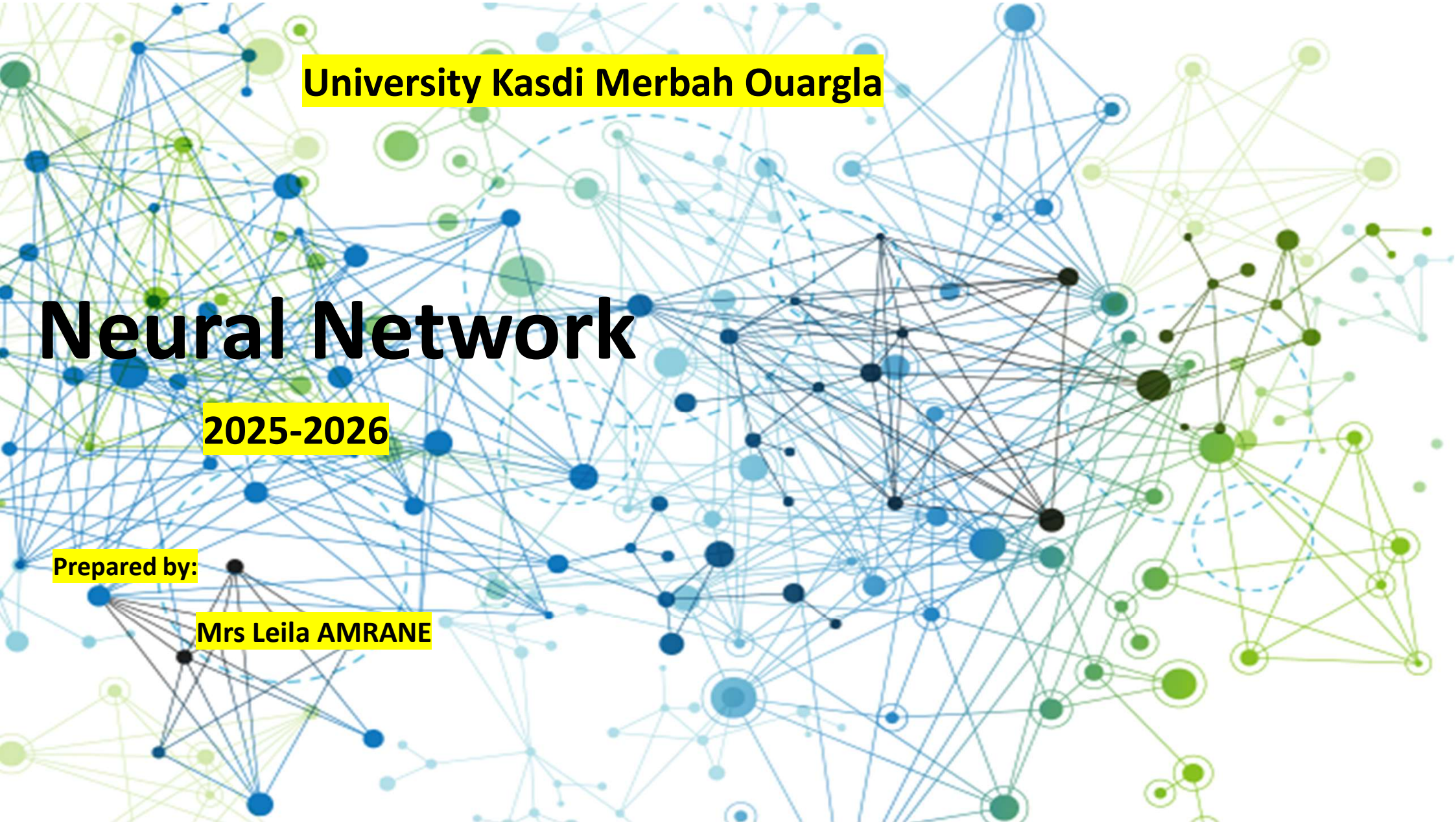


University Kasdi Merbah Ouargla

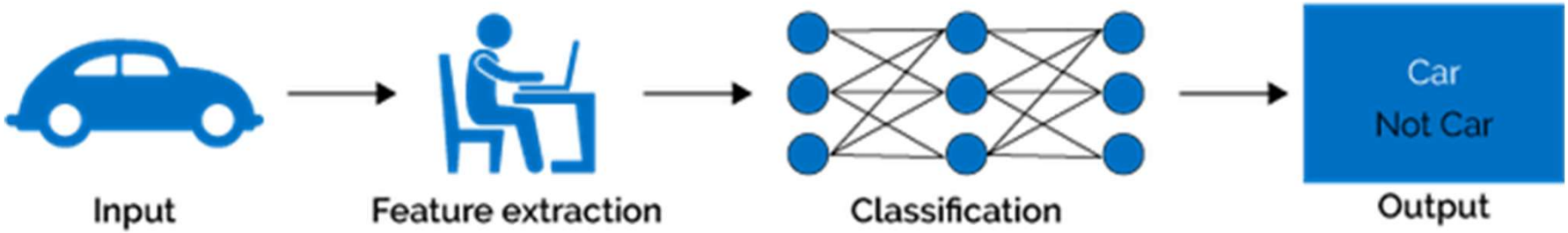
Neural Network

2025-2026

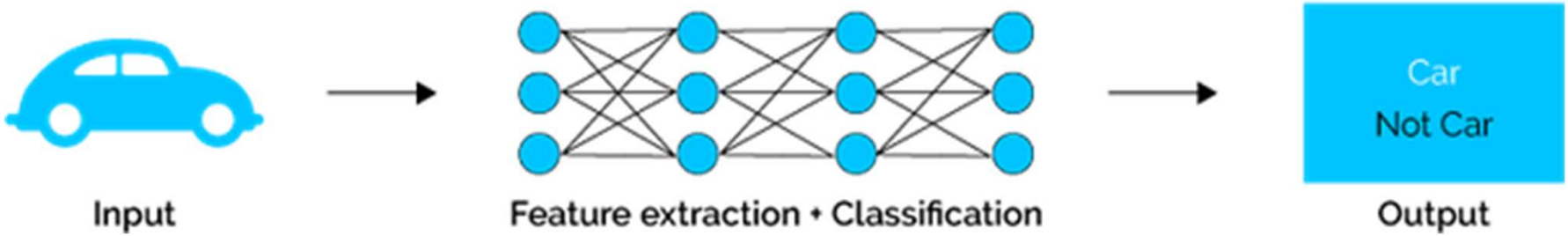
Prepared by:

