ENSEA
Ecole Nationale Supérieure de l'Electronique et de ses Applications

Strong Artificial Intelligence

RAPPORT TECHNIQUE

Student	**Afonso DIELA**
Group	1DA - TD2 - TP3
Pedagogical tutor	Si Mahmoud KARABERNOU
Year	2015 - 16

TABLE OF CONTENTS

INTRODUCTION

As part of the first year of the ITI engineering course, I have to study a technical subject to validate my scientific skills. That's why I chose "**strong**" artificial intelligence**.**

Artificial intelligence (AI) is constantly evolving, and is now present in almost every field, including computer science, medicine, defence and industry. Thanks to this evolution, scientists wish to go further by creating an AI capable of reproducing the same reasoning as humans and that it can learn by itself.

Are we capable of creating such a technology? And if we succeed, will this AI be able to compete with or support humans?

The issues, mysteries and limits of this AI as well as its impact in the future will be discussed.

I. GENERAL

Artificial intelligence (AI) goes back some 60 years. It was inspired by science fiction (robots that talk like humans, do household chores and war robots etc.). So it was all of this that drove scientists to create this technology.

I.1. What is artificial intelligence "A.I."?

It is the search for means likely to endow computer systems with intellectual capacities comparable to those of humans: understanding, reasoning, dialogue, adaptation to new situations, learning, etc.

I.2. History

John McCarthy, **Marvin Lee Minsky** and **Allen Newell** were the first to use the word "artificial intelligence" in 1956 during the Dorthmouth Conference, where 20th century computer scientists, mathematicians and cognitive psychology researchers such as **Claude Shannon** and others met to discuss several scientific topics such as neural networks and theory of computation.

Nevertheless, it all started in **1950** with **Alan Turing**, one of the pioneers of artificial intelligence with his article entitled "Computing Machinery and Intelligence" published in the journal "Mind". In this article, he explores the problem of artificial intelligence undefined. He also proposed an experiment known as the **Turing test** in an attempt to qualify a machine as "conscious". This test is still used today. There is in the appendix the definition of this AI.

There are two main categories of AI:

- Weak or descending AI.

- Strong or bottom-up AI.

II. TECHNICAL PART

II.1. AI Low (top-down)

This AI consists in imitating human intelligence. These are programs that always execute pre-programmed tasks, therefore they do not evolve.

These programs are the most used by companies because they are quick to produce and cost less.

Its operating principle is based on the expert system.

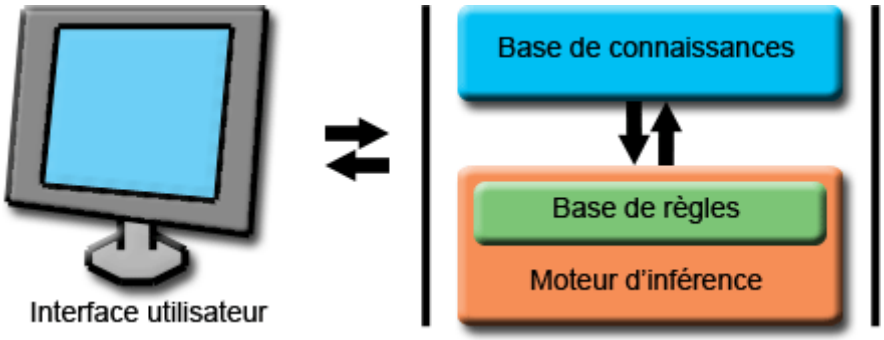

Figure 1: Expert system

An expert system is composed of three essential elements:

1) A very precise **database** on a field of use.

2) an **inference engine** containing a **rule base** that handles the logical part of the system. The inference engine dictates to the expert system the logical reasoning that it must establish between the **knowledge base**, the **rule base** and the problem to be solved.

3) a **user interface** in which the person concerned communicates his/her question or problem or adds to it if the system does not have enough information;

ELIZA, one of the first A.I. programs proper, based on the expert system written by **Joseph Weizenbaum** between 1964 and 1966, which simulates a Rogerian psychotherapist by rephrasing most of the patient's statements into questions, and asking them.

