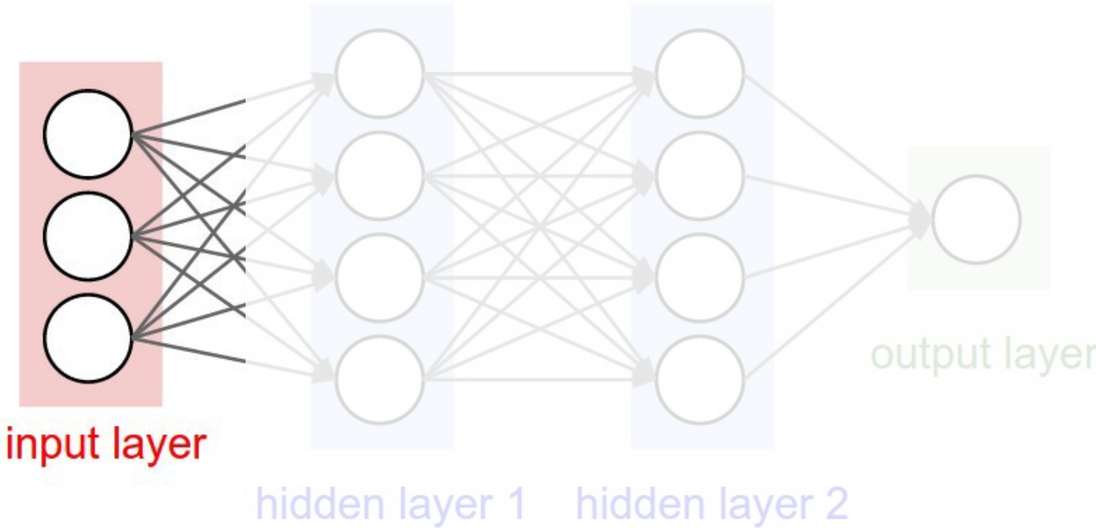
- Made up of an:
  - Input layer
  - Hidden layer(s)
  - Output layer



# Artificial Neural Networks

## Input layer

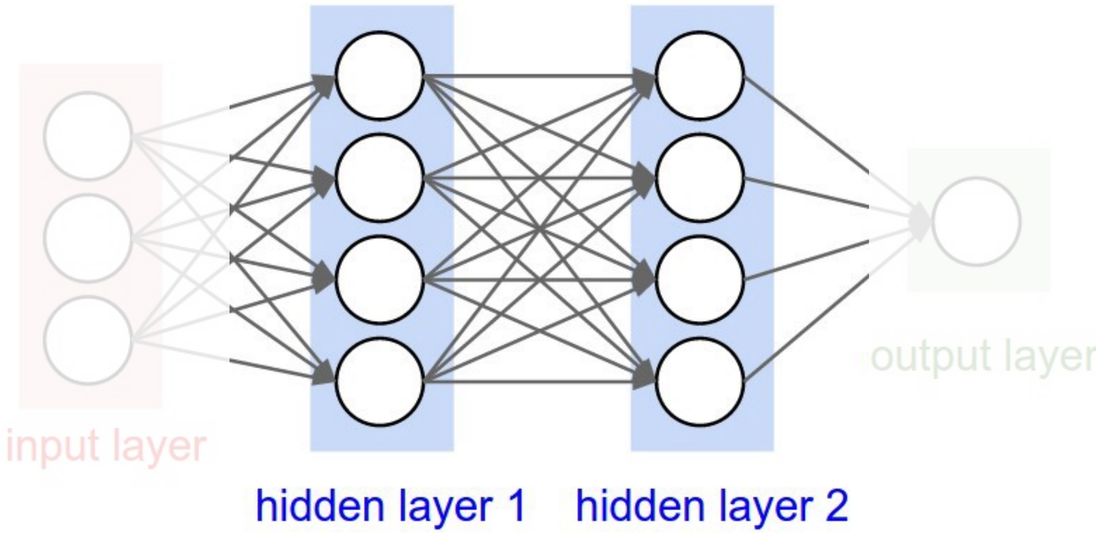
- Layer where the ANN acquires data
- Feature extractors are used in data classification
- Each input neuron represents a single feature
- When the neurons have data, it is redirected to the neurons in the hidden layer