Mrs Leila AMRANE

Machine learning



Deep learning

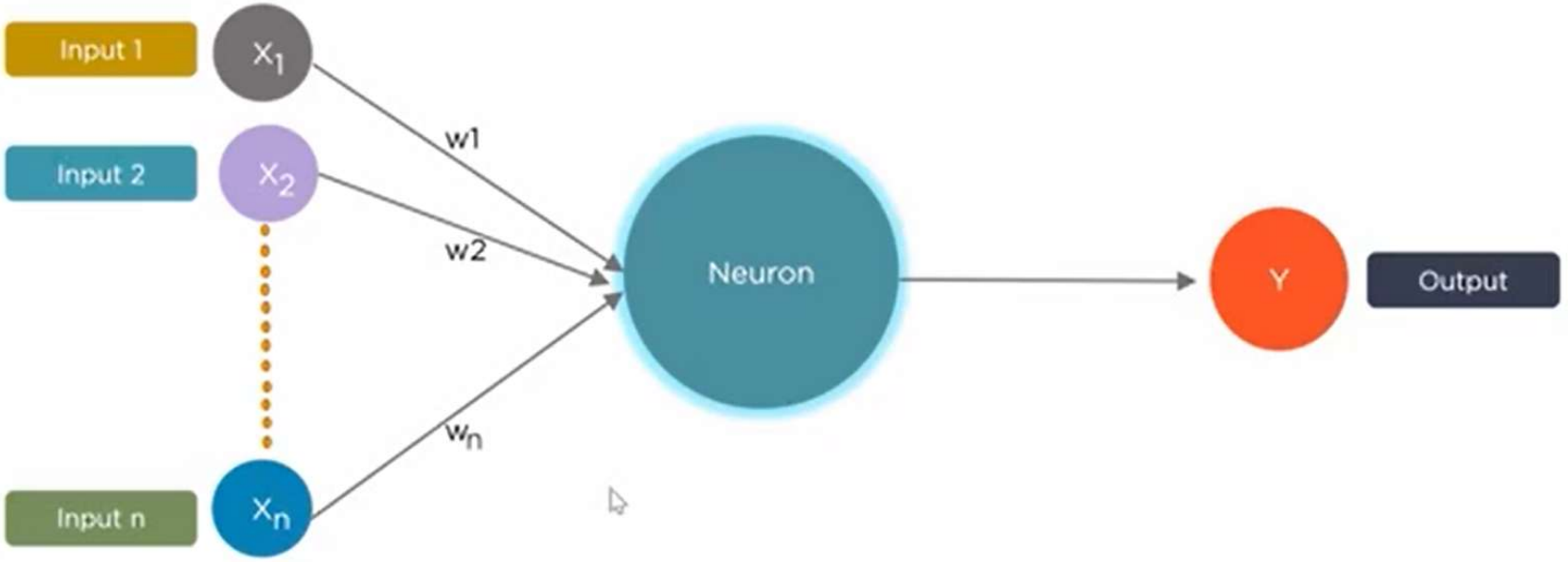


Deep learning

Deep learning is a powerful subfield of machine learning that uses artificial neural networks with many layers to automatically learn complex patterns from large amounts of data.

Instead of relying on handcrafted features (like traditional machine learning), deep learning models learn hierarchical representations directly from raw input—such as pixels, text, or sound—by stacking multiple processing layers

What is neural network?



A neural network is a computational model inspired by the structure and function of the human brain. It is a core technique in artificial intelligence (AI) and machine learning, especially in deep learning. Neural networks are designed to recognize patterns, learn from data, and make predictions or decisions—without being explicitly programmed for the specific task.

Artificial Neural Network

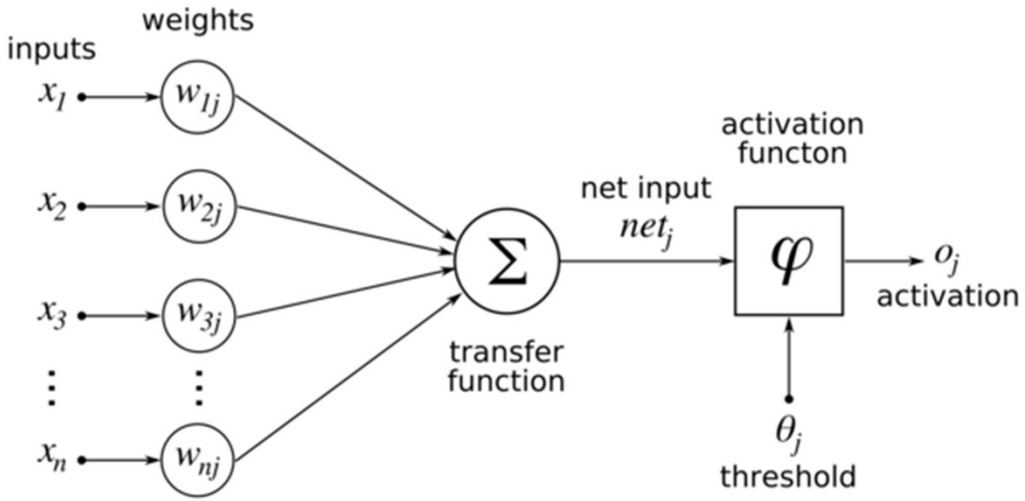
- **How It Works**

1. **Input** (e.g., image, sentence, audio) → fed into the network.
2. **Multiple Hidden Layers** → each layer transforms the data using weights, biases, and non-linear activation functions (like ReLU).
3. **Output** → prediction (e.g., "cat", sentiment = positive, translated sentence).
4. **Training** → uses backpropagation and gradient descent to adjust millions/billions of parameters and minimize error.