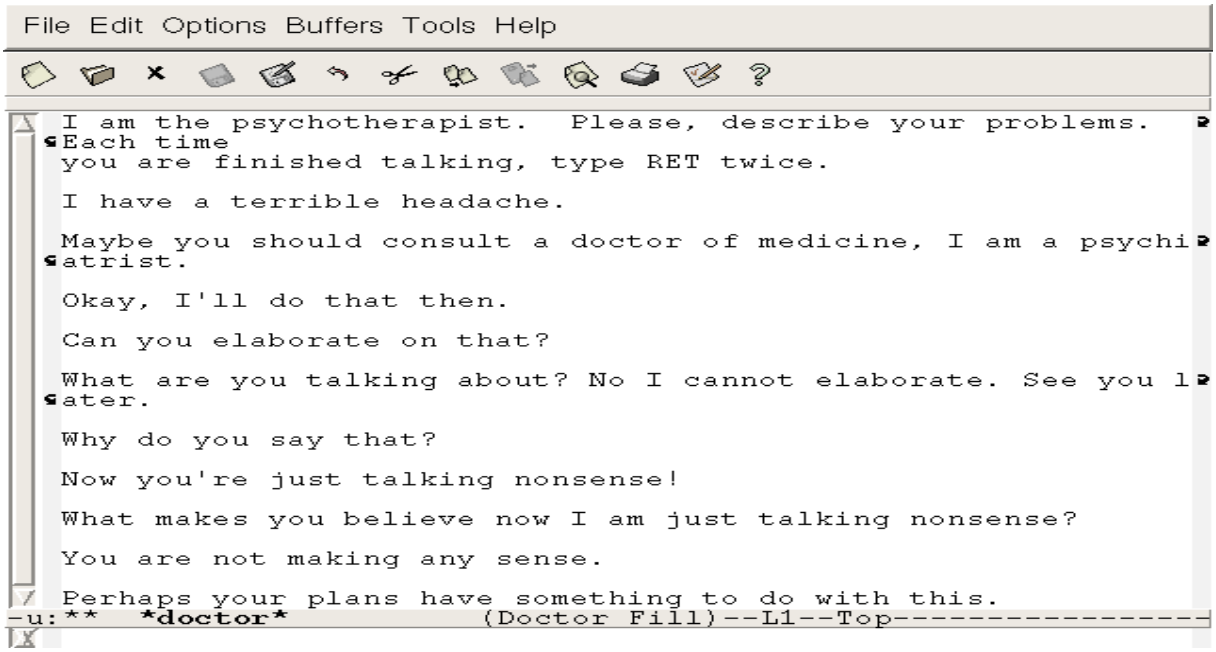

Figure 2: A screenshot of the conversation with ELIZA in Emacs.

II.1.1 Limits

The limits of this AI is that these programs don't really have a conscience, they only execute what they are asked to do.

The creator of this program even states that "These programs look intelligent, but they are not really. They will ask for details of what you say in a dialogue, they will record the data, but they will be unable to understand what they are saying or asking. They can't explain it because they have no self-awareness.

II.1.2 Computational approaches:

Nowadays computers have become more and more powerful, but they do not always solve all problems.

The hardware may not be the issue, it is often the software side that needs to be improved.

