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Machine Learning

Introduction to Neural Networks

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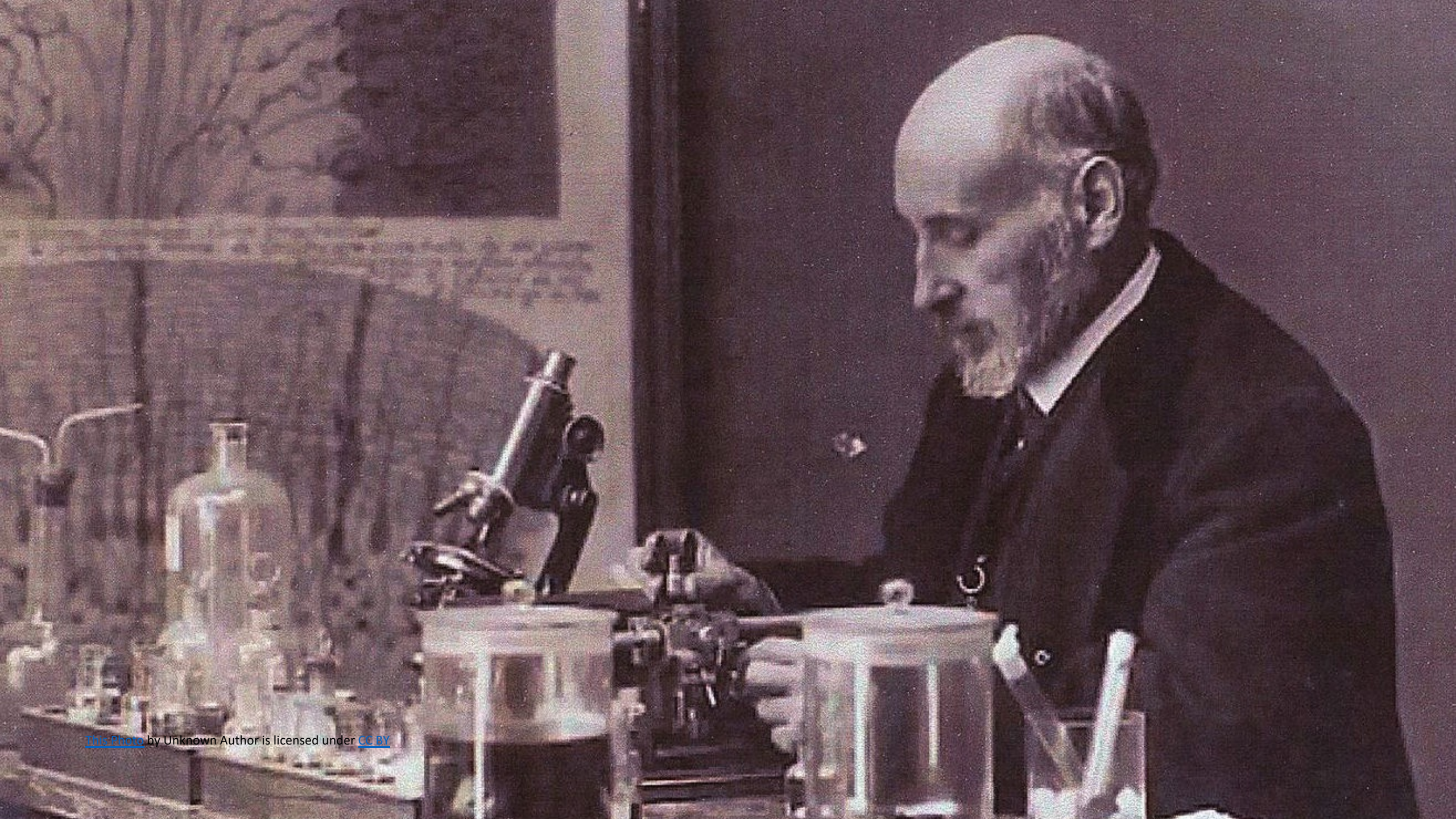
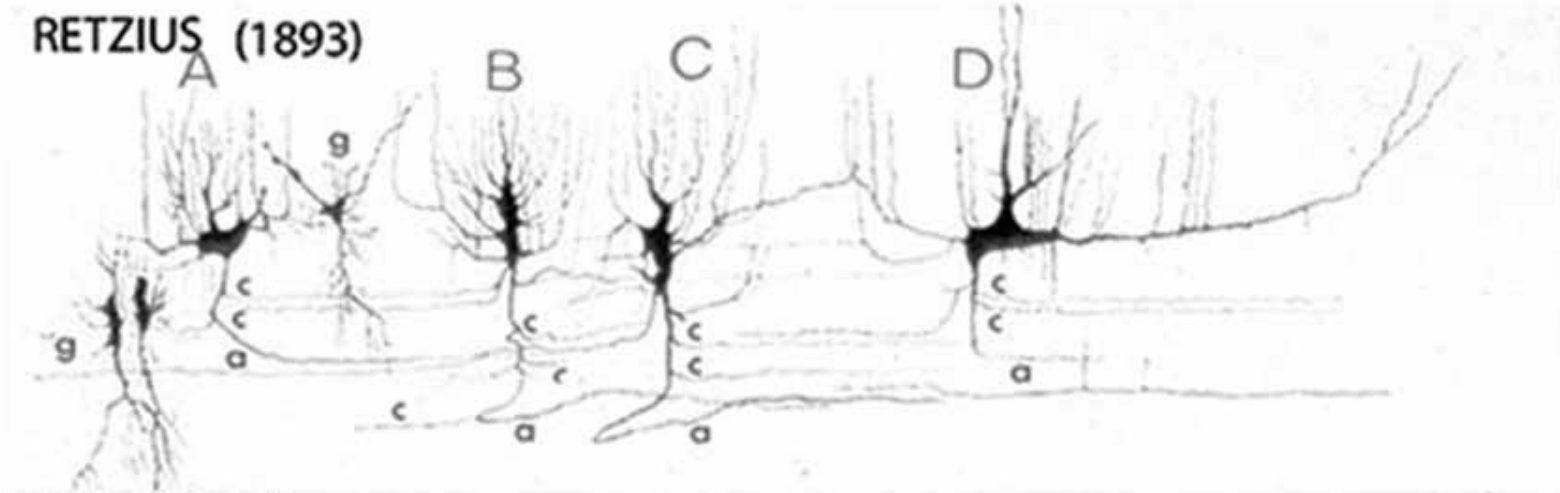
Table of Contents

- Introduction
- What is a Neural Network?
- Working of Neural Network
- Activation Functions
- Types of Neural Networks