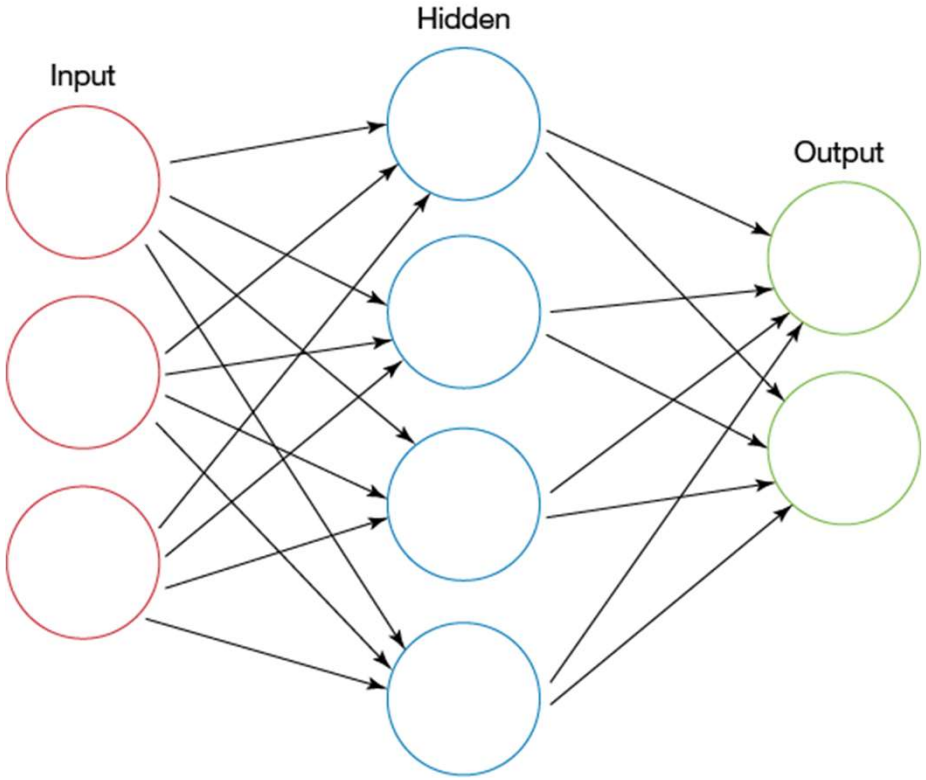
•

Artificial Neural Network

Single layer perceptron

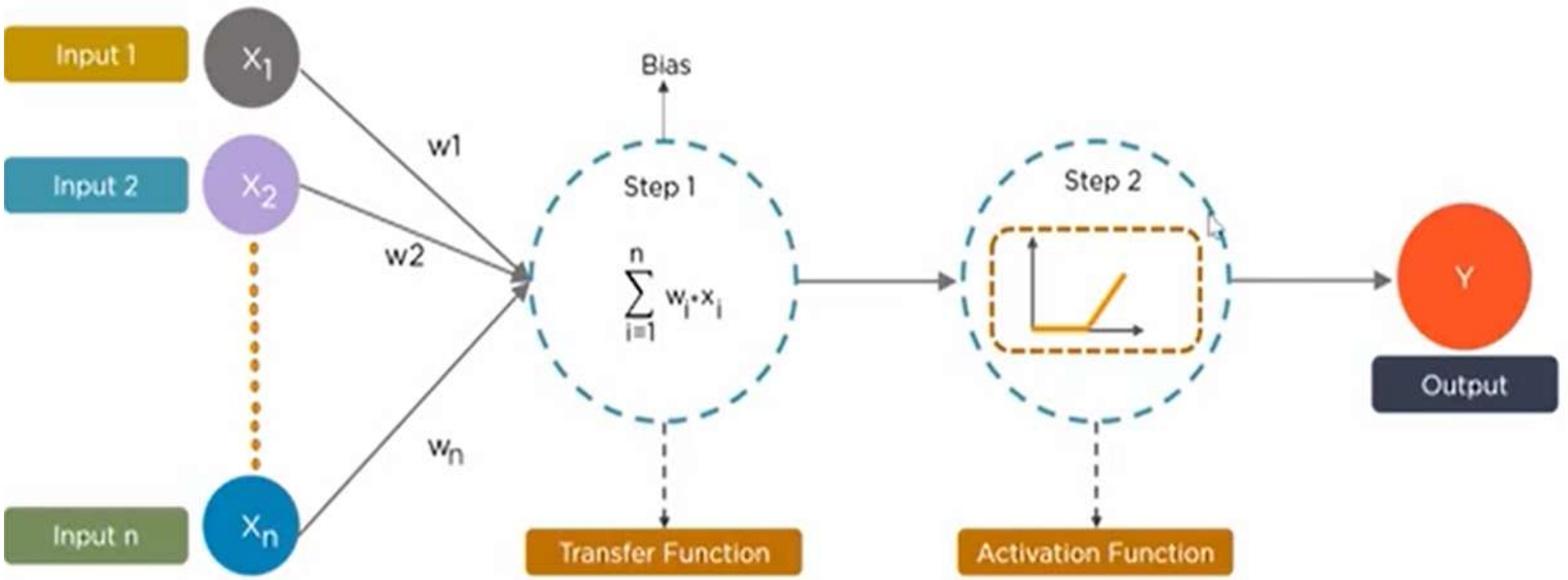


Multi-layer perceptron



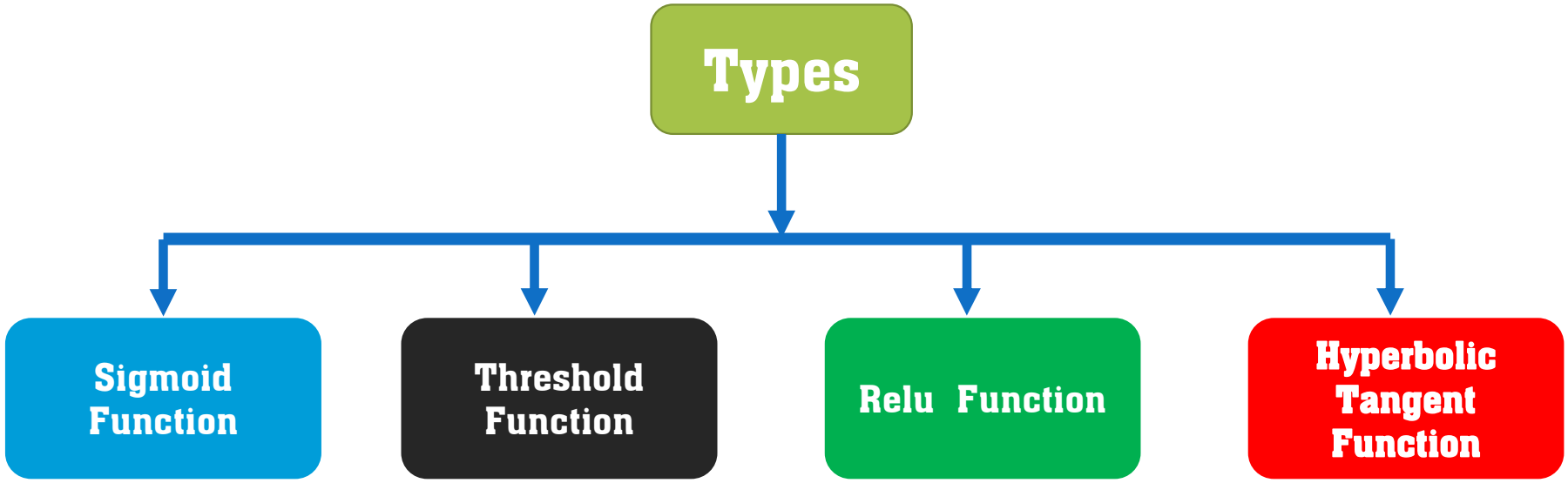
Artificial Neural Network

,



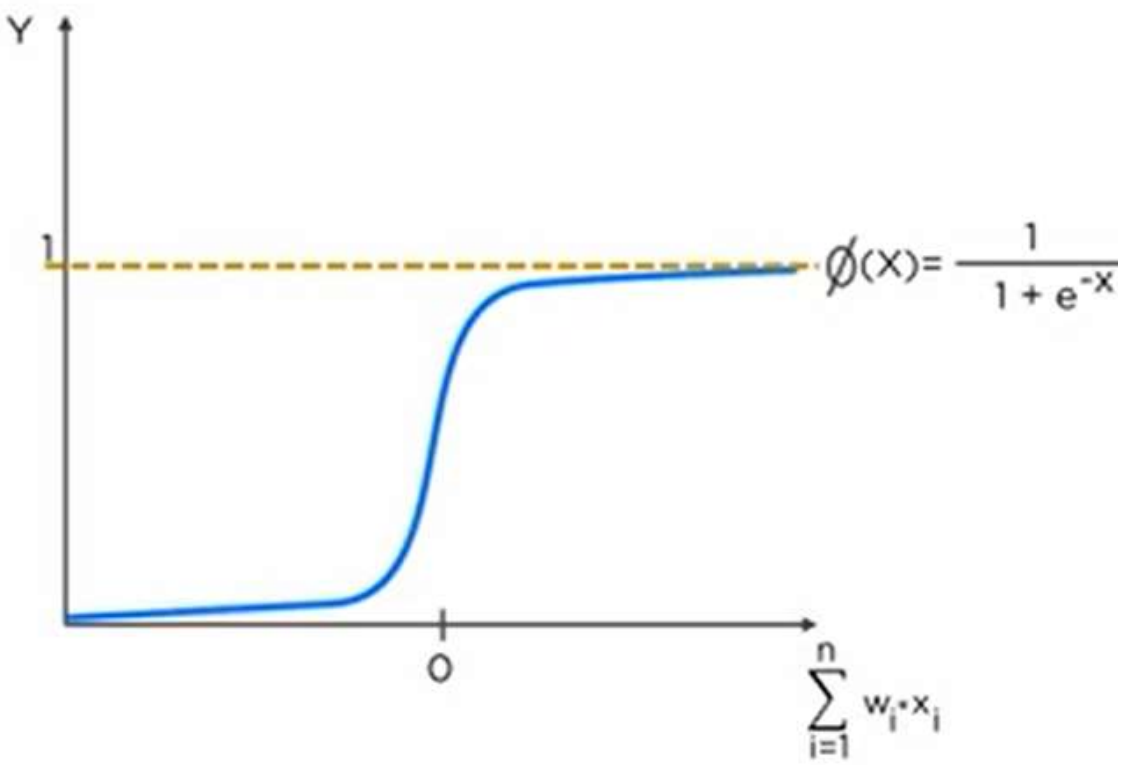
Activation function

An Activation function takes the "weighted sum of input plus the bias" as the input to the function and decides whether it should be fired or not