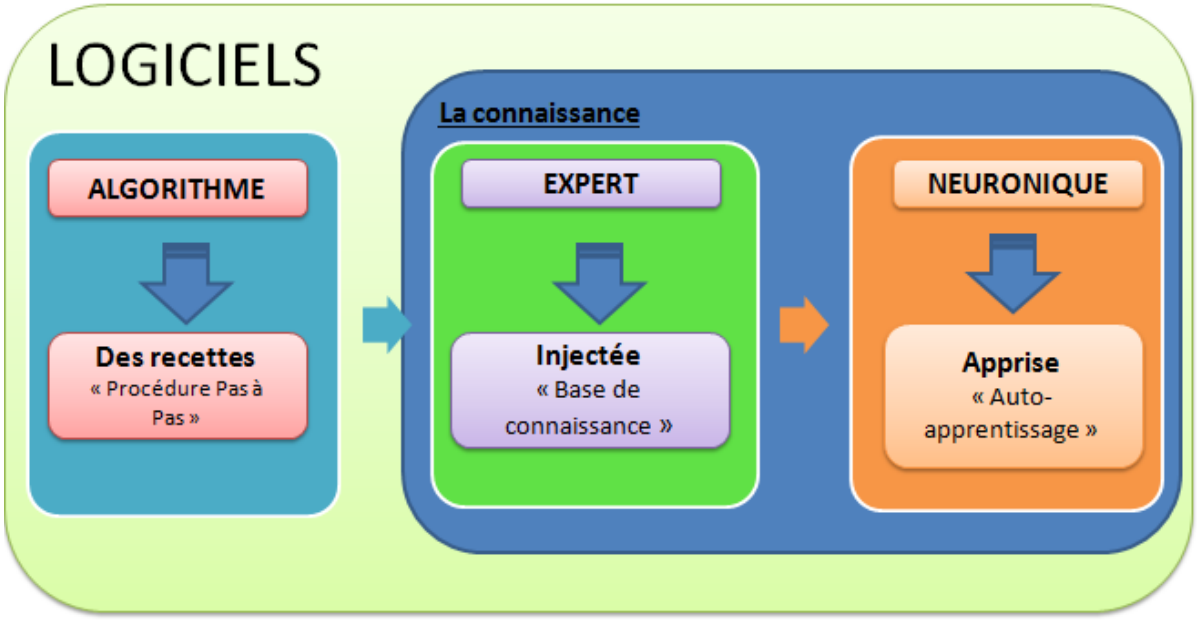

Figure 3. Scientific approach to AI

- Algorithmic approach (complete programming).
- Creation of inference engines (reasoning program; IF...ELSE...THEN conditions; expert system)
- Connectionist approach: the network is organized by learning (no programming)

Characteristics of the neural network approach :

- Non-algorithmic calculation.
- Information and memory distributed in the network.
- Globally parallel architecture (interconnected elementary processors).
- Learning by training on examples.
- Inspired by the functioning of the brain.

II.2. Strong A.I. (ascending)

The objective of this technology is to create an intelligent program capable of offering a logical reasoning close to the human being. Programming simple tasks to then do complex tasks, to understand its own functioning and to come up with its own reasoning.

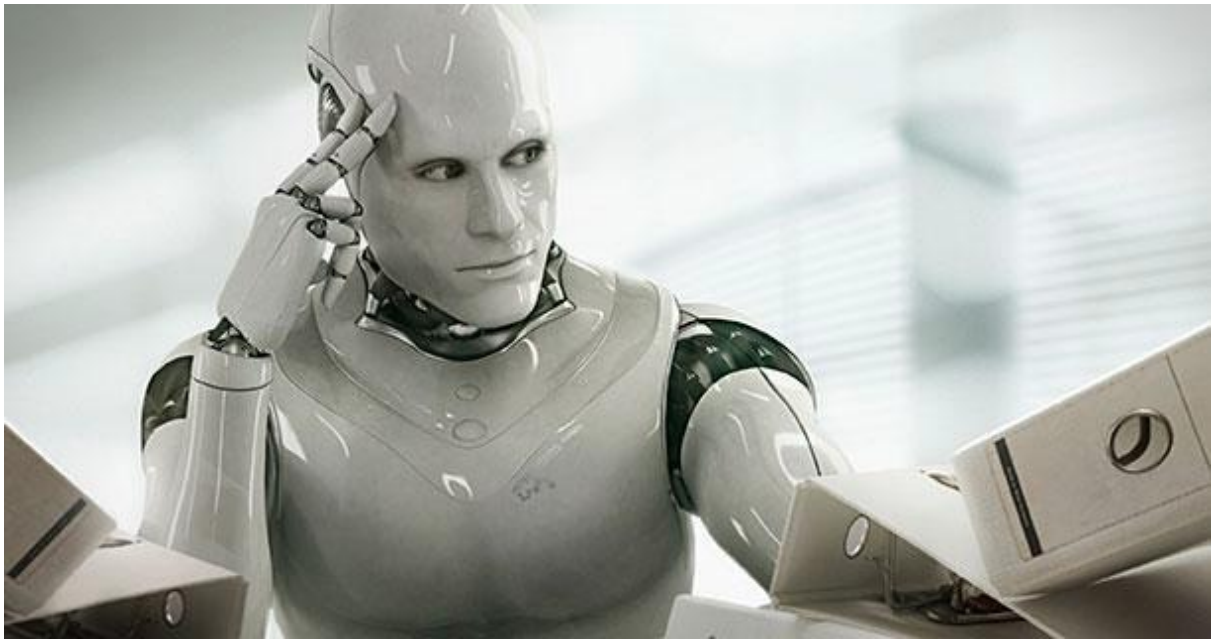

Figure 4. Approach based on the fiction of a strong AI

This AI is based on **deep learning**, a set of automatic learning methods that attempt to model data with a high level of abstraction through articulated architectures of different ***non-linear*** transformations**,** unlike weak AI.

