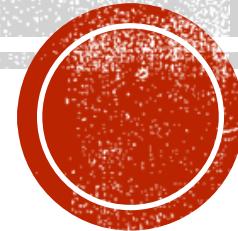


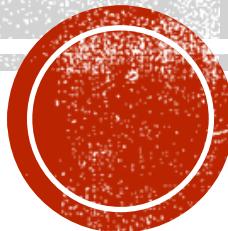
# Neural Networks



*M. Raihan*

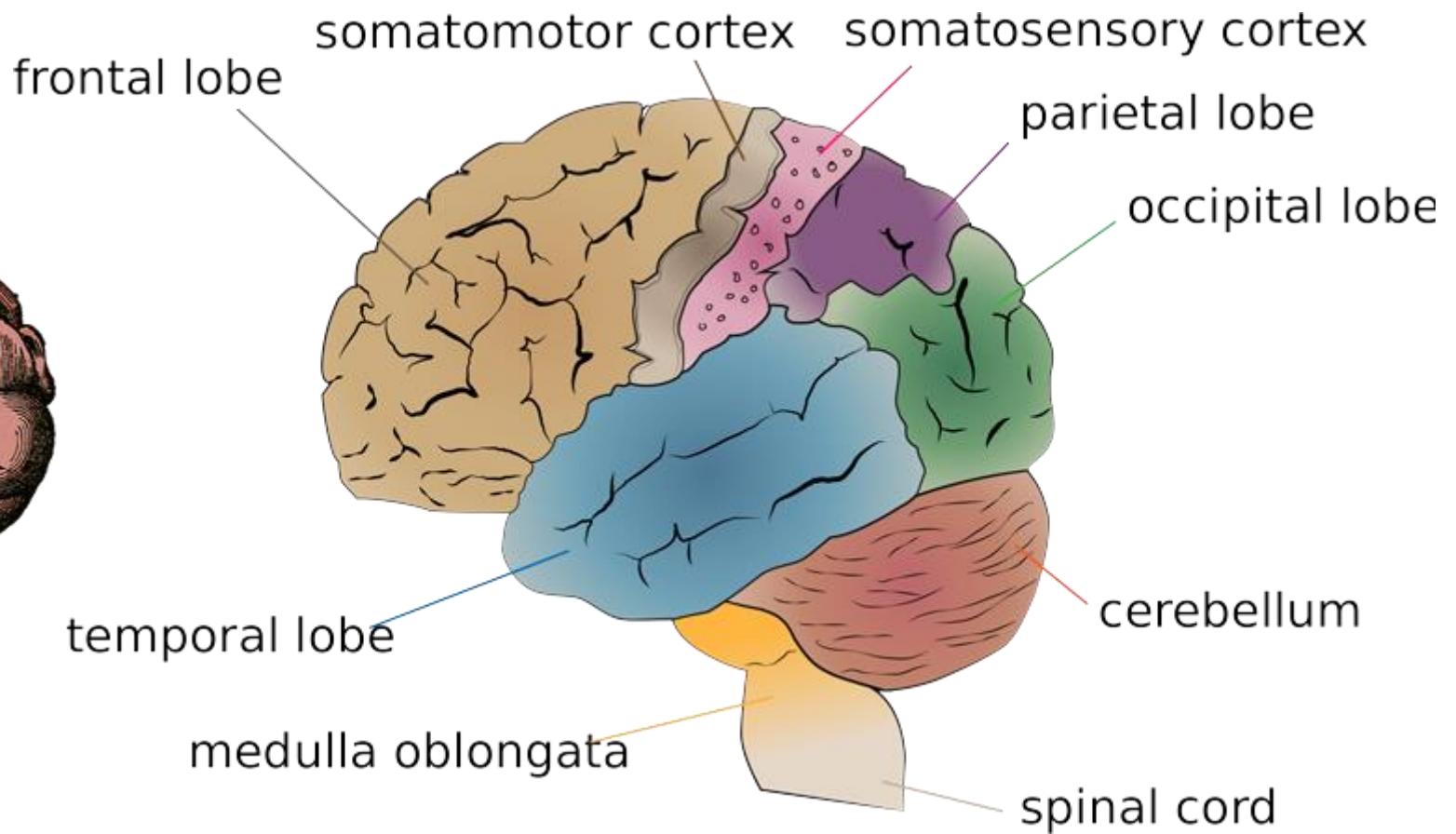
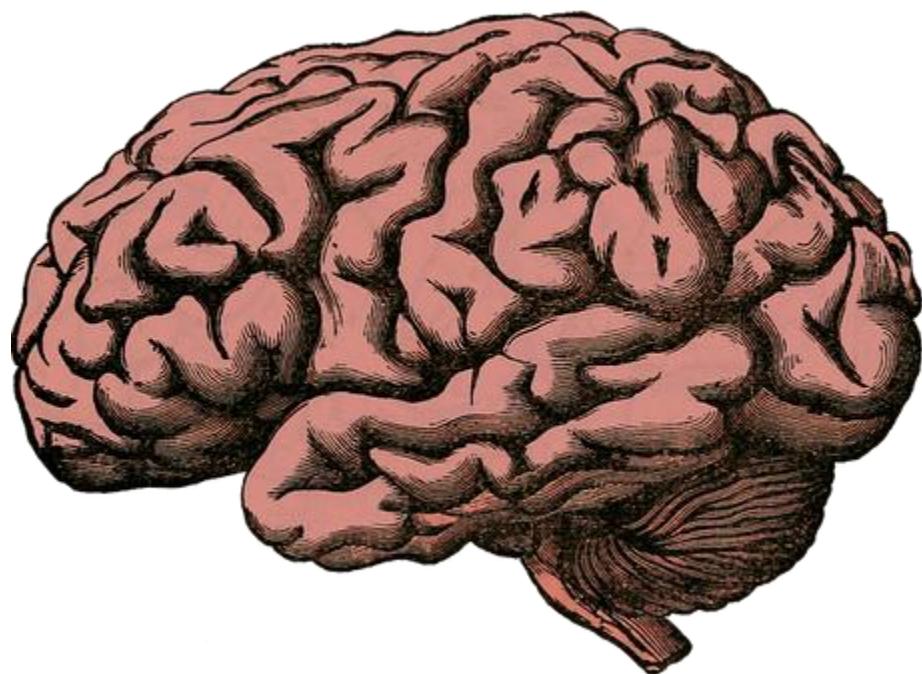
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# Lecture: 1