Sigmoid Function

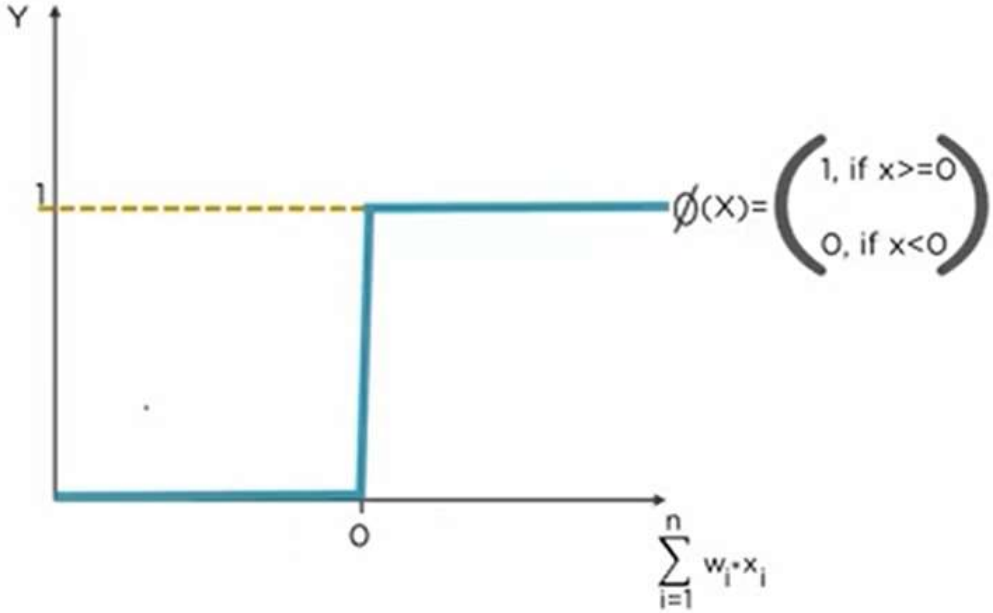
Used for models where we have to predict the probability as an output. It exists between 0 and 1.



Threshold Function (also called Step Function) is the simplest activation function, it outputs:

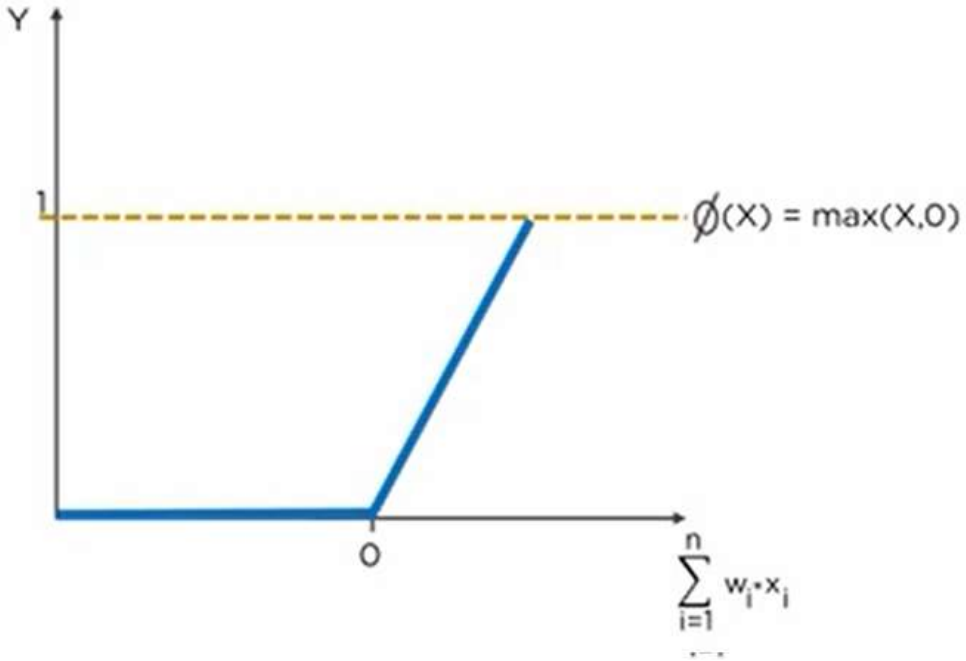
- **1 if the input (weighted sum) is ≥ 0**
- **0 if the input is < 0**

It's like an "on/off" switch — used in early neural network models (like the perceptron).