Introduction

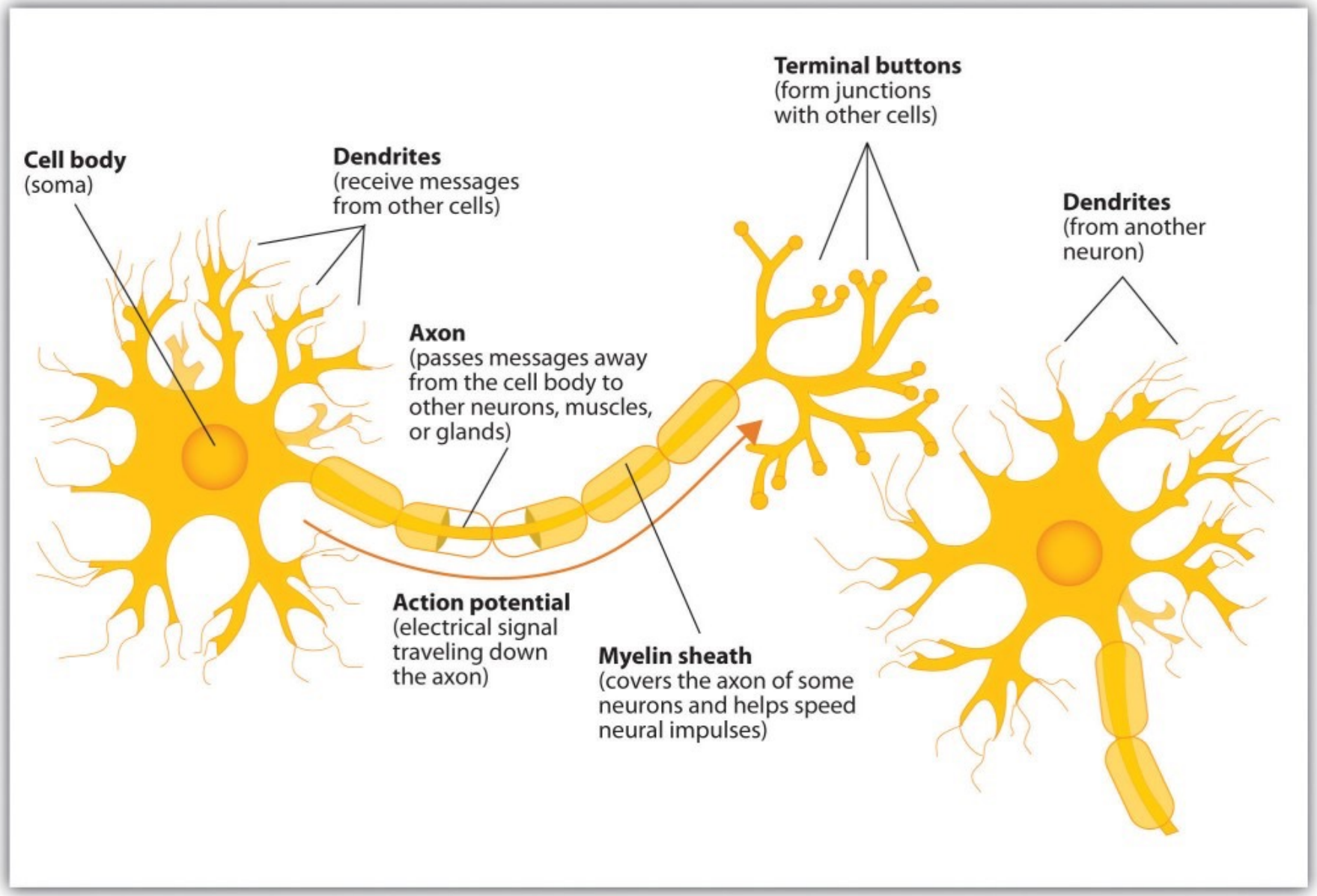


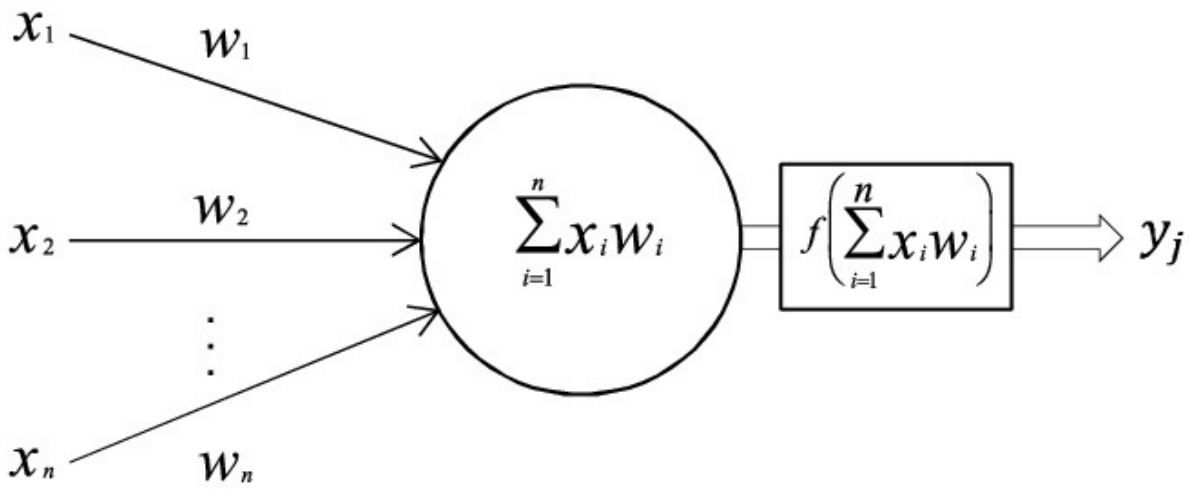
RETZIUS (1893)