# Artificial Neural Networks

## Hidden layer

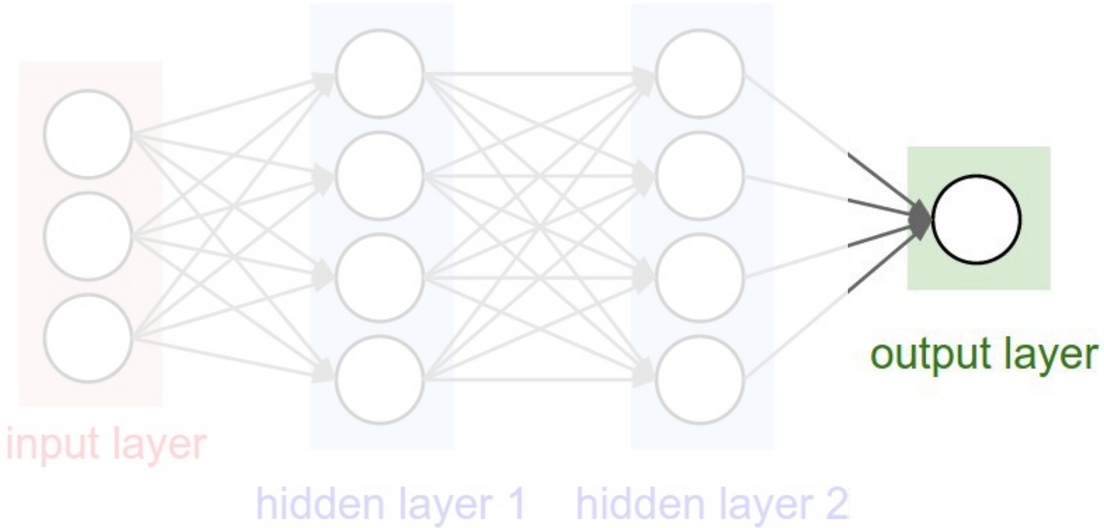
- One or more hidden layers
- Perform the most computations
- Learns the mapping function between input and output
- **Mapping function**: Intelligence that once learned can be used to perform the task
- Sends data to neurons in het output layer