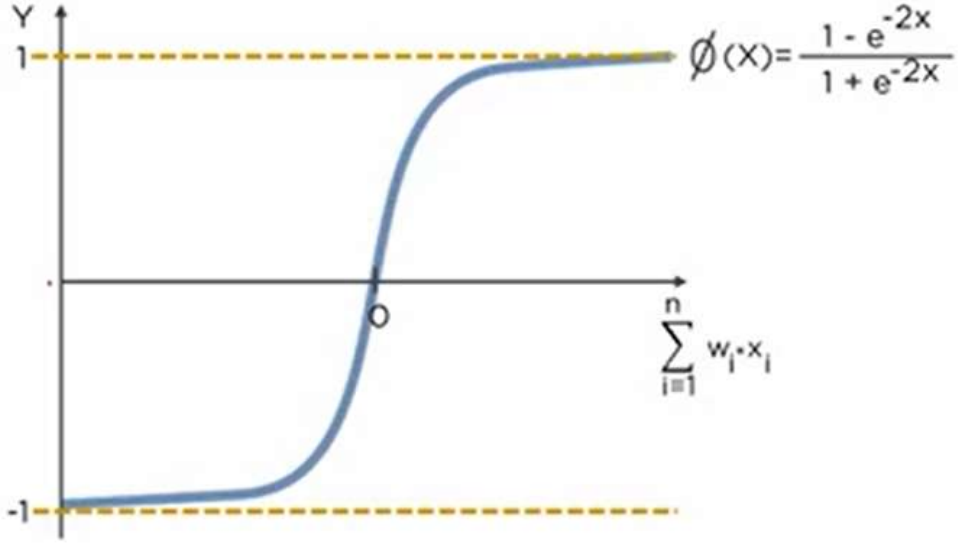
ReLU Function

stands for Rectified Linear Unit. It's the most widely used activation function in deep neural networks, especially in hidden layers of CNNs and more.