Complex technology created from a network of artificial neurons inspired by the functioning of biological neurons.

II.2.1. History

In **1943, Warren McCulloch** and **Walter Pitts** established the formal model of the neuron, which opened the way to technical models.

Six years later, **in 1949**, **Donald Hebb** developed a formal theory of biological learning through changes in neuronal connections.

In **1957 Frank Rosenblatt** realized the **Perceptron**, the first technical model based on weight modification.

Three years later **1960 Bernard Widrow** realized **Adaline** (Adaptive Linear Element), a **perceptron-like** adaptive network.

1969 Marvin Lee Minsky and **Seymour** Papert criticize and demonstrate the limitations of **perceptron-type** neural models.

The research stopped for a little more than ten years, and it is only in **1982** that **John Joseph Hopfield**, American physicist, proposes a new approach of the neural networks based on the analogy with the media with a large number of particles. This revives the interest for neural networks that since this period believes as well in artificial intelligence as in computer science.

II.2.2. Human intelligence " HI

What is **human intelligence**?

This is the characteristic of man. From the non-material point of view (parallel to the soul). We can also associate human intelligence with the specific capacity to elaborate sophisticated behaviors in changing circumstances.

The heart of human intelligence is the brain, a dynamic organ that is extremely unstable, constantly destroying all the messages it transmits, and with a capacity for transformation on numerous scales of time and space.

Our **brain is the** most important but also the most mysterious organ from a functional point of view, about 10% of our brain is used.

The processing of information is done by the brain through neurons that are interconnected to form a neural network.

II.2.3. Biological neurons

The information in the neurons arrives by the **dendrites** then it crosses the **nucleus** which processes it and sends it towards another neuron passing by the **axon** in the form of small electric current to connect another neuron thanks to the **synapses** it is thus that the message is sent to the brain, in the **spinal cord** and in the **nerves**. On average each neuron is connected to 10 million other neurons.