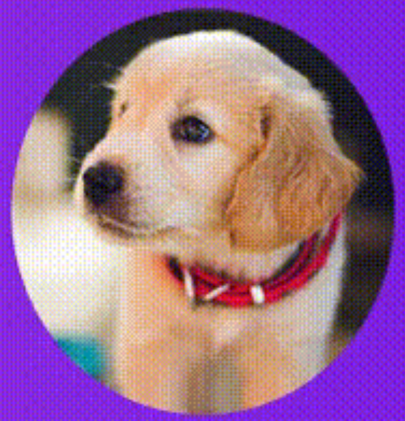


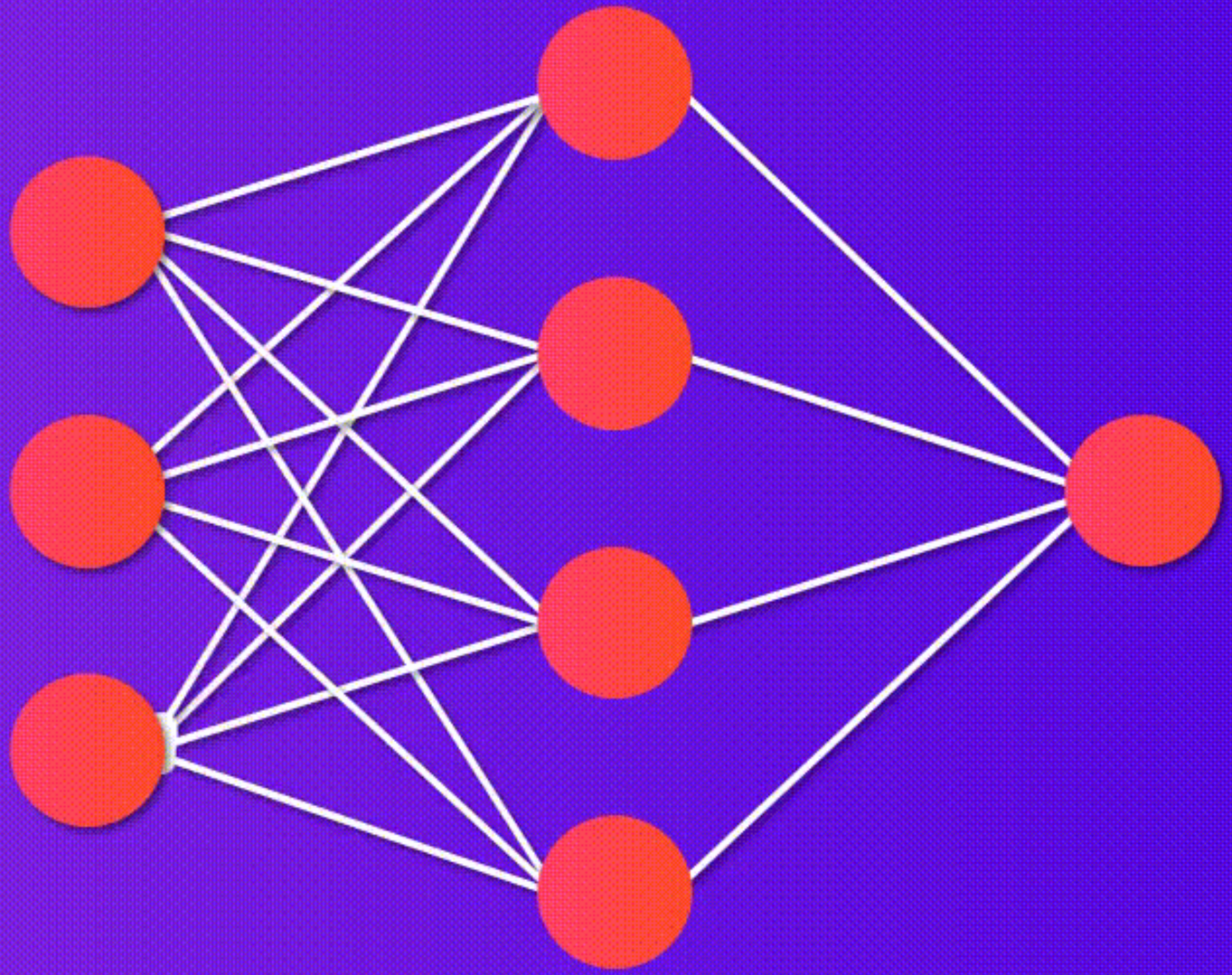
# Artificial Neural Networks

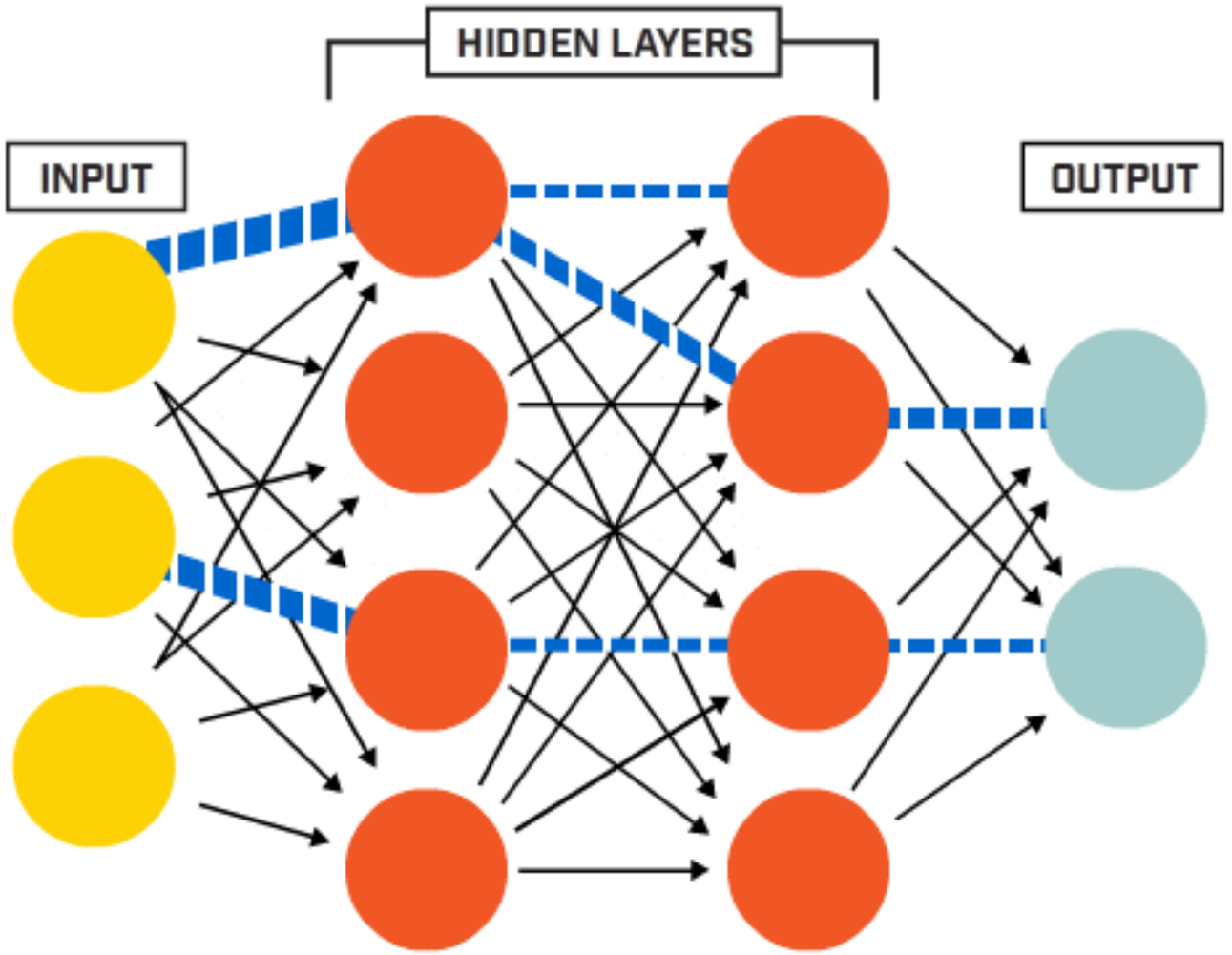