# NEURAL NETWORKS

# Neural Networks



# Neural Networks

- ↪ We are born with about **100 billion neurons**
- ↪ A neuron may connect to as many as **100,000 other neurons**

# Human Brain

- Number of neurons  $\sim 10^{10}$ , of > 20 types
- Connections per neuron  $\sim 10^{4-5}$
- Scene recognition time  $\sim 0,1$  second
- 100 inference steps doesn't seem like enough

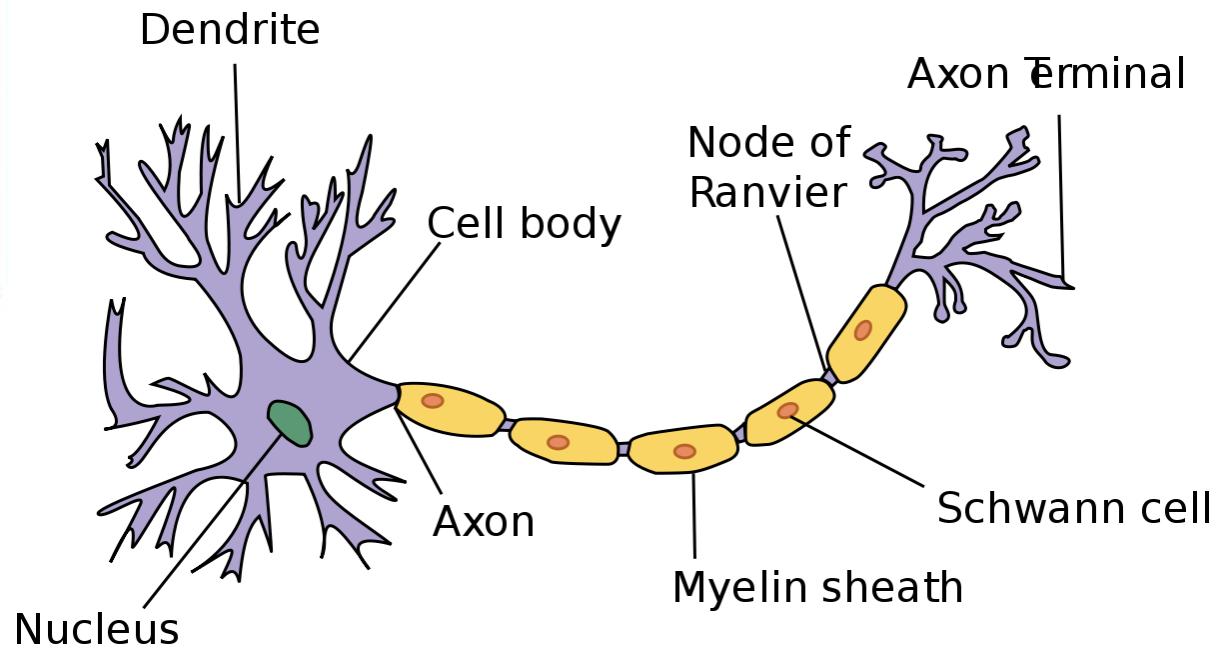
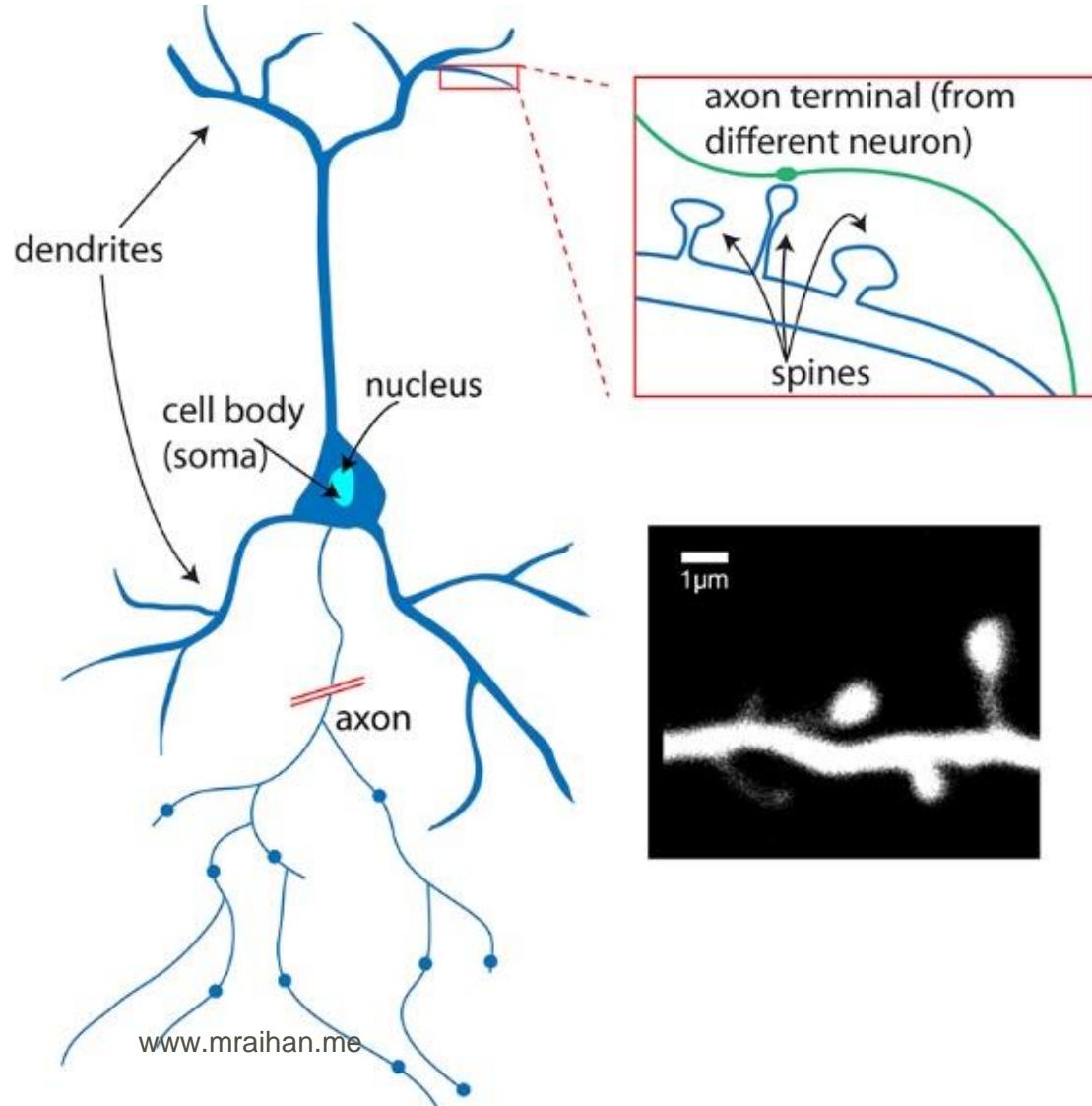
# What is Neuron

- ❖ Neurons are the fundamental units of the **brain** and **nervous system**.
- ❖ The cells responsible for **receiving sensory input** from the external world
- ❖ For **sending motor commands** to our muscles
- ❖ For **transforming and relaying** the electrical signals at every step in between.

