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*
  - ~ $1,5 \times 10^{14}$ 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 :
    - Occipital cortex (vision)
    - Temporal Cortex (hearing and spatial localization)
    - Parietal Cortex (motor coordination and touch)
    - Prefrontal cortex (high level cognitive functions)

  - Lymbic system (emotions, navigation, memory, sleeping cycle and hormone control)

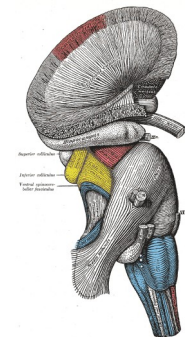 - Brain stem (reflexes, body posture, low level vision and sound processing)
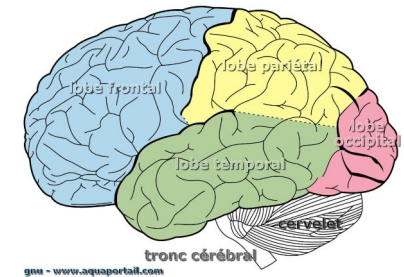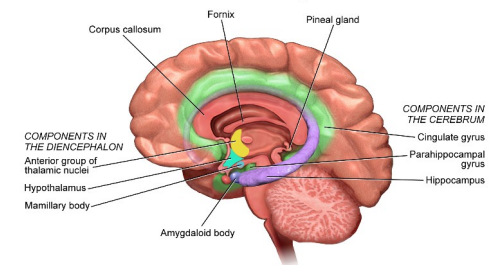
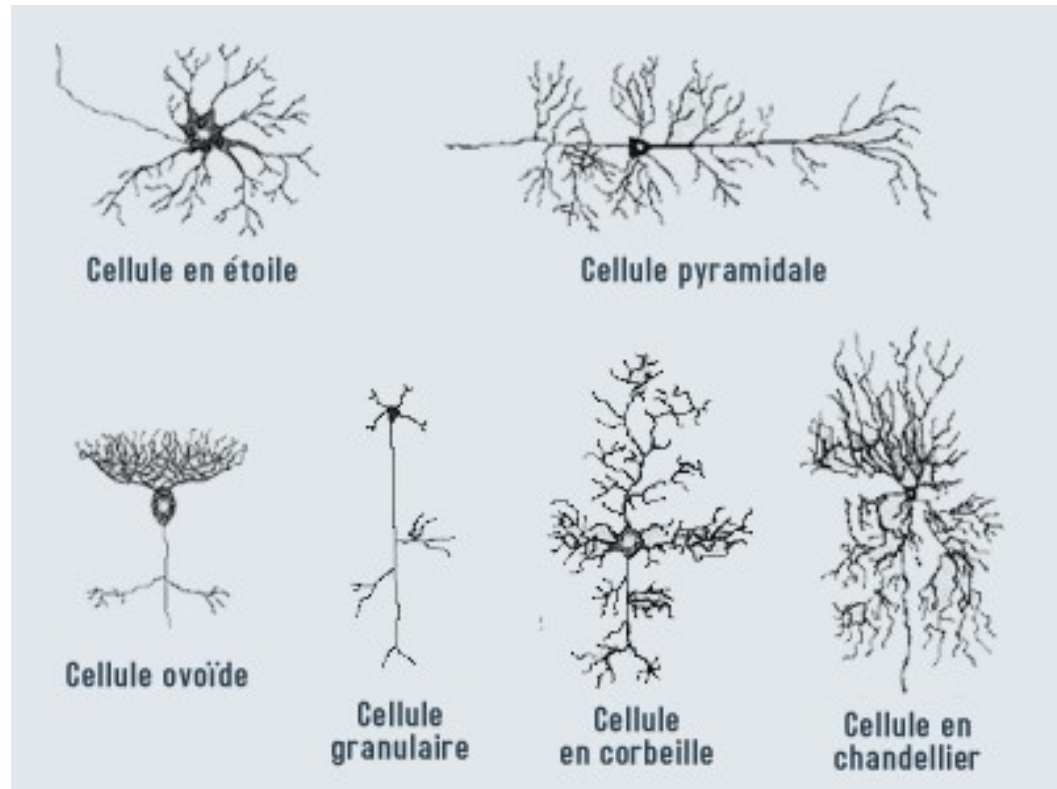- → **The brain is not a neuron tank !**

  - But all parts rely on neurons

The Limbic System

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_
  - Axon to dentride connection
  - Signal is contactless:
    - The axon emits chemical neurotransmitters
    - The dendrite receives signal through neuroreceptors
  - The strength of the connection depends on 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
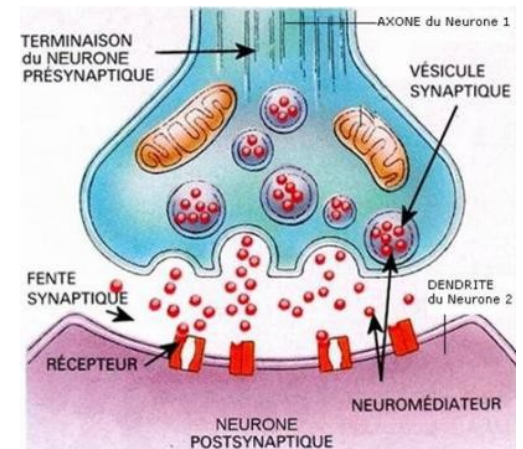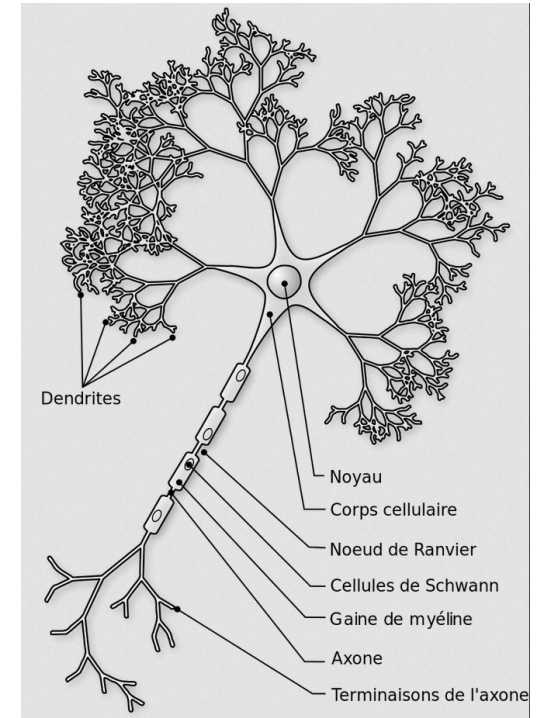
Part I-1 : the neuron

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