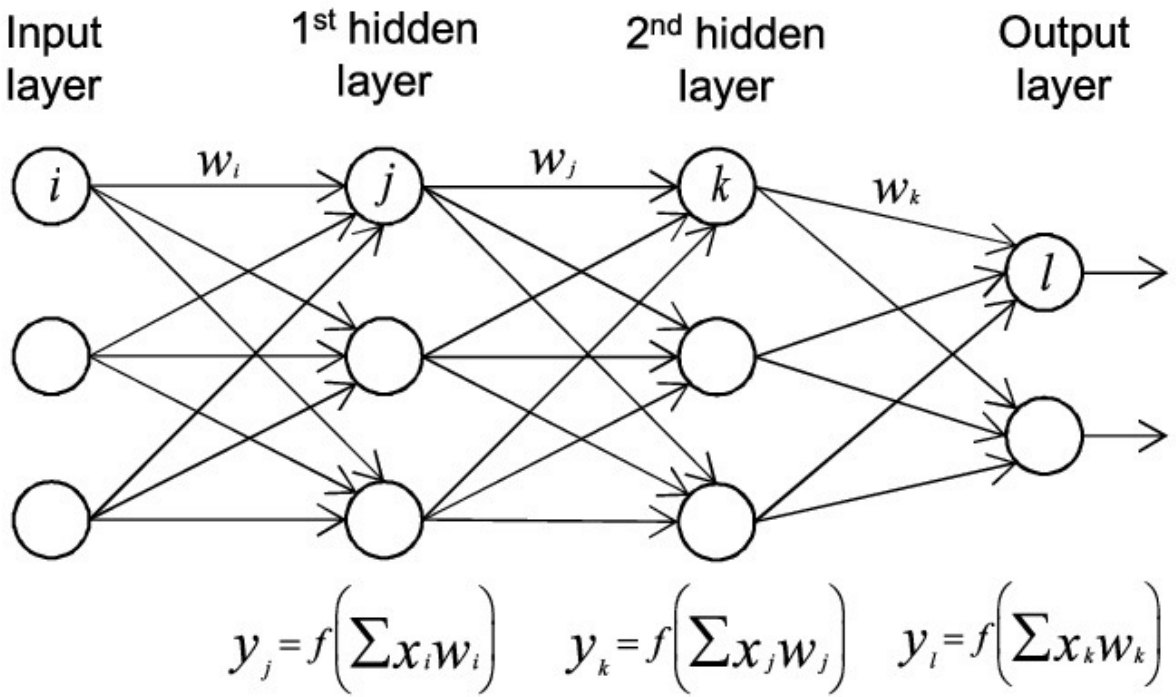


M. M-P (1984)

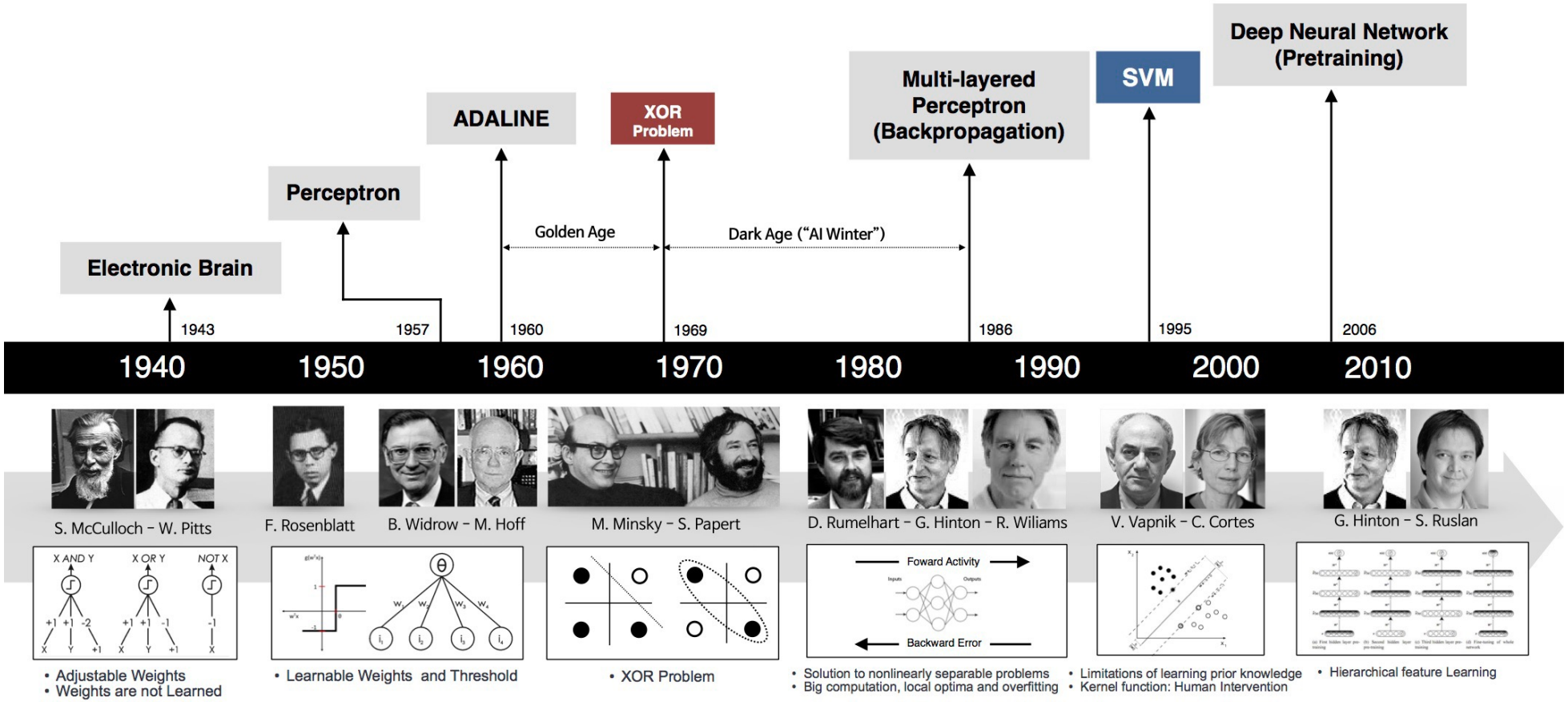
CAJAL (1911)





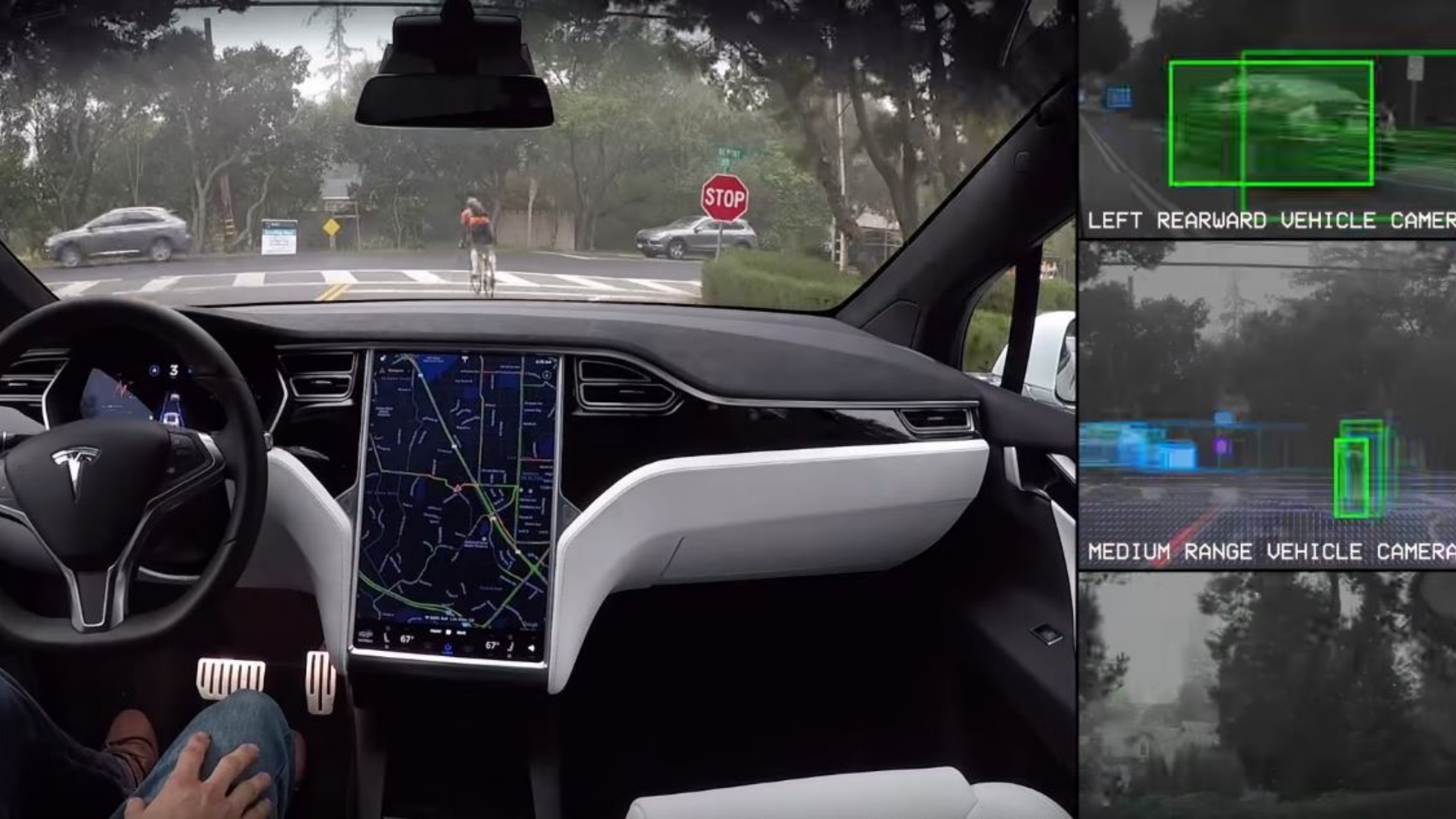


History of NNs



What is a Neural Network?


