

# Deep Learning

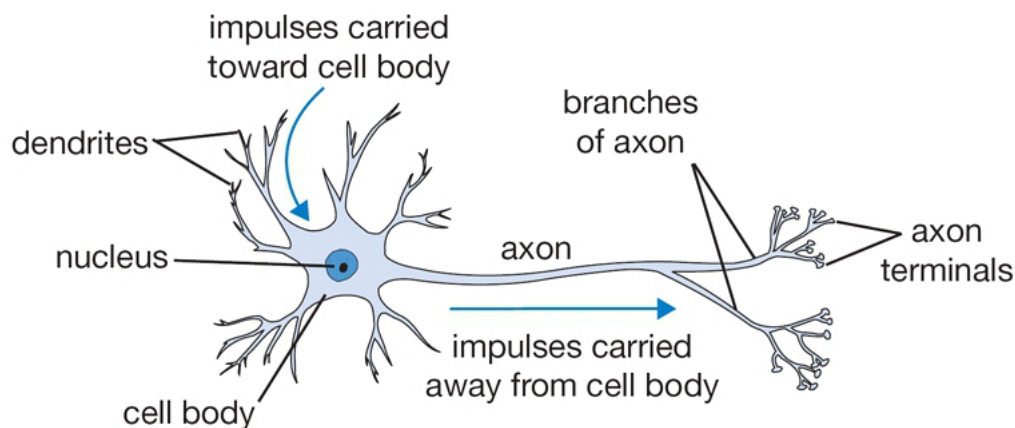
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# 1 Types of neurons

## 1.1 Brain neurons



## 1.2 Linear neurons

A linear neuron is very simple and computationally limited in what it can do.

$$y = b + \sum_i x_i w_i$$

The output  $y$  is given by the bias  $b$  plus the sum of all the input connections  $x_i$  multiplied by their weight  $w_i$ .

## 1.3 Binary threshold neurons

Binary threshold neurons output a 1 or a 0 depending on its weighted value.

Given a threshold  $\theta = -b$

$$z = b + \sum_i x_i w_i$$
$$y = \begin{cases} 1 & \text{if } z \geq 0 \\ 0 & \text{otherwise} \end{cases}$$

## 1.4 Rectified Linear Neurons or Linear threshold neurons

They compute a linear weighted sum of their inputs.

The output is a non-linear function of the total input.

Given a threshold  $\theta = -b$

$$z = b + \sum_i x_i w_i$$
$$y = \begin{cases} z & \text{if } z > 0 \\ 0 & \text{otherwise} \end{cases}$$

## 1.5 Sigmoid neurons

They give a real-valued output that is a smooth and bounded function of their total input.

The logistic function is often used.

Given a threshold  $\theta = -b$

$$z = b + \sum_i x_i w_i$$
$$y = \frac{1}{1 + e^{-z}}$$

This function has smooth derivatives that change continuously.

This characteristic makes the learning process easier.

## 2 Types of learning

### 2.1 Supervised learning

Each training consists of making the network guess the target output  $t$  for a certain input  $x$ , given the difference between the correct target and the guess we tweak the network.

There are two type of supervised learning

#### 2.1.1 Regression

The target output is a numeric value of a vector of values. [...]

#### 2.1.2 Classification

The target output is a class or label. Usually either 1 or 0. There could also be multiple labels. [...]

### 2.2 Reinforcement learning

### 2.3 Unsupervised learning