Introduction To Artificial Neural Networks

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Outline

Biological Neuron

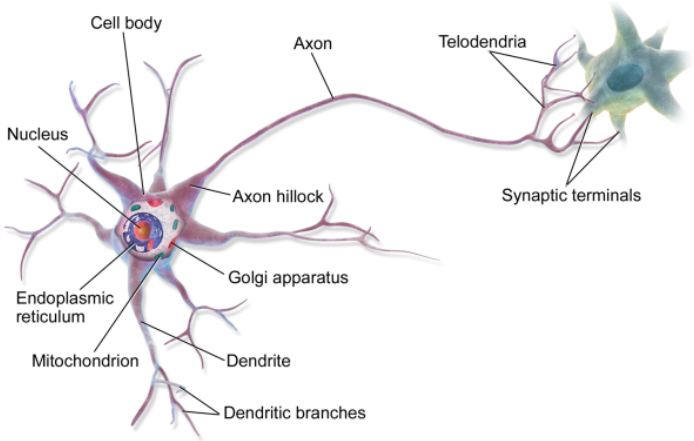


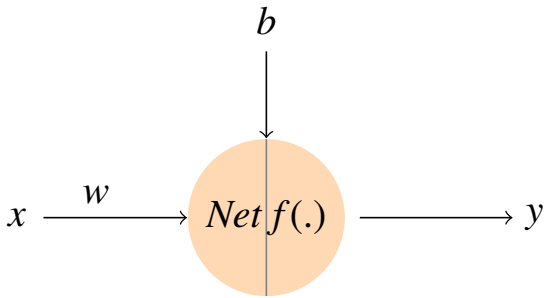
Figura: source[1]

The neurons have three principal components:

- Dendrites
- Cell body
- Axon

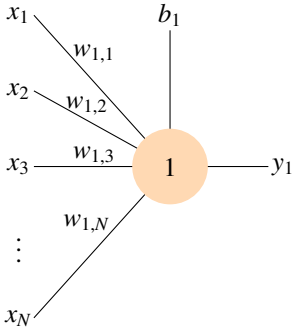
Artificial Neuron

Single-Input Neuron



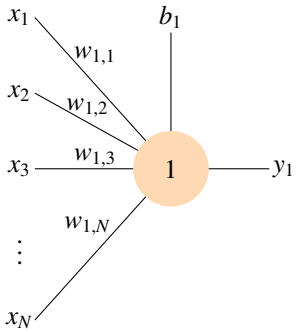
$$Net = xw + b$$
$$y = f(Net)$$

Multiple-Input Neuron



$$Net = x_1w_1 + x_2w_2 + x_3w_3 + x_nw_n + b_1$$
$$y = f(Net)$$

Weight Matrix



$$\boldsymbol{W} = \begin{bmatrix} w_{1,1} & w_{1,2} & \cdots & w_{1,N} \end{bmatrix}$$

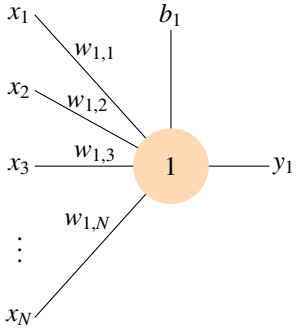
$$\boldsymbol{W_{MN}}$$

Where:

- M indicates where the connection goes
- N indicates where the connection comes from

- It represents the connection between neurons, similar to what the synapse does in biological neurons.