9:30 AM
“Join Siri & Vin on Periscope tonight at 11:30 PM UTC for ‘Conversations with Siri’”
Siri as your PA
@Vintuitive
9:30 am Aus EST
7:30 pm US EST
11:30 pm UTC


STOP
LEFT REARWARD VEHICLE CAMER
MEDIUM RANGE VEHICLE CAMERA

ALPHAGO
01:27:15

LEE SEDOL
00:45:18

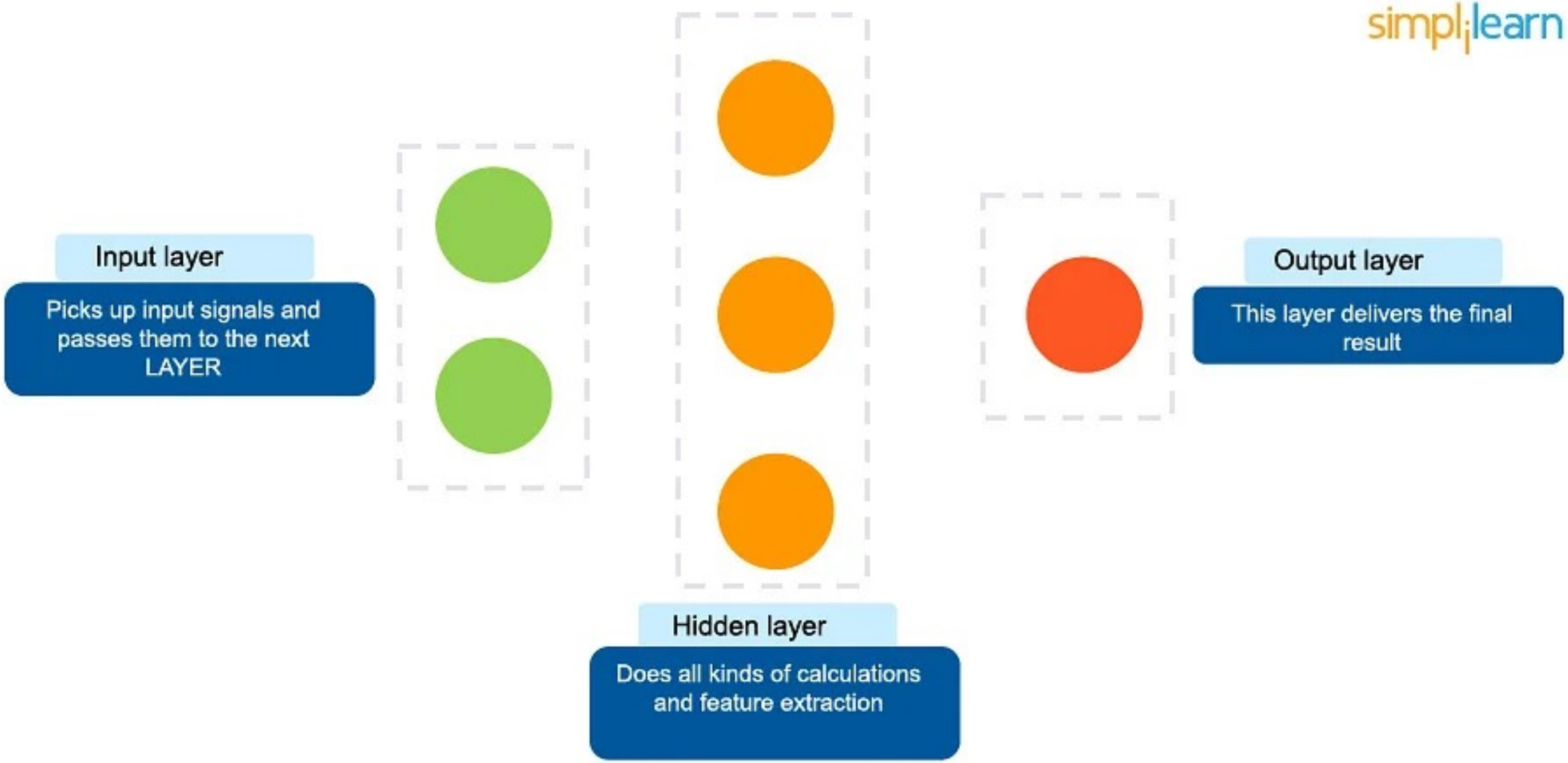
A neural network is a system or hardware that is designed to operate like a human brain.

What is a Neural Network?

Neural networks can perform the following tasks:

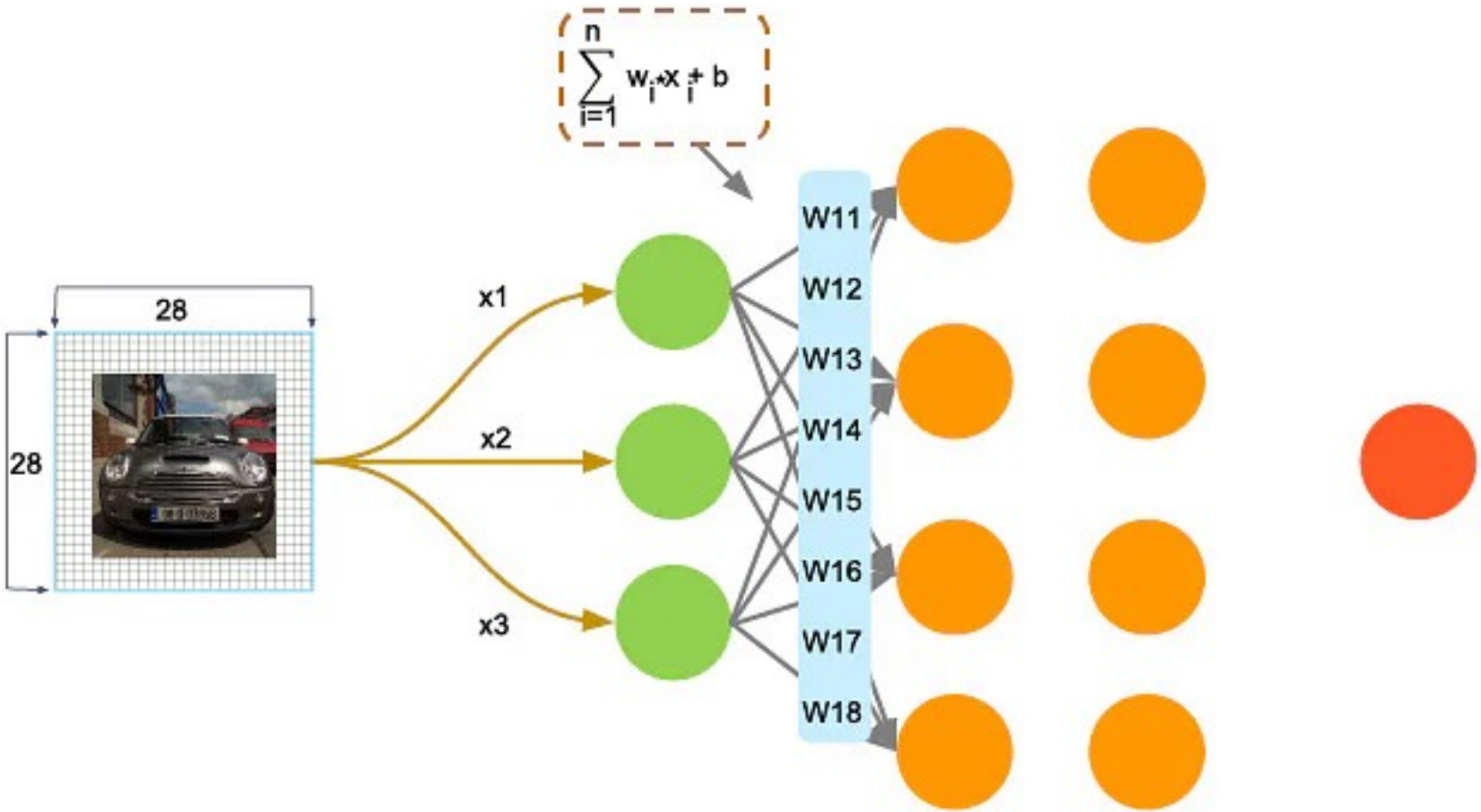
- Translate text
- Identify faces
- Recognize speech
- Read handwritten text
- Control robots
- And a lot more

Working of Neural Network


simplilearn
Input layer
Picks up input signals and passes them to the next LAYER
Hidden layer
Does all kinds of calculations and feature extraction
Output layer
This layer delivers the final result

Working of Neural Network

- A neural network is usually described as having different layers.
- The first layer is the input layer, it picks up the input signals and passes them to the next layer.
- The next layer does all kinds of calculations and feature extractions—it’s called the hidden layer. Often, there will be more than one hidden layer.
- And finally, there’s an output layer, which delivers the final result.