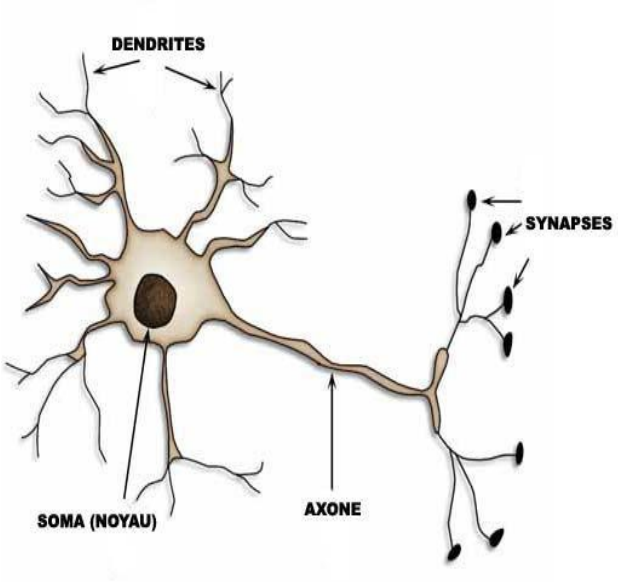

Figure 7. Biological neuron

II.2.4. Zoom in on the connection between two neurons

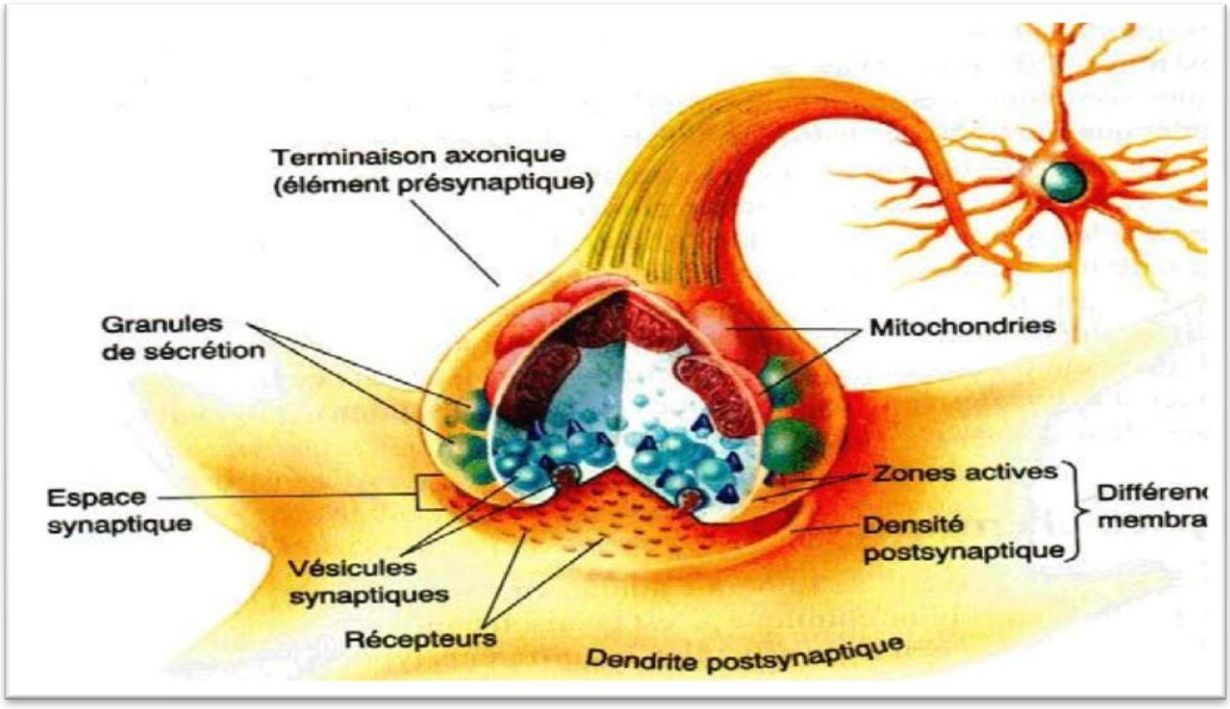

Figure 8. Connection between two neurons

There are about 100 billion neurons but not all information is processed at the same time or by the same neural networks.

II.2.5. Models from the human brain to the formal brain.

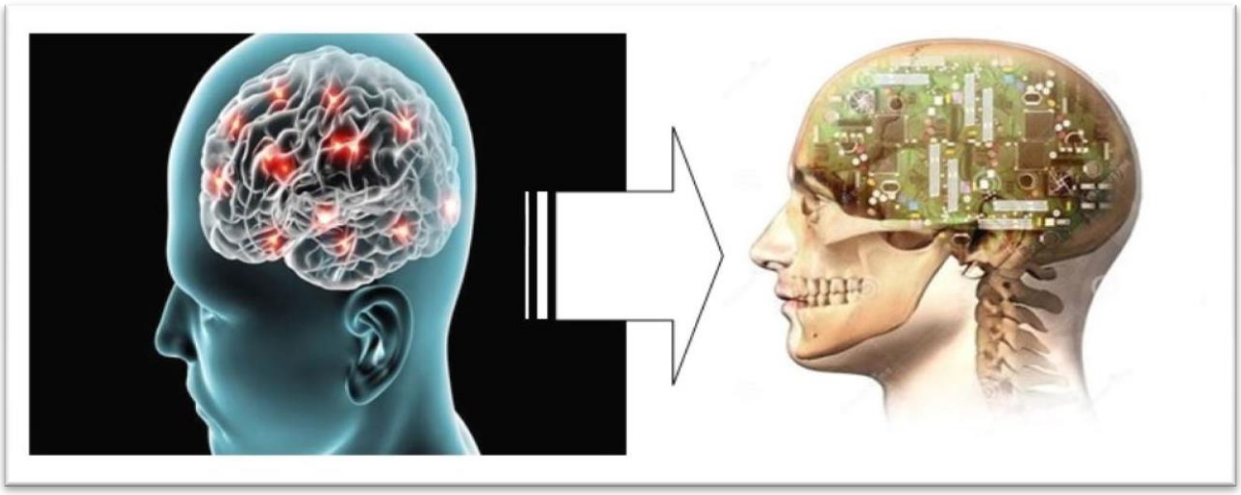

Figure 9. Defines formal brain

II.2.6. Logic model of the neuron

Système nerveux	Système de calcul
Neurone	Processeur
Dendrite	Fonction de combinaison
Corps du neurone	Fonction de transfert
Axone	Elément de sortie
Synapse	Poids

Figure 10. Logic model of the neuron developed in 1946 by McCulloch and Pitts.

The **formal neuron** is a classical computer. It has a simple or complex, low or high speed **processor.** A formal neuron can have one or more processors. It also has a separate or integrated **memory to** the processor addressable by the content. In terms of reliability, these neurons are very vulnerable, robust.

