Machine learning introduction

Part I – From neurons to networks

1 – The neuron

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Part I-1 : the neuron

- **Artificial intelligence aims to mimic several properties of human or animal intelligence**

- **This intelligence emerges from the most incredible but also mysterious organ : the brain**

  - **Let’s analyze it !**

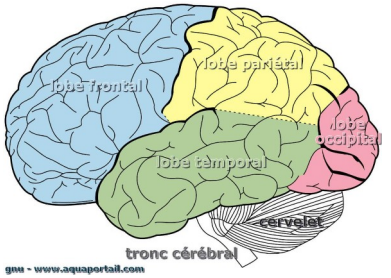
Part I-1 : the neuron

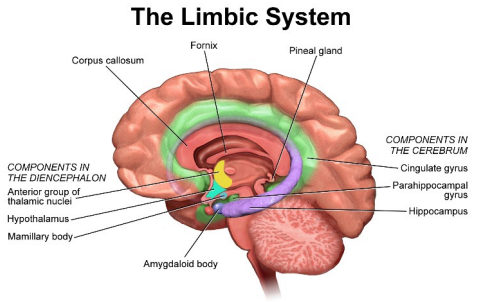
- **Characteristics of human brain:**
  - ~80-100 billions neurons
  - Equivalent number of *glial cells*
  - ~ 1,5 x 10^{14} connections
  - 10.000 to 50.000 neurons and 100 à 500 millions connections by mm^3

- **Even animals' brains are beyond computer's possibilities:**
  - Cat : 760 millions neurons
  - Mouse : 71 millions
  - frog : 16 millions
  - fish : 10 millions
  - bee : 960 000 (1 billion connections)
  - fly : 250 000 (10 millions connections)

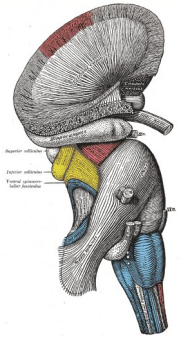
Part I-1 : the neuron

- **Brains are composed of different areas associated to specific functions:**
  - Cortex :
    - Cortex occipital (vision)
    - Cortex temporal (hearing and spatial localization)
    - Cortex pariétal (motor coordination and touch)
    - Cortex préfrontal (high level cognitive functions)
  - Lymbic system (emotions, navigation, memory, sleeping cycle and hormone control
  - Brain stem (reflexes, body posture, low level vision and sound processing)