# How does a Neuron look like

- ☛ A useful analogy is to think of a neuron as a **tree**.
- ☛ A neuron has **three main parts**: **dendrites**, an **axon**, and a **cell body or soma** which can be represented as the **branches, roots and trunk of a tree** respectively.
- ☛ A **dendrite** (**tree branch**) is where a neuron receives input from other cells.
- ☛ The **axon** (**tree roots**) is the **output structure of the neuron**; when a neuron wants to talk to another neuron, it **sends an electrical message called an action potential** throughout the entire axon.
- ☛ The **soma** (**tree trunk**) is where the **nucleus lies**, where the neuron's DNA is housed, and where proteins are made to be transported throughout the **axon and dendrites**.

# Continue



# Inspiration from Neurobiology

- 🖱️ A neuron: many-inputs / one output unit.
- 🖱️ Output can be **excited or not excited**.
- 🖱️ Incoming signals from other neurons determine if the neuron shall excite ("fire")
- 🖱️ Output subject to attenuation in the **synapses**, which are junction parts of the neuron

## Hebb's Rule

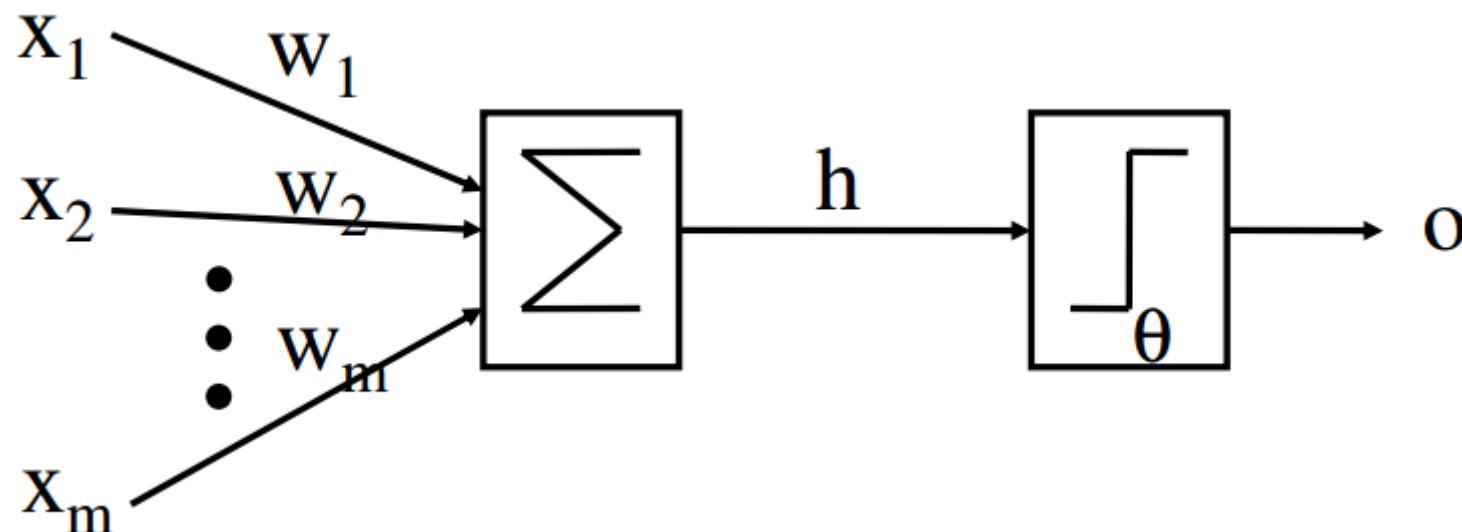
If an input of a **neuron** is **repeatedly** and **persistently** causing the **neuron** to **fire**, a **metabolic change** happens in the **synapse** of that **particular input** to reduce its **resistance**.