Net Input

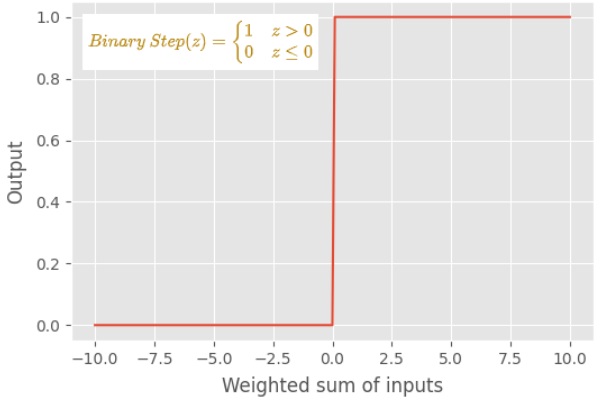


$$\boldsymbol{Net = WX + b}$$

- Represents the total input of information or stimulus that a neuron receives

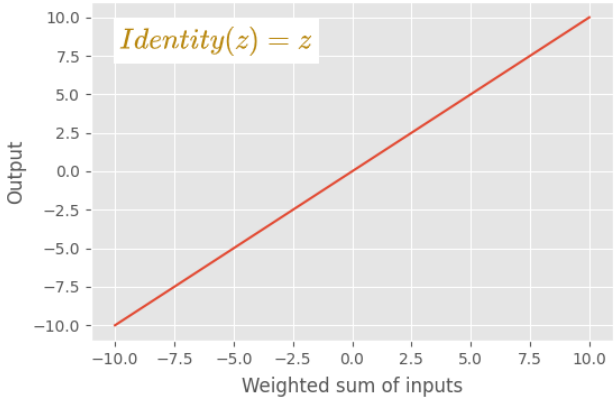
Transfer Functions

Activation Functions: Binary Step



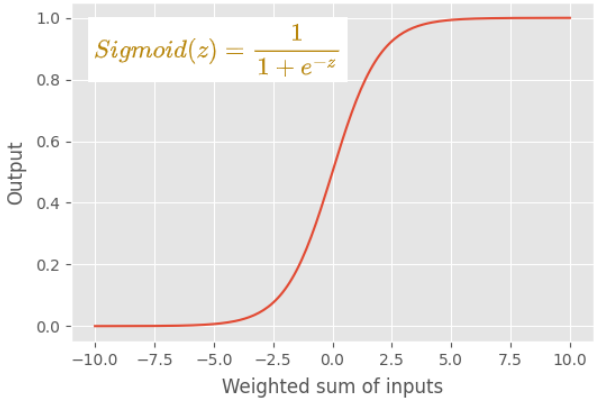
Transfer Functions

Activation Functions: Identity



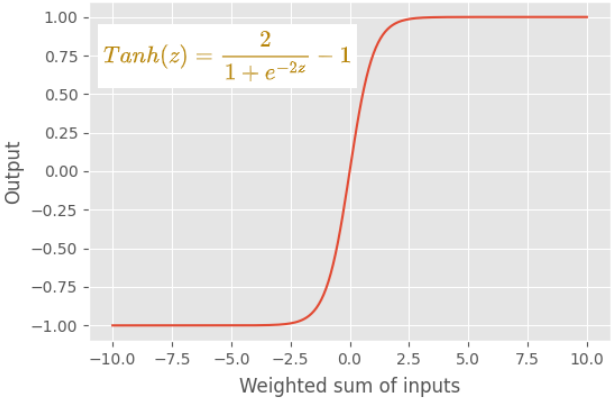
Transfer Functions

Activation Functions: Sigmoid



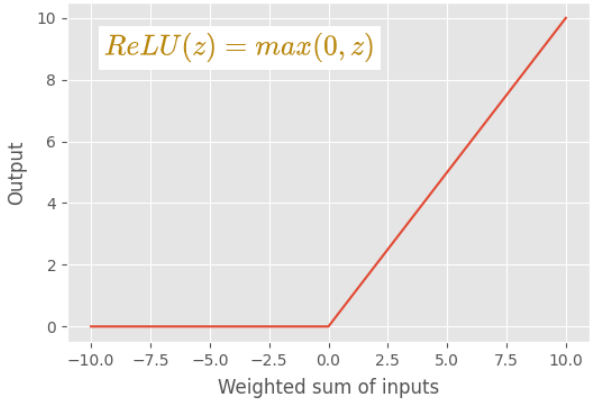
Transfer Functions

Activation Functions: Tanh



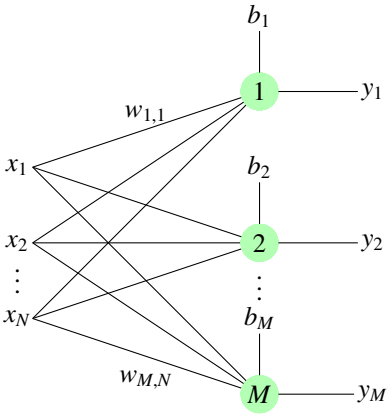
Transfer Functions

Activation Functions: ReLU (Rectified Linear Unit)



Artificial Neural Networks

Single-layer Network



- **layer:** set of neurons that receive the same information.