He is able to manipulate numbers, symbols and perceptual problems.

Other characteristics are learning, adaptability, generalization capacity, contextualized information processing, distributed information representation, massive parallelism.

II.2.6. Level of neural modeling

The diagram below is an architecture that illustrates the different levels of modeling of a neuron.

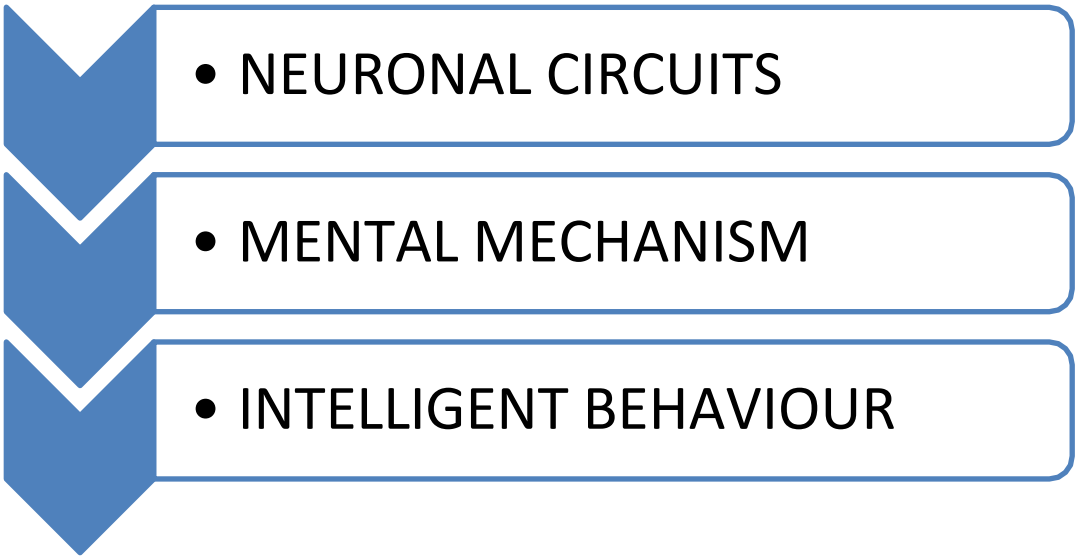

Figure 11. Level of neural modeling

II.2.7. Graphical representation and transfer functions

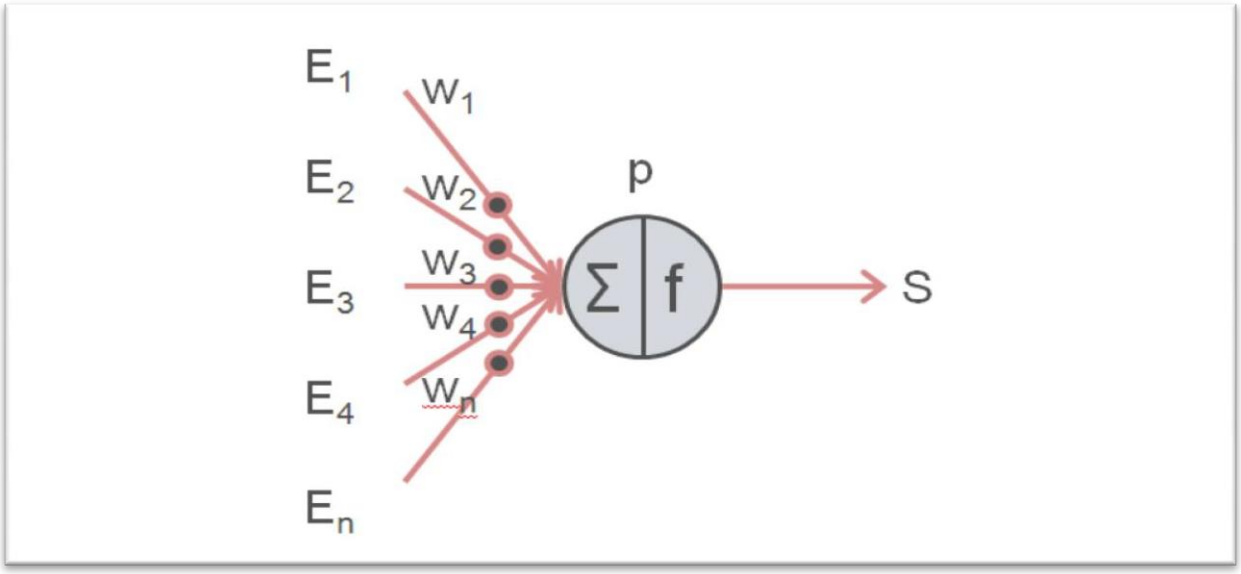

Figure 12. Graphical representation of a formal neuron modeled by McCulloch and Pitts.