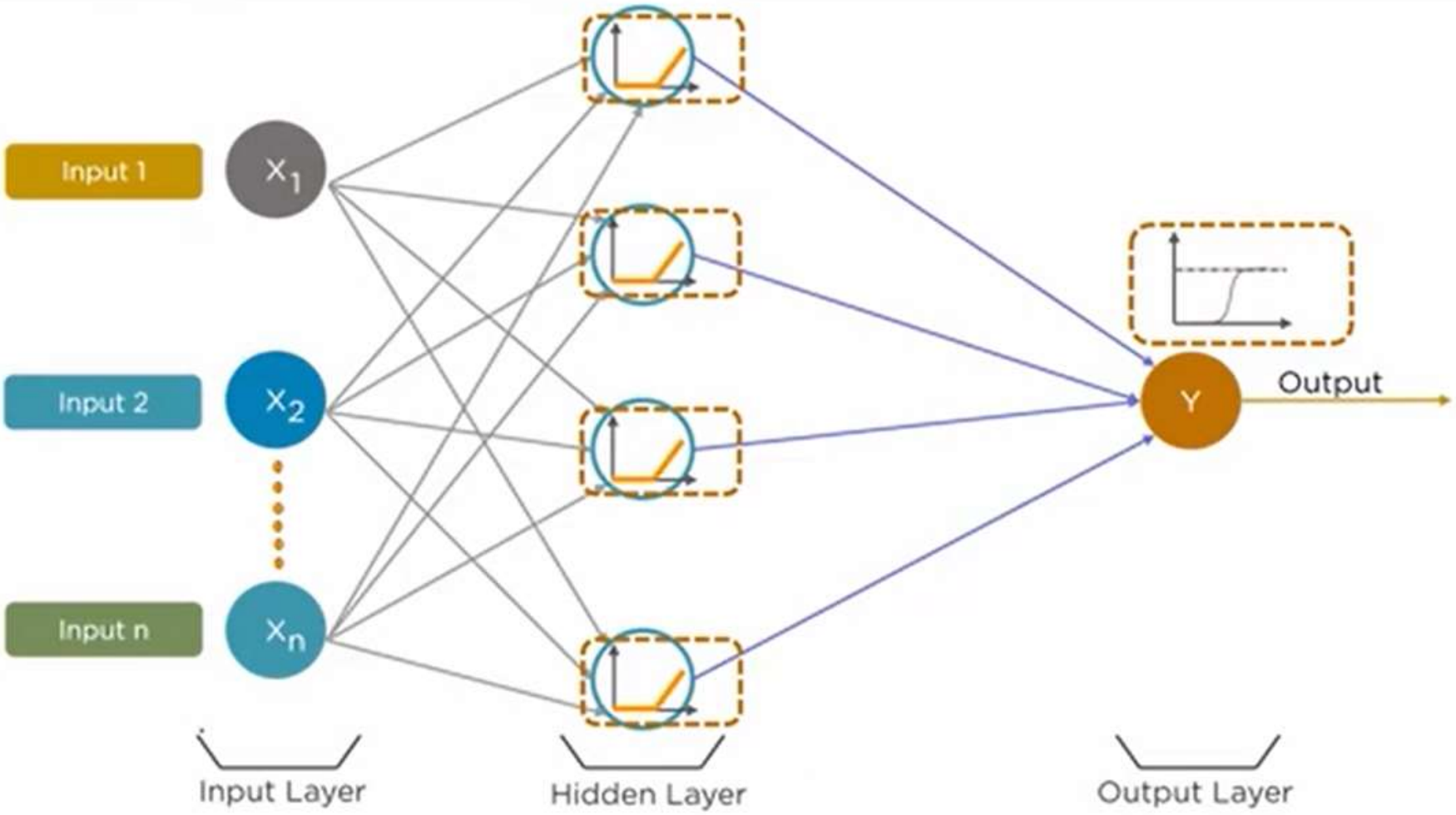


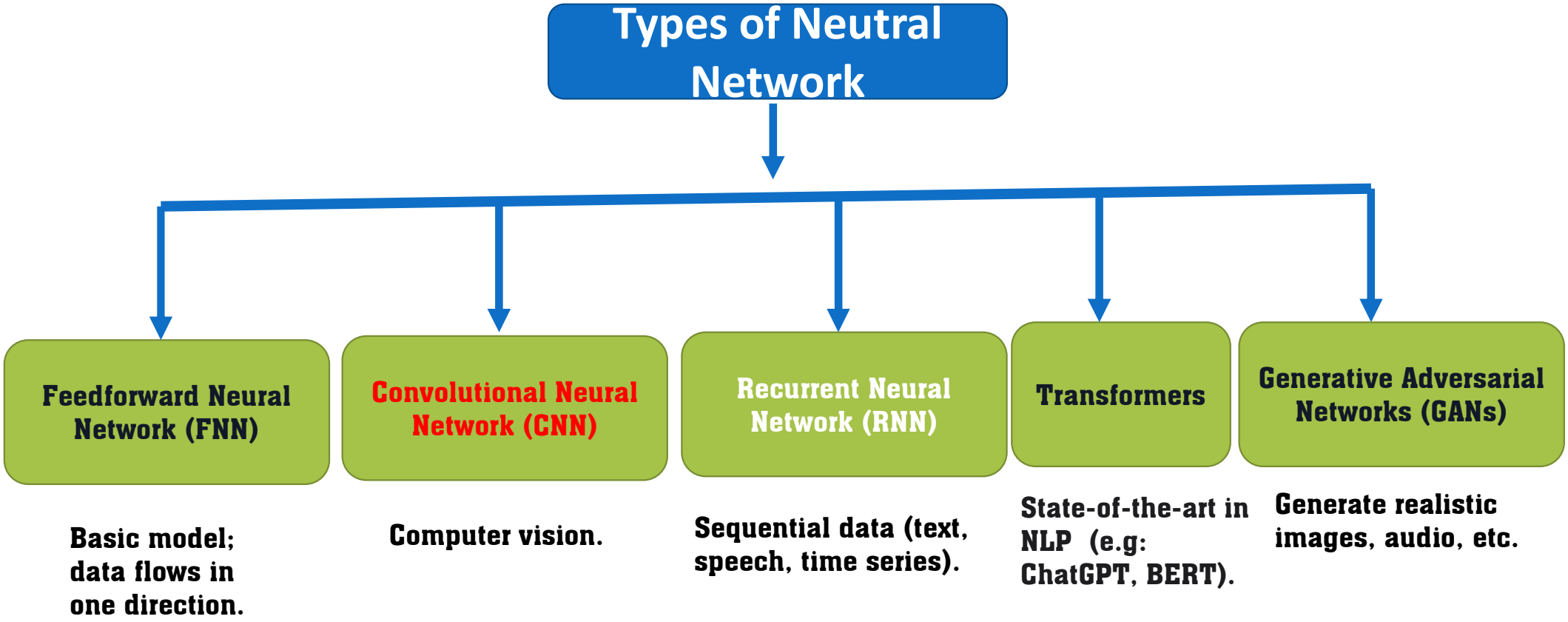
Hyperbolic Tangent Function

This function is similar to Sigmoid function and is bound to range (-1, 1)



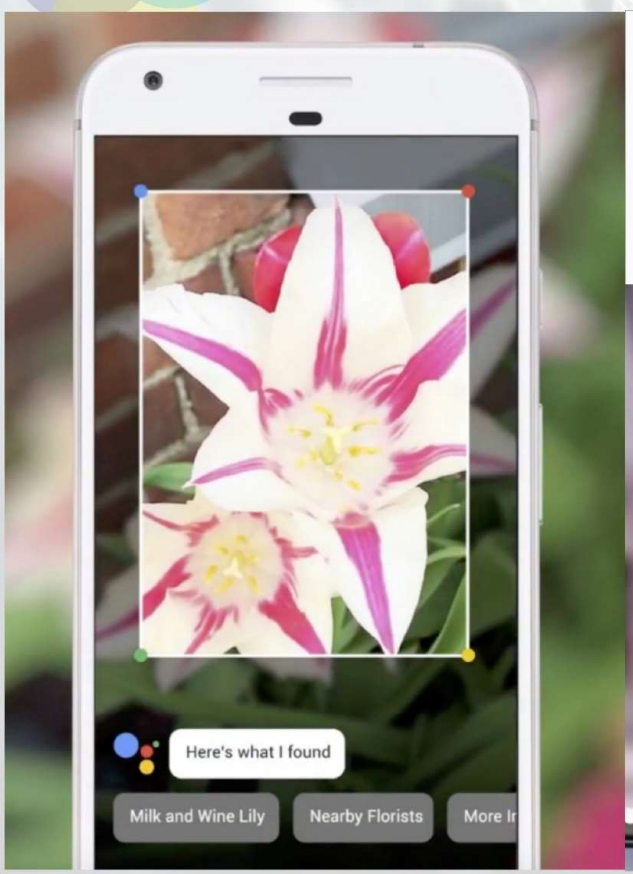
Activation function

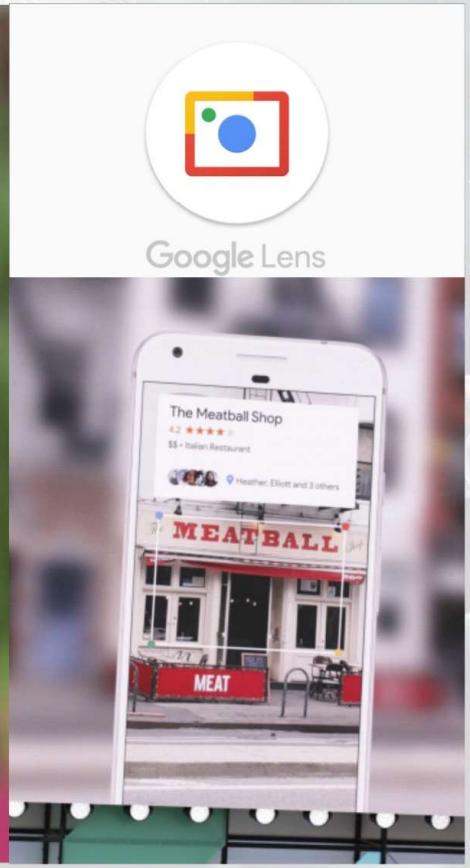



Types of Neutral Network
Feedforward Neural Network (FNN)
Convolutional Neural Network (CNN)
Recurrent Neural Network (RNN)
Transformers
Generative Adversarial Networks (GANs)
Basic model; data flows in one direction.
Computer vision.
Sequential data (text, speech, time series).
State-of-the-art in NLP (e.g: ChatGPT, BERT).
Generate realistic images, audio, etc.