Mathematical Process:

$$Net = WX + b$$
$$Y = f(Net)$$

Matrix Notation:

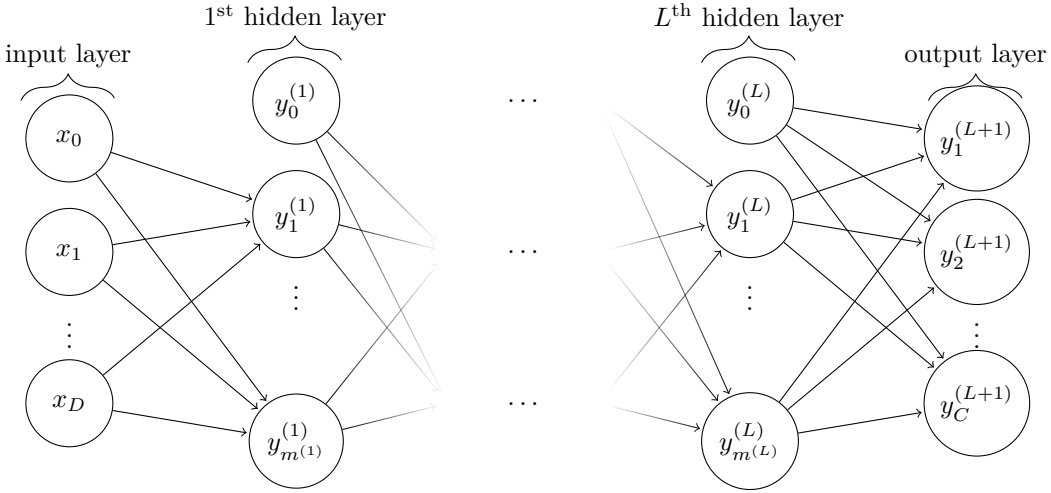
$$[Y] = f([Net])$$

where:

$$W = \begin{bmatrix} W_{1,1} & W_{1,2} & \cdots & W_{1,N} \\ W_{2,1} & W_{2,2} & \cdots & W_{2,N} \\ \vdots & \vdots & & \vdots \\ W_{M,1} & W_{S,2} & \cdots & W_{M,N} \end{bmatrix}, X = \begin{bmatrix} x_1 \\ x_2 \\ \vdots \\ x_N \end{bmatrix}, b = \begin{bmatrix} b_1 \\ b_2 \\ \vdots \\ b_M \end{bmatrix}$$

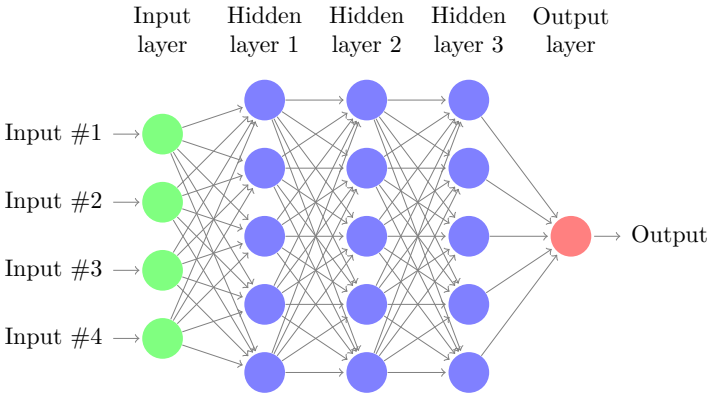
Artificial Neural Networks I

Multi-Layer Network



Artificial Neural Networks II

Multi-Layer Network



$$Y^{(4)} = f^{(4)}(W^{(4)}Y^{(3)} + b^{(4)})$$
$$Y^{(3)} = f^{(3)}(W^{(3)}Y^{(2)} + b^{(3)})$$
$$Y^{(2)} = f^{(2)}(W^{(2)}Y^{(1)} + b^{(2)})$$
$$Y^{(1)} = f^{(1)}(W^{(1)}X + b^{(1)})$$

$$Y^{(4)} = f^{(4)}(W^{(4)}f^{(3)}(W^{(3)}f^{(2)}(W^{(2)}f^{(1)}(W^{(1)}X + b^{(1)}) + b^{(2)}) + b^{(3)}) + b^{(4)})$$

Artificial Neural Networks Winters

Timeline

- 1943: Electronic Brain - S. McCulloch and W. Pitts.
- 1957: Perceptron - F. Rosenblatt
- 1960: ADALINE - B. Widrow and M. Hoff
- 1969: XOR Problem (first winter) - M. Minsky and S. Papert
- 1986: Multi-Layer Perceptron (Backpropagation)
- 1999: Vanishing Gradient (second winter) - Y. Bengio, G. Hinton and Y. LeCun
- 2006: Deep Neural Netwookrs (Deep Learning) - G. Hinton et al.