# McCulloch and Pitts Neurons

- ❖ McCulloch & Pitts (1943) are generally recognized as the **designers of the first neural network.**
- ❖ Many of their ideas still used today (e.g. many simple units combine to give increased computational power and the idea of a threshold).

# McCulloch and Pitts Neurons

- ↪ Greatly simplified biological neurons
- ↪ Sum the inputs
  - ↪ If total is less than some threshold, neuron fires
  - ↪ Otherwise does not



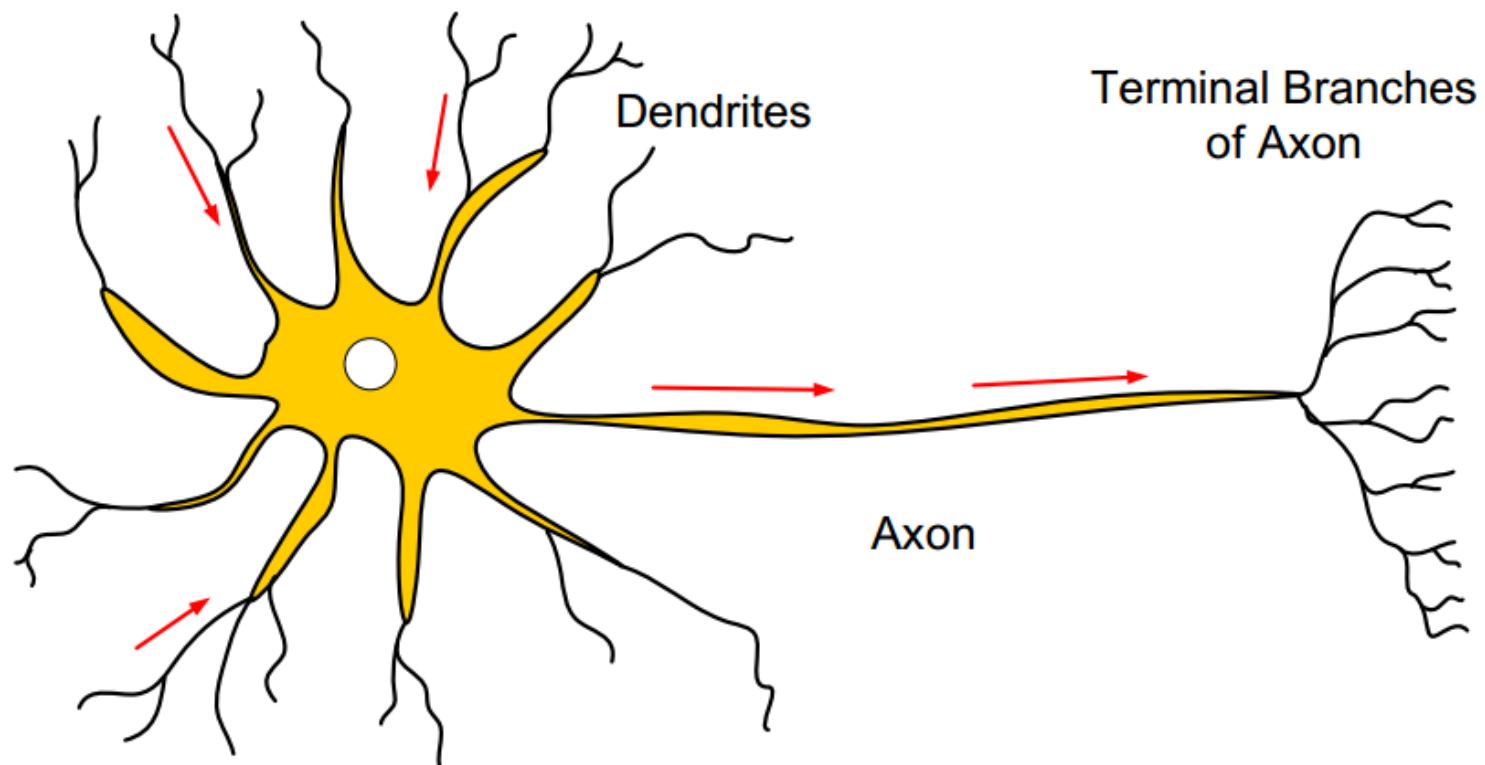
# McCulloch and Pitts Neurons

- ↪ The weight  $w_j$  can be **positive or negative**
  - ↪ Inhibitory or excitatory.
- ↪ Use only a **linear sum of inputs**.
- ↪ No refractory period.
- ↪ Use a **simple output** instead of a pulse (spike train)