## Output layer

- Layers that predicts the outcome





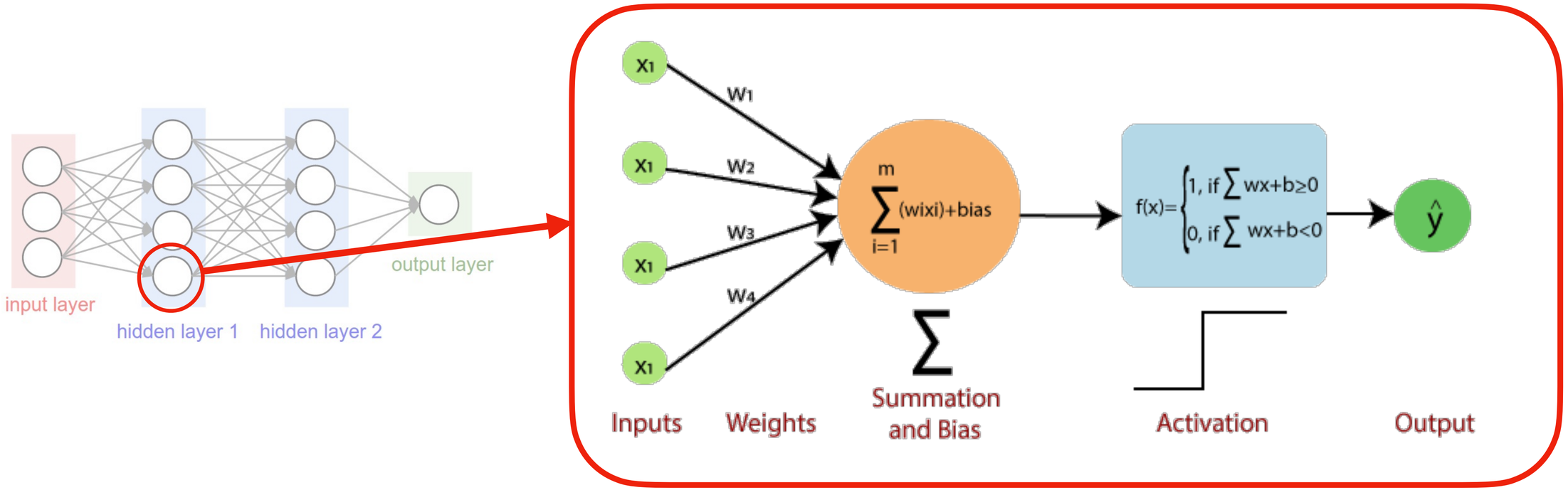



HIDDEN LAYERS
INPUT
OUTPUT