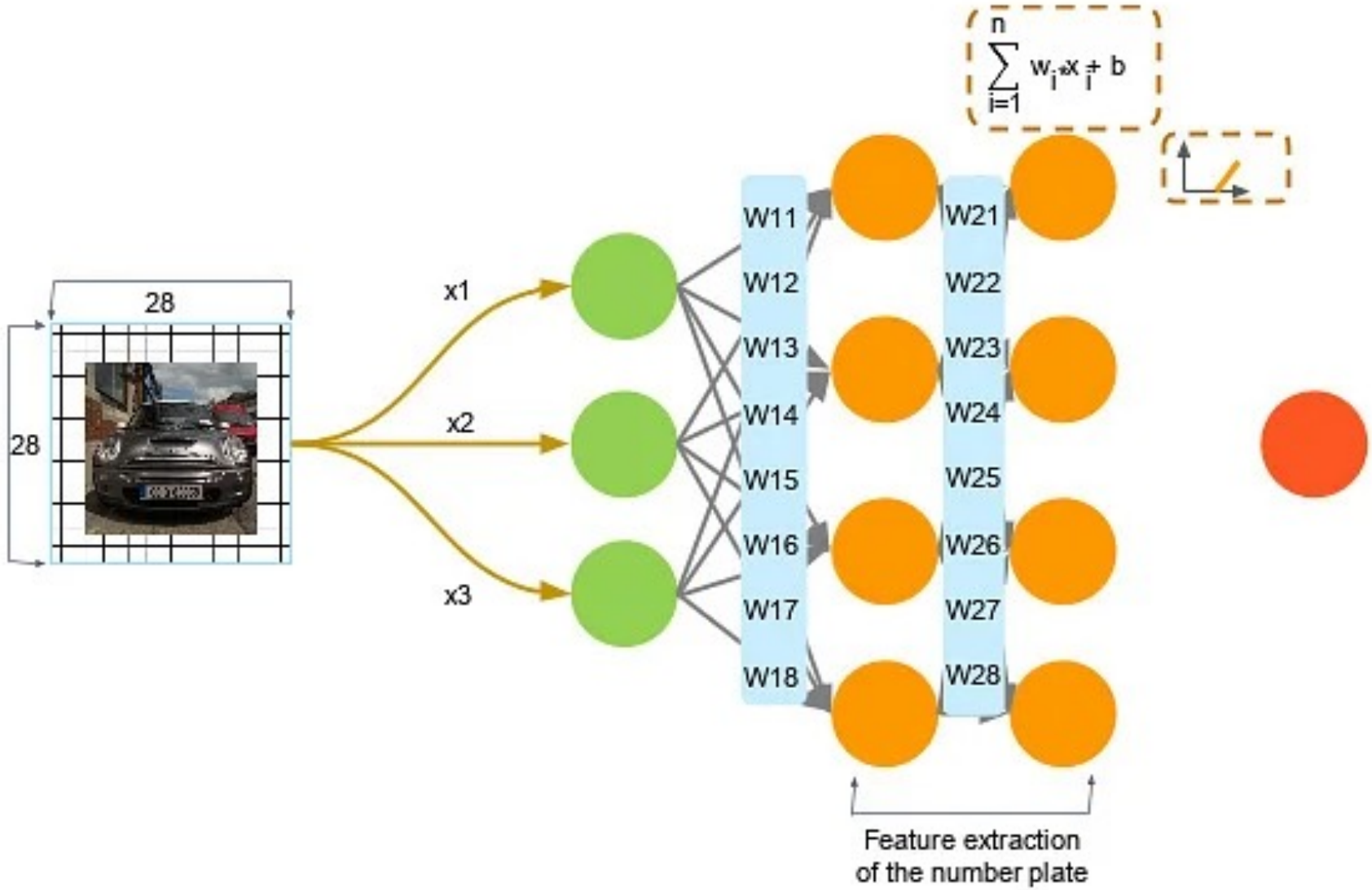
The weights are multiplied with the input signals and a bias is added to all of them..

Working of Neural Network

- Let’s take the real-life example of how traffic cameras identify license plates and speeding vehicles on the road.
- The picture itself is 28 by 28 pixels, and the image is fed as an input to identify the license plate.
- Each neuron has a number, called activation, which represents the grayscale value of the corresponding pixel, ranging from 0 to 1
- it’s 1 for a white pixel and 0 for a black pixel.
- Each neuron is lit up when its activation is close to 1.

Working of Neural Network

- Pixels in the form of arrays are fed into the input layer.
- If your image is bigger than 28 by 28 pixels, you must shrink it down, because you can’t change the size of the input layer.
- In our example, we’ll name the inputs as X1, X2, and X3.
- Each of those represents one of the pixels coming in.
- The input layer then passes the input to the hidden layer. The interconnections are assigned weights at random. The weights are multiplied with the input signal, and a bias is added to all of them.



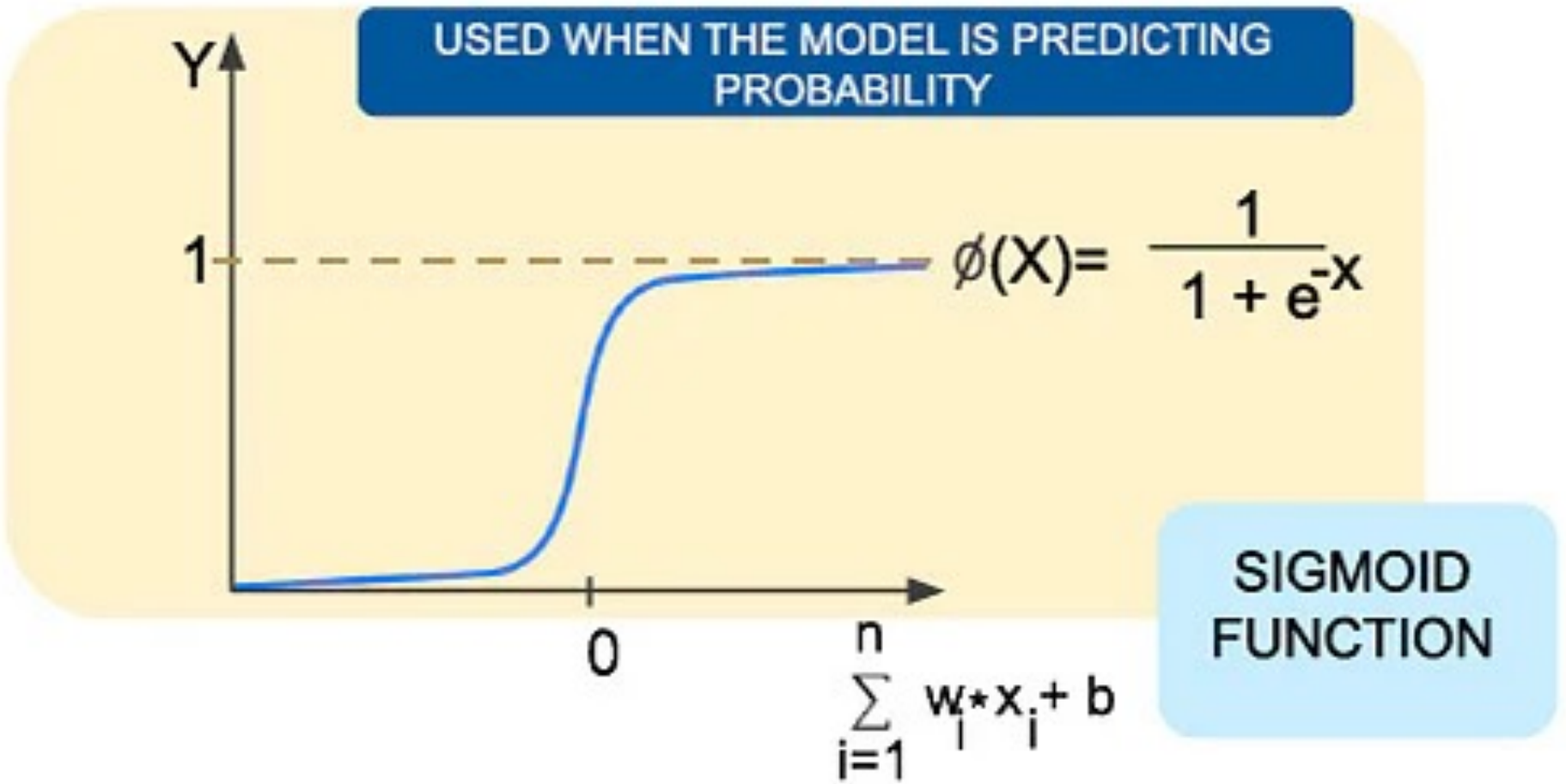
As the signal flows within the hidden layers, the weighted sum of inputs is calculated and is fed to the activation function in each layer to decide which nodes to fire