E: inputs to the neuron from either other **processing** elements or from the environment.

W : weights of the neuron which determine the influence of each input.

p: combination function that combines inputs and weights. It calculates the influence of each input by taking into account its weight. It sums the weighted inputs

$$p = \sum W_i E_i$$

The output **S** is given by the transfer function as a function of the input combination.

$$S = f(p) \qquad S = f(\sum W_i E_i)$$

W_i : weight of the connection to the input **i**.

E_i : signal from the **i** input**.**

The transfer function **' f ' ,** determines the state of the neuron (in output). It can have several forms.

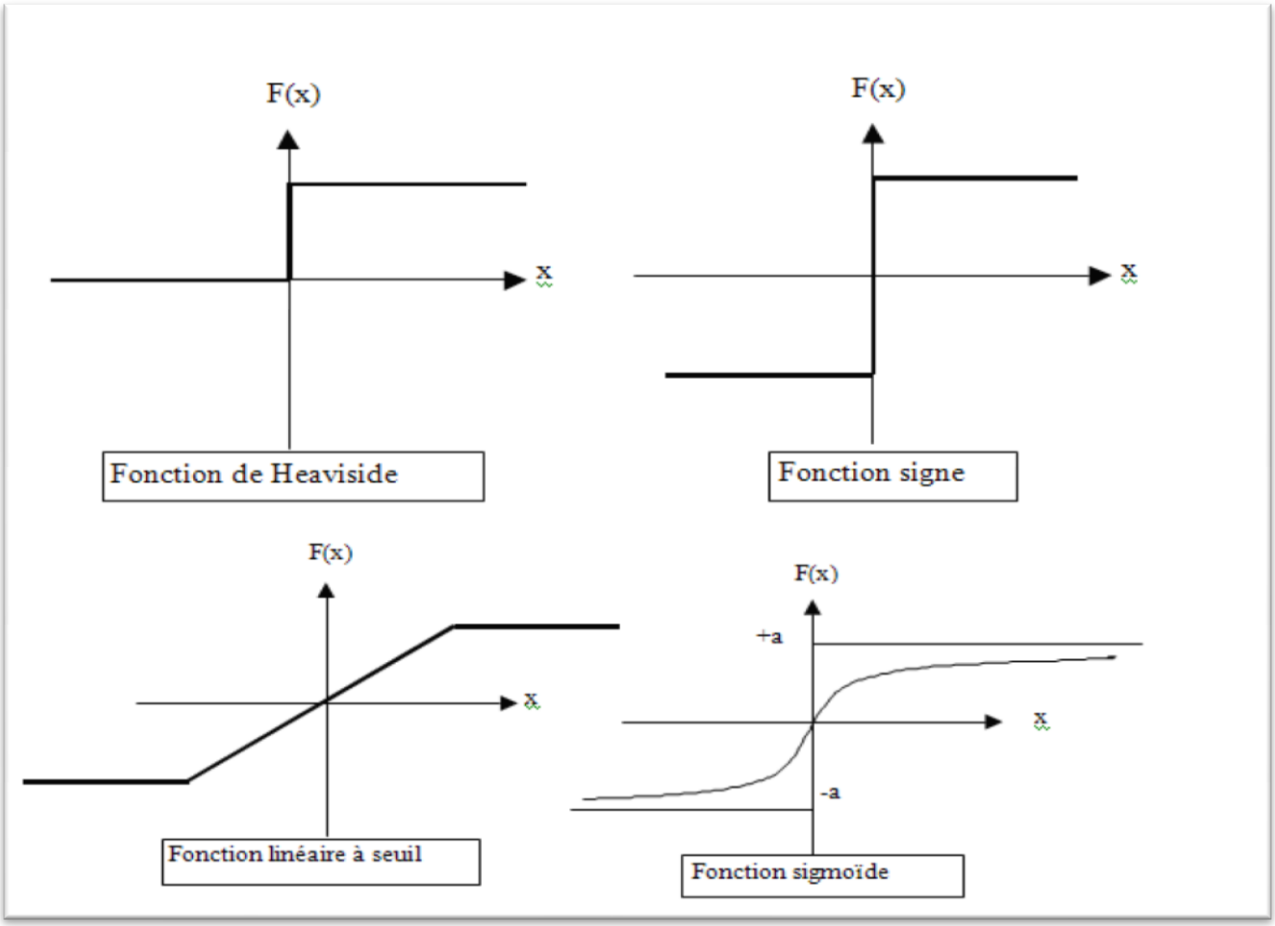

Figure 13. Transfer function

II.3. Automatic learning

The purpose of neural networks is to learn to respond correctly to different inputs, by making changes to the weights by two means of **supervised** and **unsupervised** (less used) learning.

- **Supervised learning**: an instructor system corrects incorrect answers.
- **Unsupervised learning:** the neural system learns by itself by forming classes of inputs with common responses.

II.3.1 Supervised learning

Imposed association between an input vector (multidimensional shape) and an output vector (the desired response). The calculation is done at each trial to correct the weights. The weights are modified to the minimum error or no error.

Supervised learning is the most common form of learning in the biological as well as the technical world.

One of the applications of this type of learning is OCR (character recognition or text recognition) illustrated in figure 15.

Here we try to model the letter "a". One and only one output vector must be activated

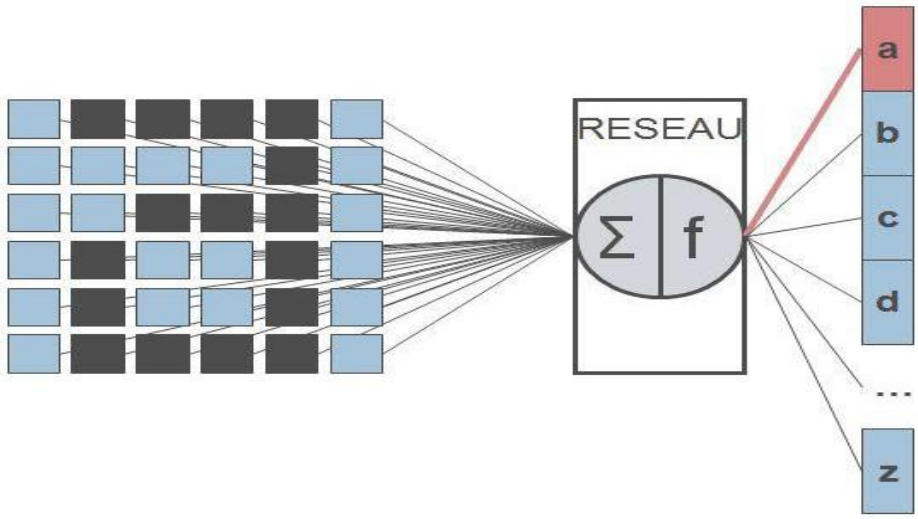