# Artificial Neural Networks

## How does it work?

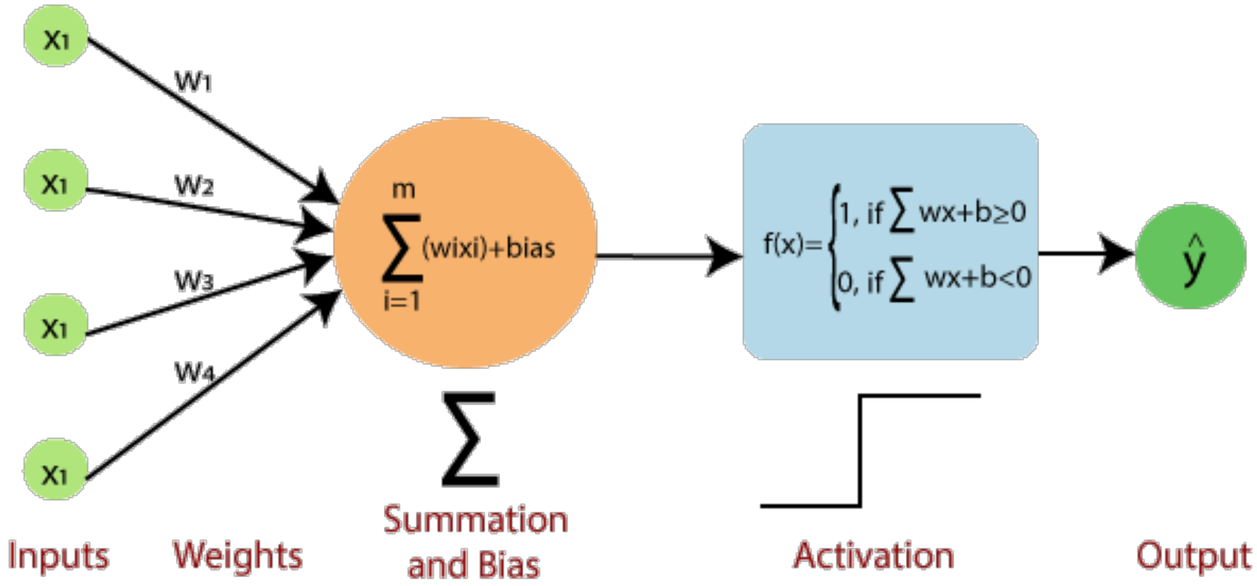
- An artificial neurons or perceptron consist of:



# Artificial Neural Networks

## How does it work?

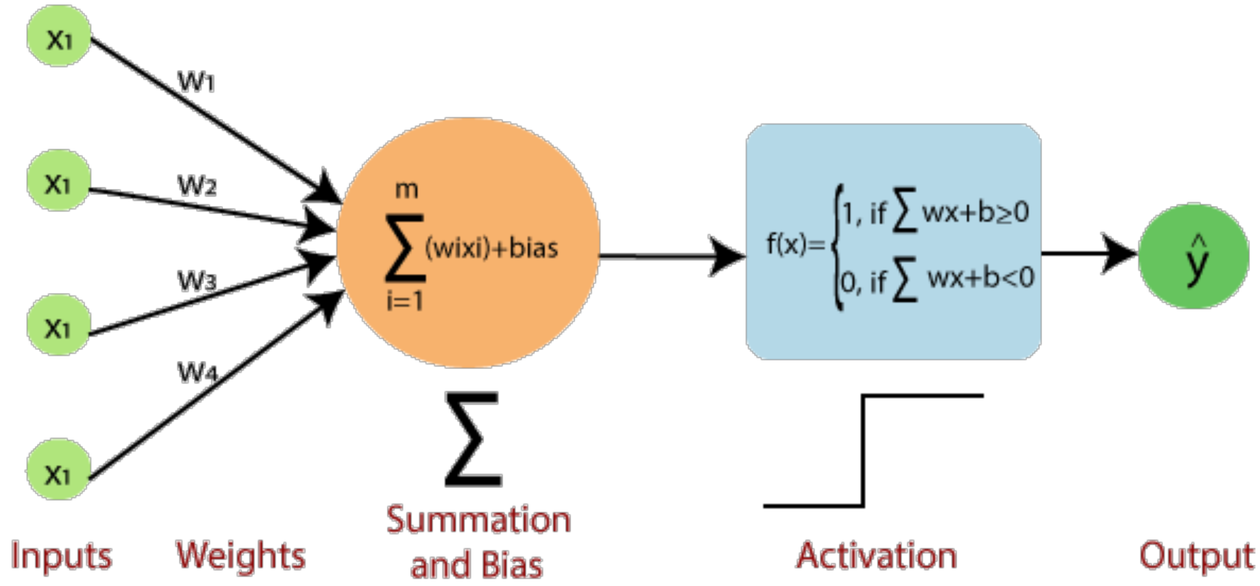
- Each input (X) is assigned with weights (W)
- Weights determine what impact the input will have on the output.