Working of Neural Network

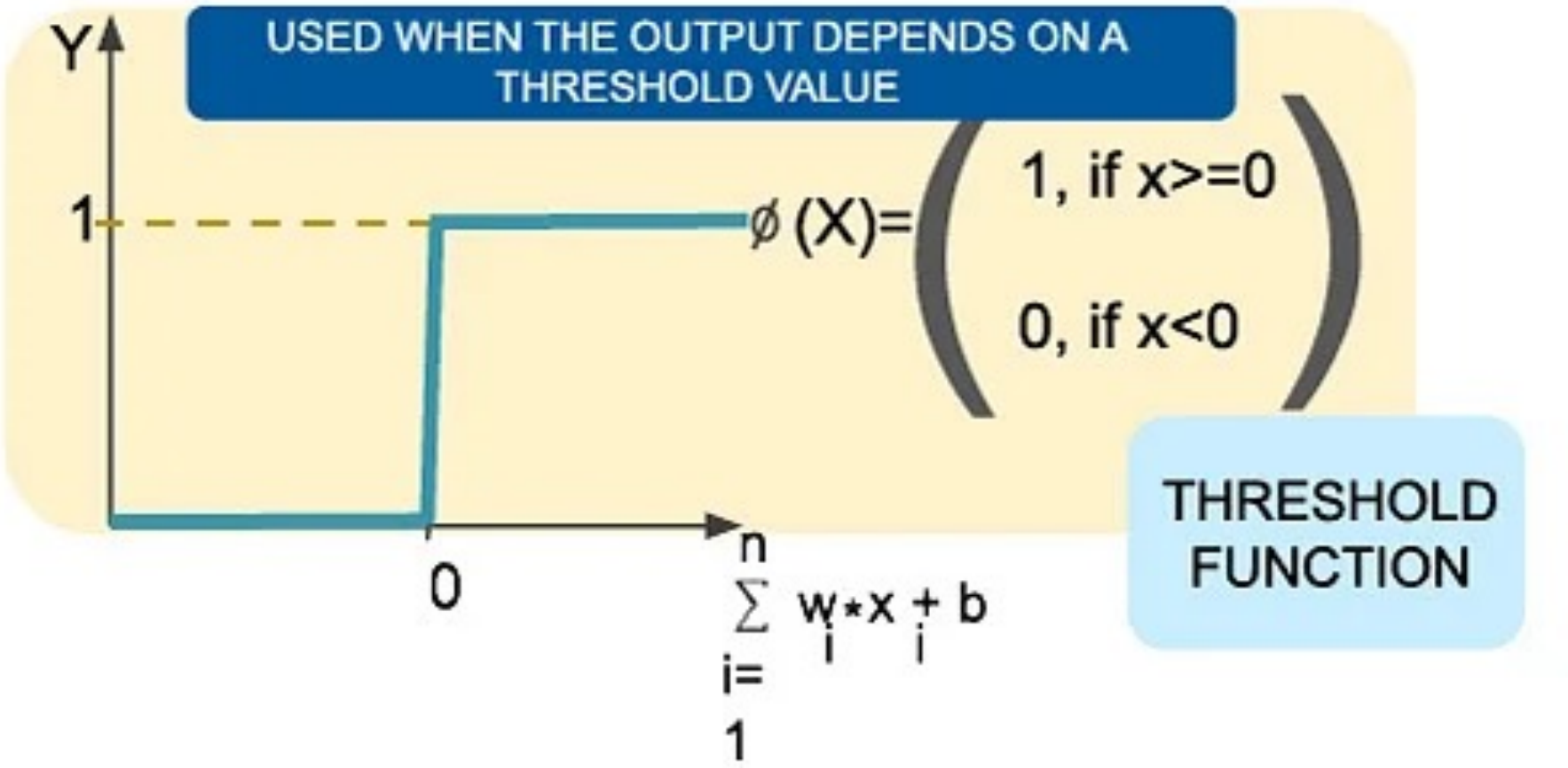
- The weighted sum of the inputs is fed as input to the activation function, to decide which nodes to fire for feature extraction.
- As the signal flows within the hidden layers, the weighted sum of inputs is calculated and is fed to the activation function in each layer to decide which nodes to fire.