`https://playground.tensorflow.org`

Artificial Neural Networks

Other Network Architectures

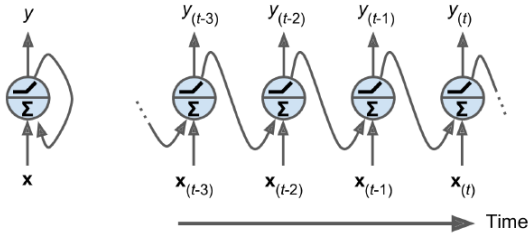


Figura: **Recurrent Neural Network** source[1]

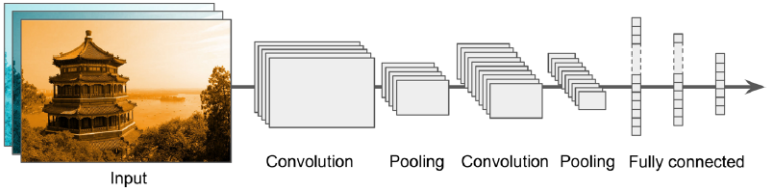
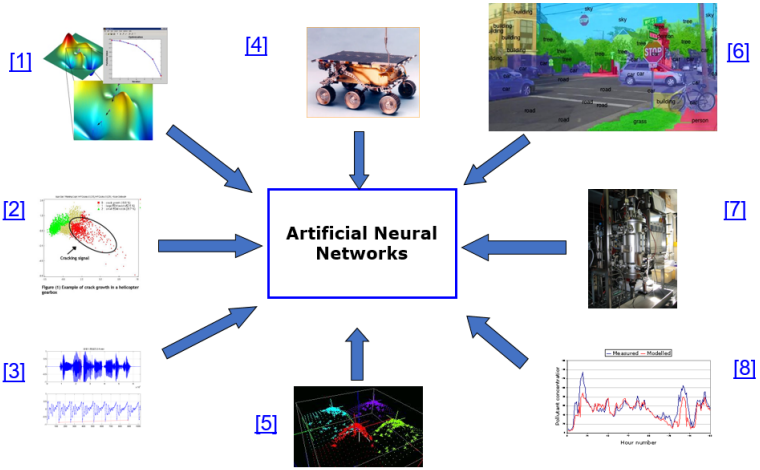


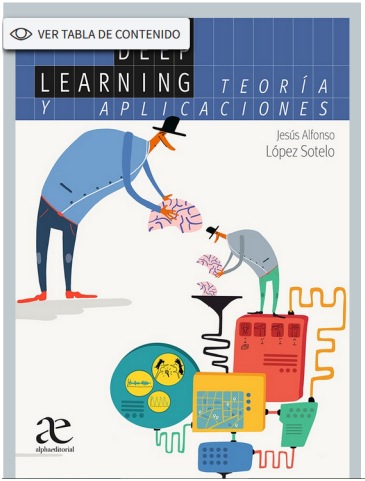
Figura: **Convolutional Neural Network** source[1]

Applications



1. Optimization
2. Classification
3. Signal Processing
4. Robotics
5. Clustering
6. Computer Vision
7. Automatic Control
8. Time Series Modeling

Recommended Textbook



Deep Learning

Teoría y aplicaciones

Jesús Alfonso López Sotelo

El aprendizaje profundo o Deep Learning es una evolución de las redes neuronales artificiales (RNA). Las RNA constituyen una de las técnicas más relevantes de la inteligencia artificial que trata de emular la manera como trabajan las neuronas del cerebro. Este enfoque se encuentra dentro de la vertiente denominada conexionista, pues se basa en imitar el funcionamiento cerebral por medio de redes formadas por unidades sencillas (neuronas artificiales) interconectadas entre sí. Además. el conocimiento se modifica

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CONTENIDO EXTRA

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