# Artificial Neural Networks

## How does it work?

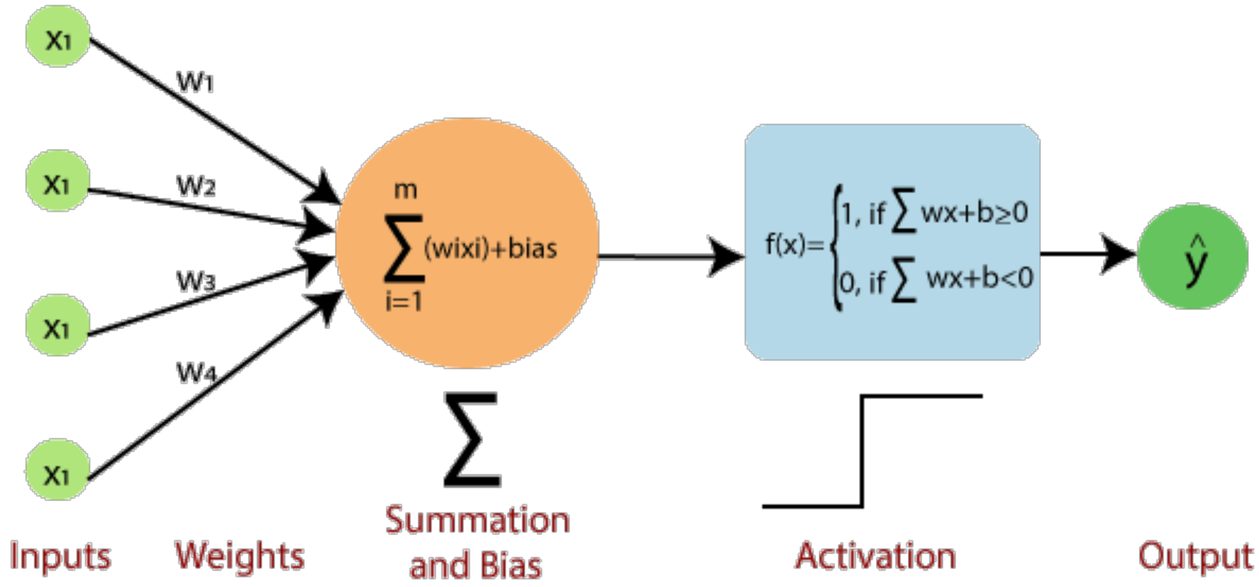
- The inputs and weights are multiplied and their sum is sent to neurons in het hidden layer
- Bias, an additional parameter, is applied to each neuron



# Artificial Neural Networks

## How does it work?

- The activation function outcome decides if a neuron is activated or not
- An activated neuron transfers information into the other layers
- **Feed-forward propagation**