Deep Learning Applications

Applications of Deep Learning





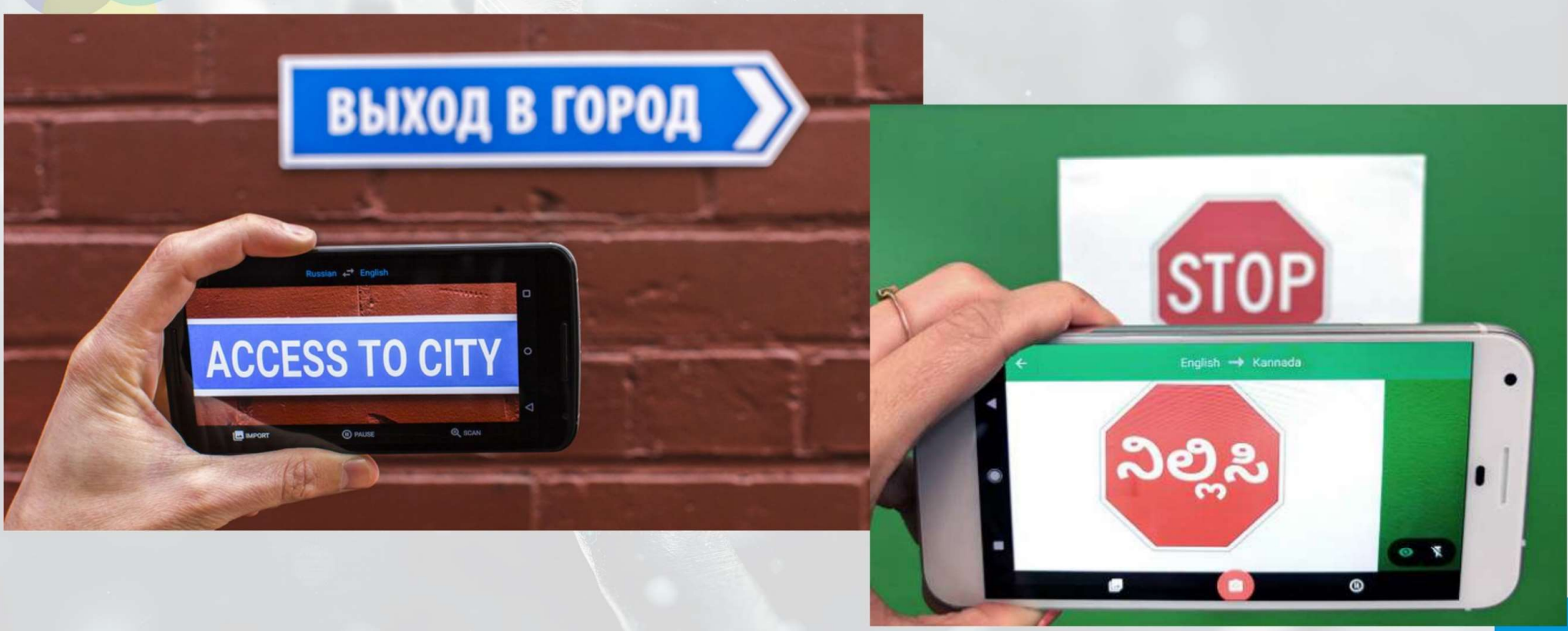
- Google lens is a set of vision based computing capabilities that allows your smartphone to understand what's going on in a photo, video or a live feed.
- For instance, point your phone at a flower and Google Lens will tell you on the screen which type of flower it is.
- You can aim the camera at a restaurant sign to see reviews and other information.

Applications of Deep Learning

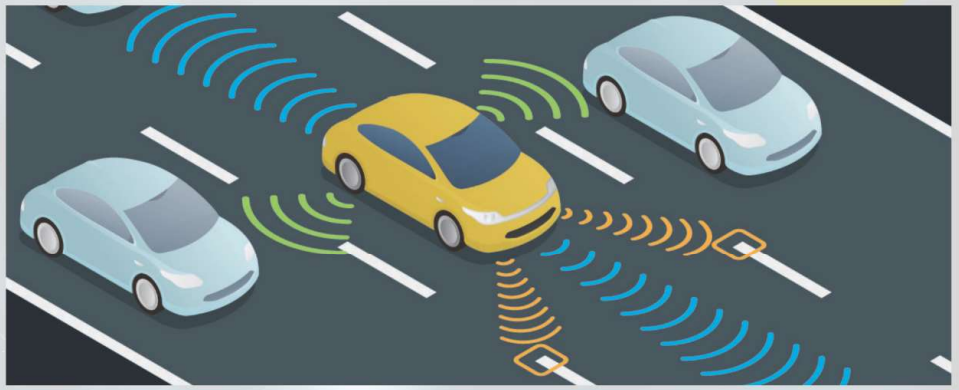
Translation

- This is a situation where you are given words in some language and you have to translate the words to desired language say english
- This kind of translation is a classical example of image recognition