Working of Neural Network

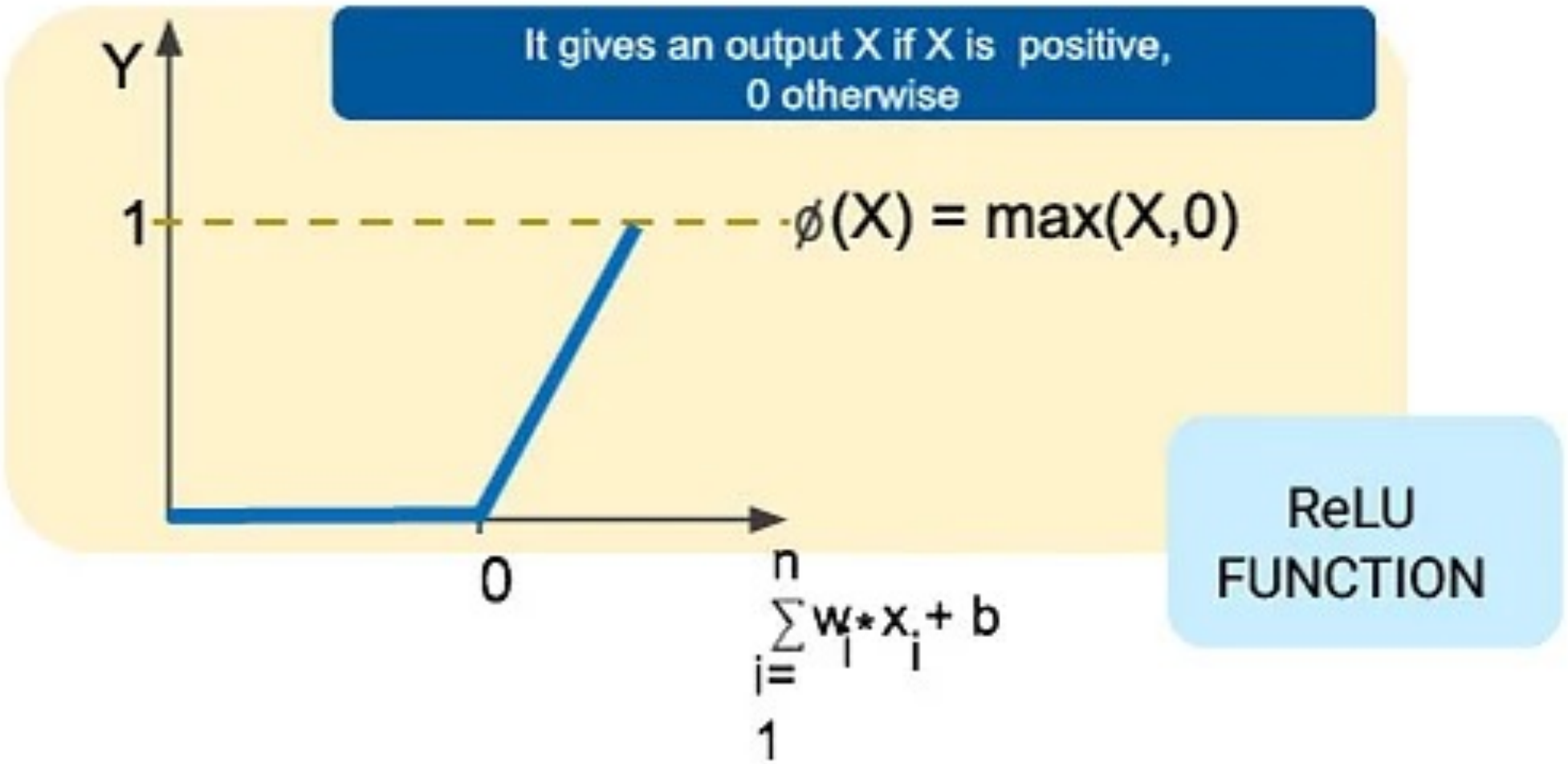
Activation Function



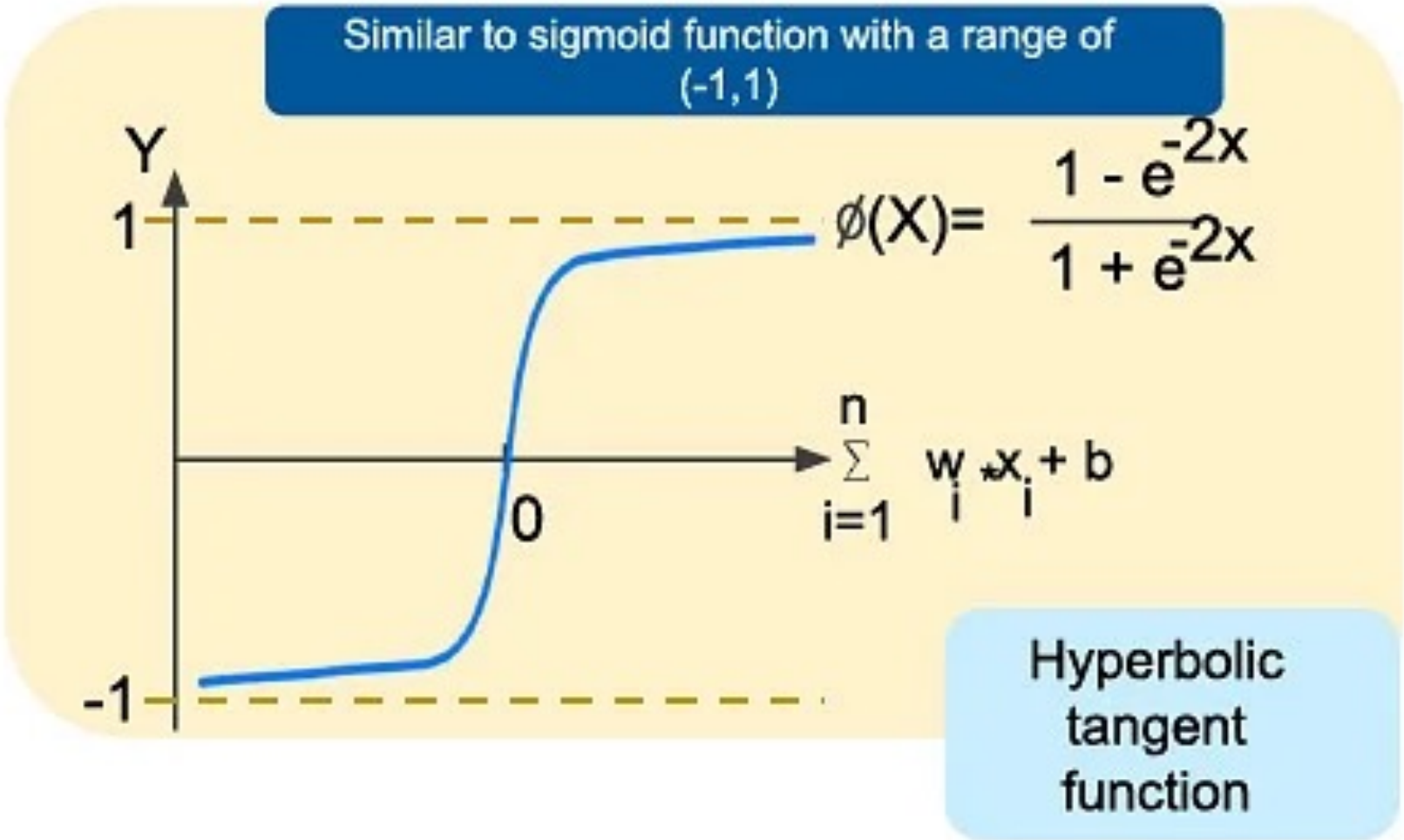
The sigmoid function is used when the model is predicting probability.



The threshold function is used when you don’t want to worry about the uncertainty in the middle.



The ReLU (rectified linear unit) function gives the value but says if it’s over 1, then it will just be 1, and if it’s less than 0, it will just be 0. The ReLU function is most commonly used these days.



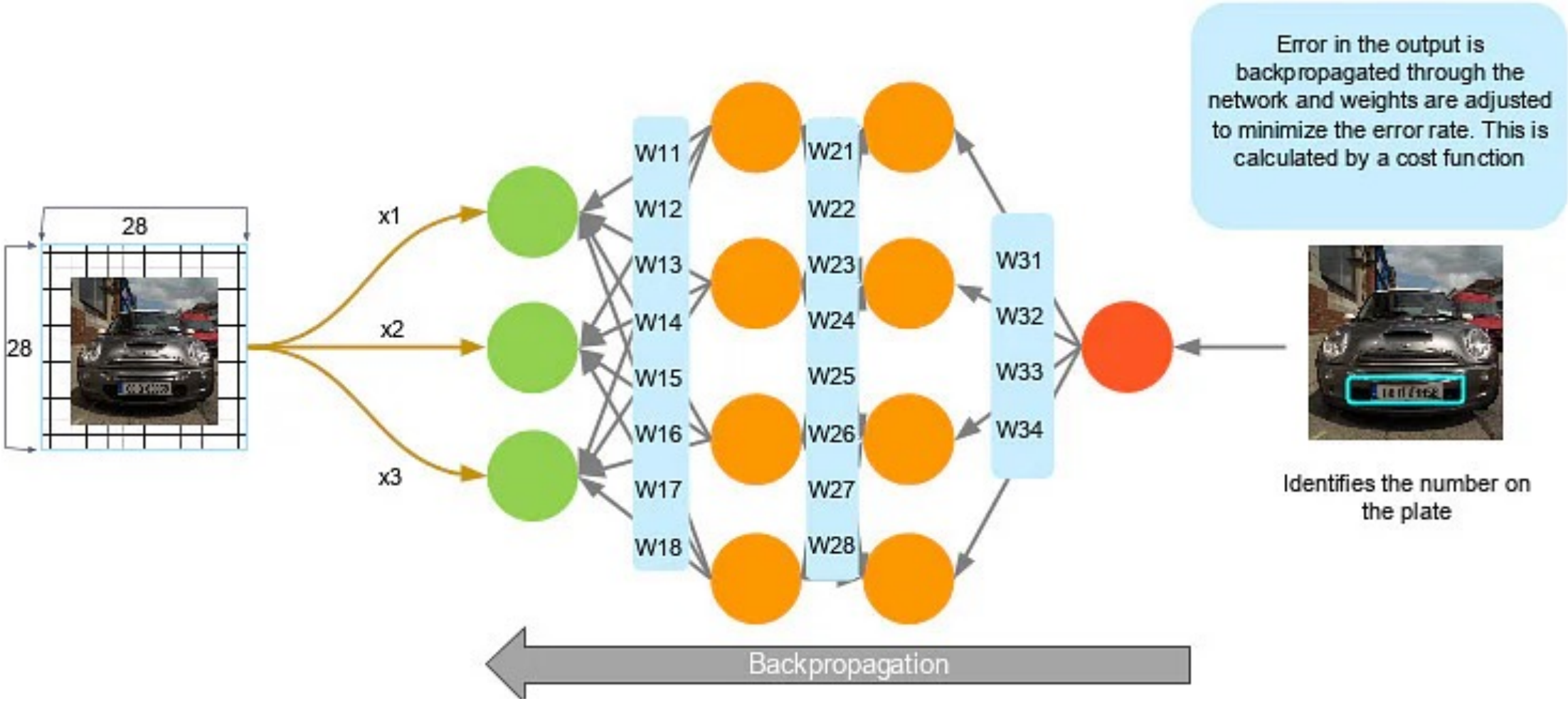
The hyperbolic tangent function is similar to the sigmoid function but has a range of -1 to 1.