# Biologically Inspired

☛ **Electro-chemical signals.**

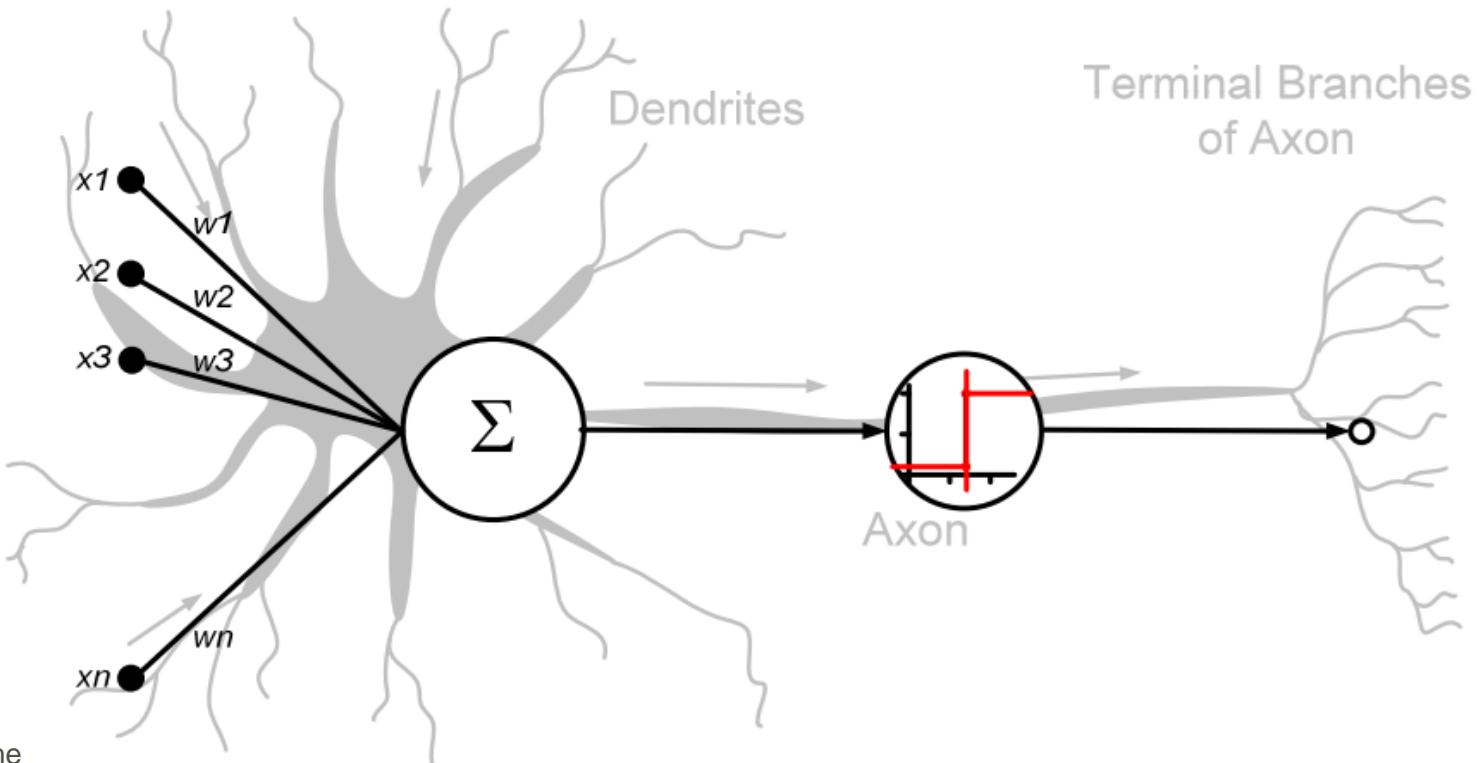
☛ **Threshold output firing.**



# The Perceptron

↪ **Binary classifier** functions.

↪ **Threshold activation** function.



# Limitations of (McCulloch and Pitts Neurons Model)

- How realistic is this model?
- Not Very.
  - Real neurons are much more complicated.
  - Inputs to a real neuron are not necessarily summed linearly.
  - *Real neuron do not output a single output response, but a SPIKE TRAIN.*
  - Weights  $w_i$  can be positive or negative, which has not been biologically.

# Thank You