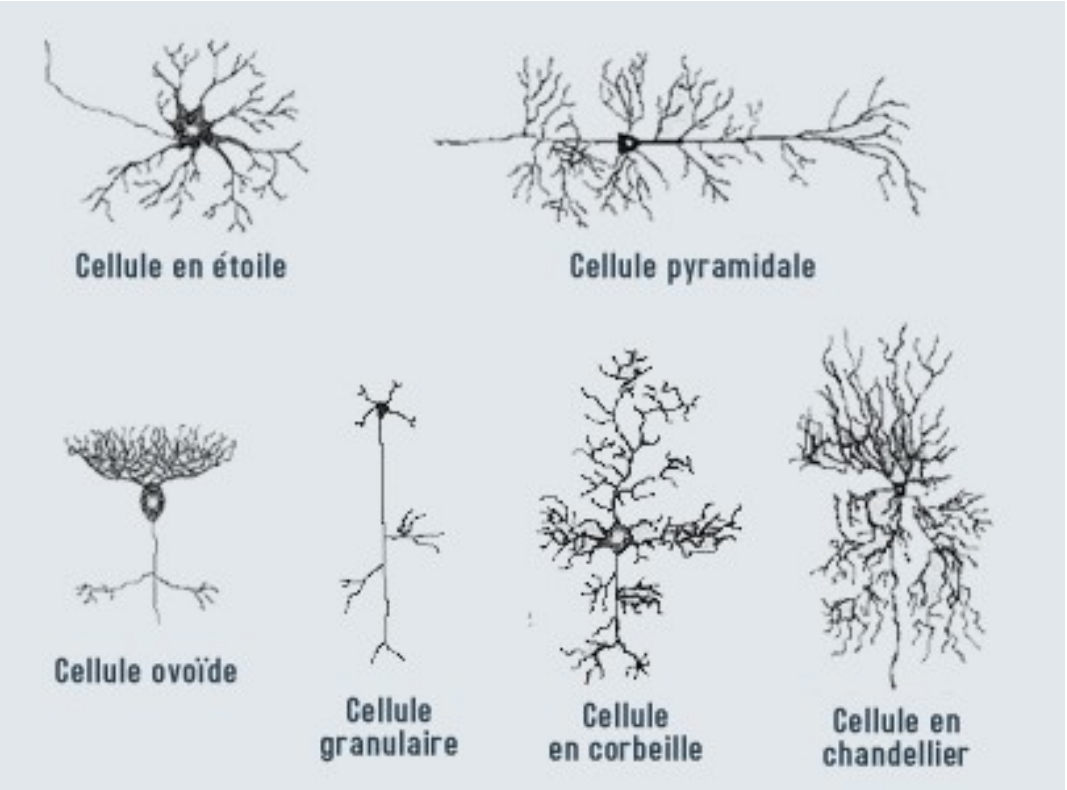


- → **The brain is not a neuron tank !**
  - But all parts rely on neurons



Part I-1 : the neuron

There are many types (>200) of neurons, with their own working principles



New types are regularly discovered → last one was discovered in 2018 (called rosehip neurons)

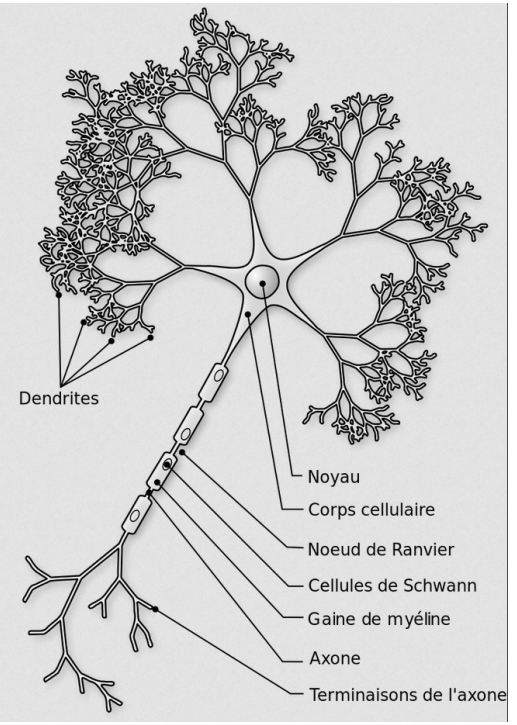
Part I-1 : the neuron

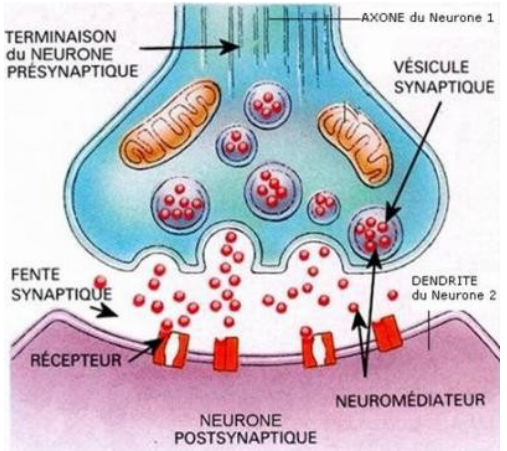
The most common neuron type (and thus the most known) are *multipolar neurons*

- Anatomy of the neuron:
  - A body (also called pericaryon or soma)
  - *Dendrites* (around 7000 per neuron) → inputs
  - A unique *axon* → output

- Neurons communicate through *synapses*
  - Axone to dentride connection
  - Signal is contactless:
    - The axon emits chemical neurotransmitters
    - The dendrite receive signal through neuroreceptors
  - The strength of the connection depends of the amount of neurotransmitter emitters/receptors in the synapse

- When receiving pulse signals, the neuron tension increase (presence of ions)
  - When reaching -55mV, the neuron emits an electric impulsion of +100mV through its axon, sending a signal to connected neurons
  - Information is encoded in synapses





Part I-1 : the neuron

Synaptic learning

- Most common mechanism: Hebb principle (Donald Hebb , 1949)
  - Neurons triggering simultaneously reinforce their synaptic connection
    - When two neurons trigger simultaneously, the number of neurotransmitter emitter/receptor increases to facilitate the signal reception.
    - When two neurons are strongly connected, the signal sent by the first neuron is more likely to trigger the second neuron, that will transmit the signal to next neurons
- Other mechanisms are used by other types of neurons