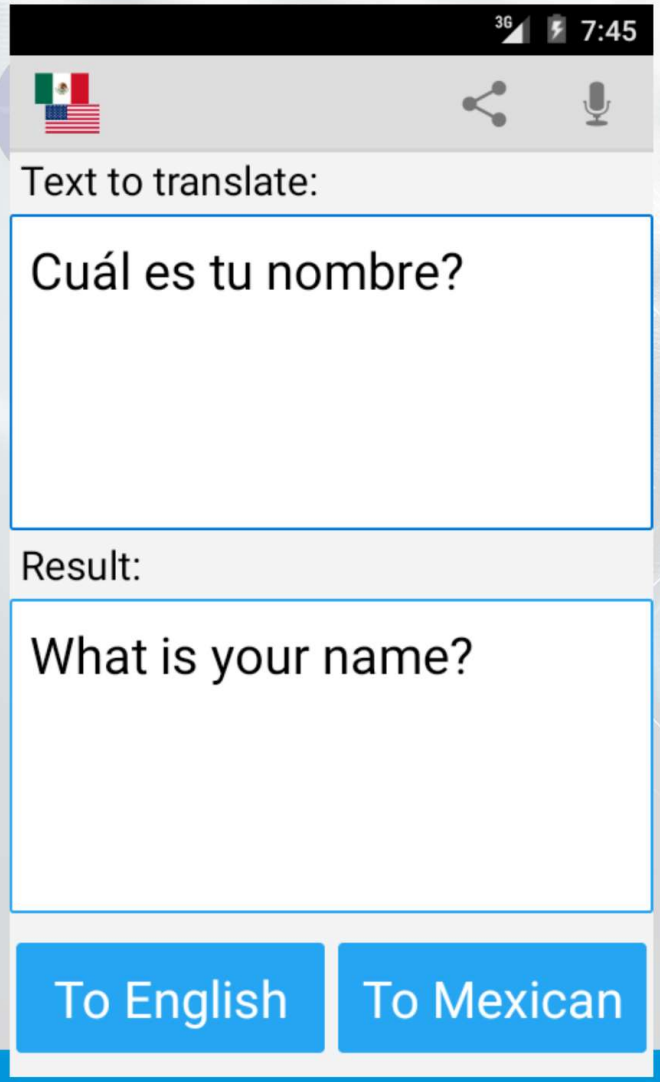
Instant Visual Translation

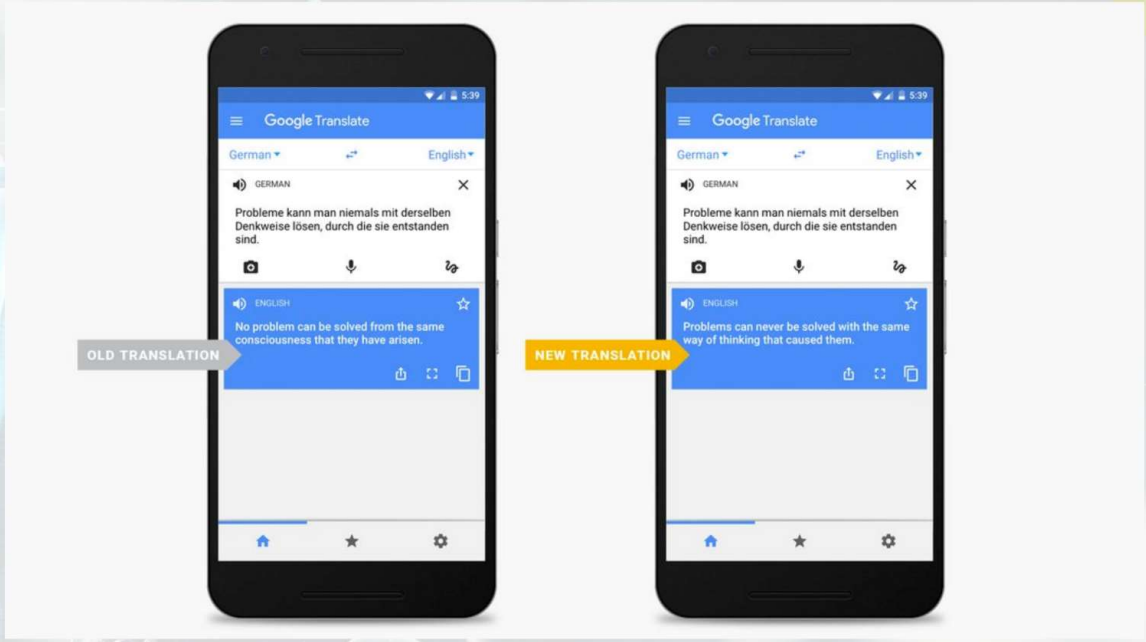


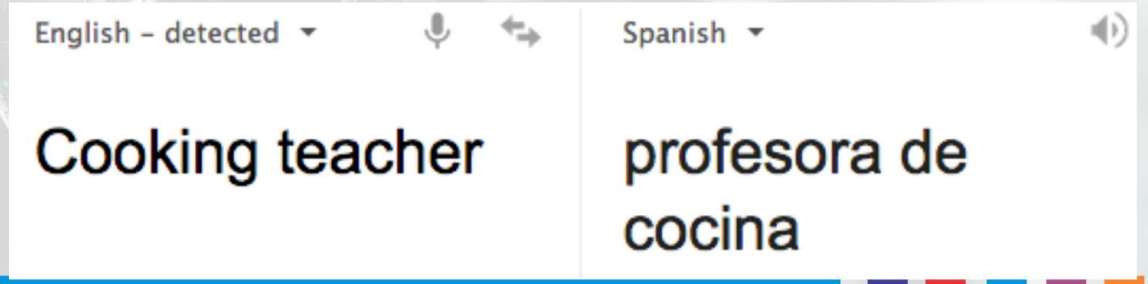
Self Driving Cars



Automatic Machine Translation







Simple Example (1 Neuron)

- Input: $x = 2$
- Weight: $w = 0.5$
- Bias: $b = 1$
- Activation: ReLU → $a = \max(0, wx + b) = \max(0, 2) = 2$
- True label: $y = 3$
- Loss: $\mathcal{L} = (a - y)^2 = (2 - 3)^2 = 1$

Backprop steps:

1. $\frac{\partial \mathcal{L}}{\partial a} = 2(a - y) = -2$
2. $\frac{\partial a}{\partial z} = 1$ (since ReLU derivative = 1 for z > 0)
3. $\frac{\partial \mathcal{L}}{\partial w} = \frac{\partial \mathcal{L}}{\partial a} \cdot \frac{\partial a}{\partial z} \cdot \frac{\partial z}{\partial w} = (-2)(1)(x) = -4$
4. Update: $w \leftarrow w - \eta \cdot (-4)$

Exercise: Single Artificial Neuron (Perceptron)

An artificial neuron receives three inputs:

- $x_1 = 2$
- $x_2 = -1$
- $x_3 = 0.5$

The corresponding **weights** are:

- $w_1 = 0.8$
- $w_2 = -1.2$
- $w_3 = 0.3$

The neuron has a **bias** $b = 0.4$.

The neuron uses the **ReLU activation function**:

$$\mathrm{ReLU}(z) = \max(0, z)$$

Questions:

1. **Compute the weighted sum** $z = w_1 x_1 + w_2 x_2 + w_3 x_3 + b$.
2. **What is the neuron's output** $y = \mathrm{ReLU}(z)$?
3. **Would the neuron "fire" (i.e., output > 0)?** Explain why or why not.

Activation function:

$$\sigma(z) = \frac{1}{1 + e^{-z}}$$

Questions:

1. Compute the neuron's output $y = \sigma(z)$.
2. If this neuron is used for **binary classification**, how would you interpret this output?

Activation function:

$$\phi(z) = \begin{cases} 1, & \text{if } z \geq 0 \\ 0, & \text{if } z < 0 \end{cases}$$

Questions:

1. What is the neuron's output?
2. Would the neuron "fire"?