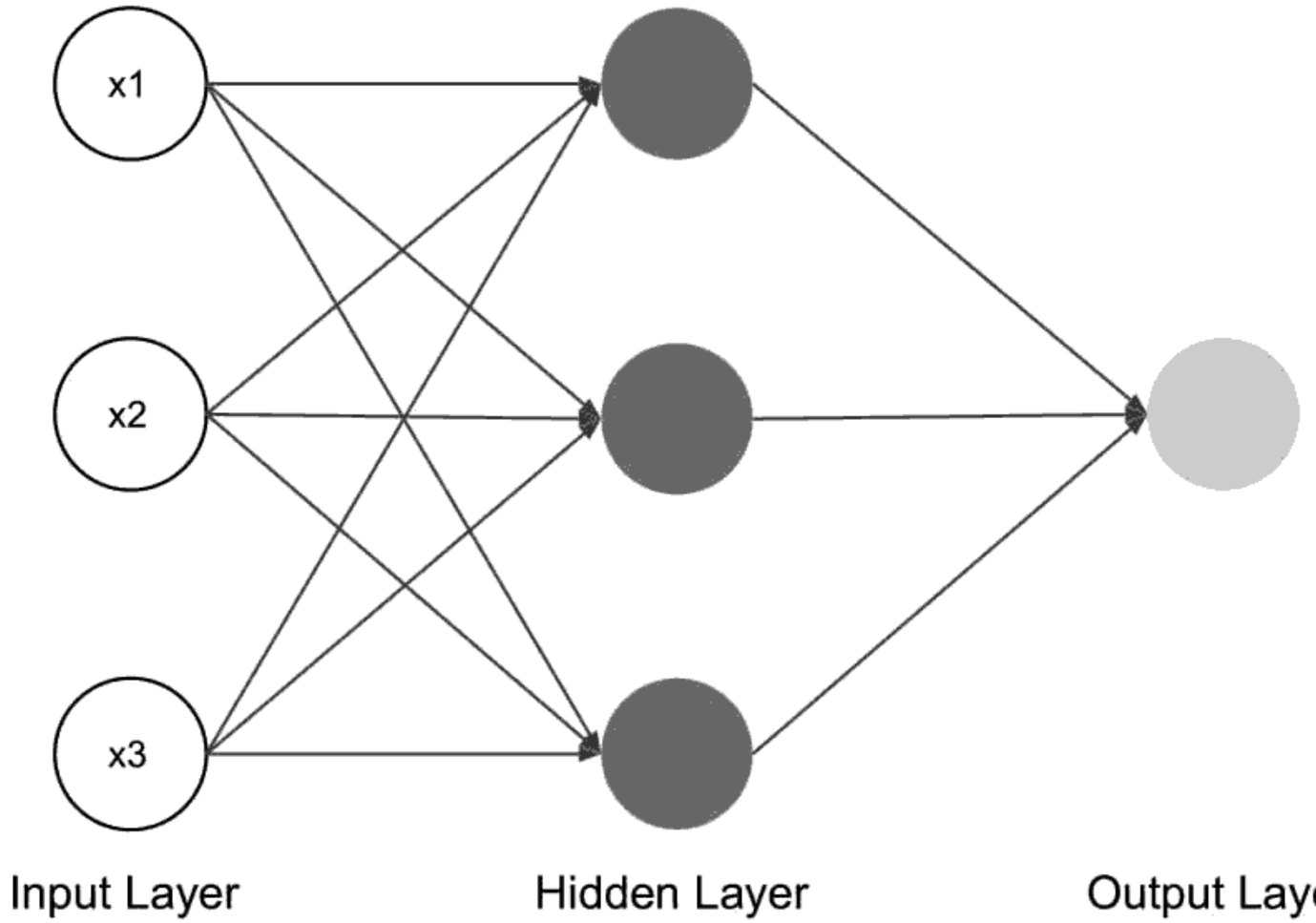


# Artificial Neural Networks

## Feed-forward propagation

- Process of inputing data into an input node and getting the output through the output node
- Output wrong? **Back propagation** takes place
- **Back propagation**: re-adjusting each input's weight to minimize the errors, thus resulting in a more accurate output

# Feedforward



# Artificial Neural Networks

## Advantages

- **Fault tolerance**
  - In an ANN, even if a few neurons are not working properly, that would not prevent the neural networks from generating outputs.
- **Real-Time Operations**
  - ANNs can learn synchronously and easily adapt their changing environments

# Artificial Neural Networks

## Advantages

- **Adaptive Learning**
  - ANNs can learn how to work on different tasks. Based on the data given to produce the right output
- **Parallel processing capacity**
  - ANNs have the strength and ability to perform multiple jobs simultaneously

# Artificial Neural Networks

## Disadvantages

- **Unexplained behavior of the network**
  - Due to the complexity of the networks, it doesn’t provide the reasoning behind the decisions it made.The network is a **black box**.
- **Determination of appropriate network structure**
  - There is no specified rule for a neural network procedure. A proper network structure is found by a trail and error approach.

# Deep Learning

## Applications

- **Self-driving cars**
  - In the automotive sector, researchers and developers are working diligently on deep learning-based techniques for self-driving cars.
- **Natural Language Processing**
  - Machines are taught to understand the complexities associated with languages and semantics. NLP through DL plays a significant role to solve these problems.

# Deep Learning

## Applications

- **Healthcare**
  - Clinical researchers use DL to find a cure for untreatable diseases. DL helps with a speedy diagnostic of dangerous conditions. Many cancer tests, such as the Pap test and Mammograms, use DL to examine cell images under a microscope.
- **Fraud detection**
  - Fraud prevention is done by recognizing patterns in customer transactions.

# Machine learning vs. Deep Learning

- ML algorithms require extensive data, pre-processing, and manual feature extraction. While DL relies on its layers of neural networks and performs feature extraction automatically.
- ML can be used when there is a lack of computational power available or a small dataset. As opposed to DL's performance that improves with the increased size of a dataset. That is why DL algorithms are fed petabytes of data, which can require weeks of training.
- ML algorithms can perform well on low-end machines. While DL performs better on a powerful machine equipped with multiple GPUs, providing higher performance.