Working of Neural Network
Activation Functions

- Now that you know what an activation function is, let’s get back to the neural network. Finally, the model will predict the outcome, applying a suitable application function to the output layer.
- In our example with the car image, optical character recognition (OCR) is used to convert it into text to identify what’s written on the license plate.
- In our neural network example, we show only three dots coming in, eight hidden layer nodes, and one output, but there’s really a huge amount of input and output.

Working of Neural Network

Backpropagation


Error in the output is backpropagated through the network and weights are adjusted to minimize the error rate. This is calculated by a cost function
28
28
x1
x2
x3
W11
W12
W13
W14
W15
W16
W17
W18
W21
W22
W23
W24
W25
W26
W27
W28
W31
W32
W33
W34
Identifies the number on the plate
Backpropagation

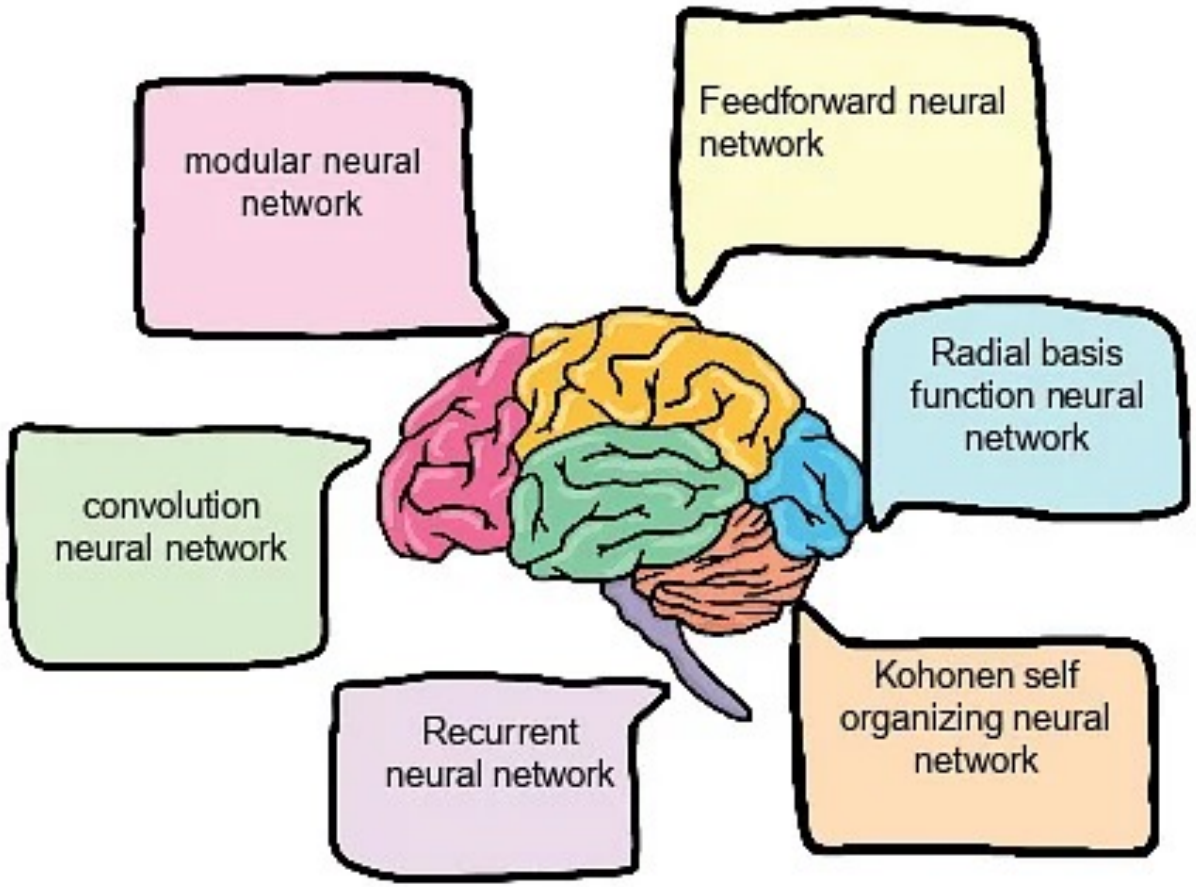
Backpropagation

- Error in the output is back-propagated through the network and weights are adjusted to minimize the error rate.
- This is calculated by a cost function.
- You keep adjusting the weights until they fit all the different training models you put in.

Backpropagation

- The output is then compared with the original result, and multiple iterations are done for maximum accuracy. With every iteration, the weight at every interconnection is adjusted based on the error.
- That math gets complicated, so we’re not going to dive into it here.
- But, we would look at how it’s being done while executing the code for our use case.

Types of Neural Networks


modular neural network
Feedforward neural network
Radial basis function neural network
convolution neural network
Recurrent neural network
Kohonen self organizing neural network

Feed-forward Neural Network

- This is the simplest form of ANN (artificial neural network); data travels only in one direction (input to output). This is the example we just looked at. When you actually use it, it’s fast; when you’re training it, it takes a while. Almost all vision and speech recognition applications use some form of this type of neural network.

Radial Basis Functions Neural Network

- This model classifies the data point based on its distance from a center point. If you don’t have training data, for example, you’ll want to group things and create a center point. The network looks for data points that are similar to each other and groups them. One of the applications for this is power restoration systems.

Kohonen Self-organizing Neural Network

- Vectors of random input are input to a discrete map comprised of neurons. Vectors are also called dimensions or planes. Applications include using it to recognize patterns in data like a medical analysis.

Recurrent Neural Network

- In this type, the hidden layer saves its output to be used for future prediction. The output becomes part of its new input. Applications include text-to-speech conversion.

Convolution Neural Network

- In this type, the input features are taken in batches—as if they pass through a filter. This allows the network to remember an image in parts. Applications include signal and image processing, such as facial recognition.

Modular Neural Network

- This is composed of a collection of different neural networks working together to get the output. This is cutting-edge and is still in the research phase.

Summary

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