Figure 14. Character recognition with supervised learning.

The input shape can be more or less distorted. In this case the recognition is done with a certain accuracy index.

Industrial applications:

Recognition of postal codes (AT&T, Post Office).
Control of process parameters in industrial pulp production (Siemens).
Water consumption forecasting (Générale des Eaux).
Decision support software.
Weather forecast.
In the automotive industry (Autopilot).
In defense: The control or piloting of autonomous drones.
Computer science: voice recognition (Cortana new Window 10), image recognition (Facebook: photo identification, DeepDream Google: distinguishes between a human and a cat).
Medicine: Image processing. (Detection of a disease from the blood test). Another application recipe and news, is the AI **AlphaGo** created by Google that has defeated in October 2015 the European champion of Go game the French **Fan Hui.**

At the moment**,** it will face the world champion of GO game, **Lee Sedol** from Korea. Some say that it is impossible that this AI will win against the world champion. But if we go back in time to 1997 when **Deep Blue,** an AI designed by IBM, beat the undisputed chess champion **Garry Kasparov, who is** considered the best player of all time in this modality, it was only a weak AI.

Thanks to its AI based on deep learning and neural networks, will **AlphaGo** defeat **Lee Sedol** as **Deep Blue** did against Kasparov?
This match could go down as the most significant event in the history of AI if **AlphaGo** wins against **Lee Sedol.** For two main reasons:
The **first one** is because Go was the only game that for years had never managed to beat a human.
The **second is** that it will represent a great scientific advance resulting from 20 years of research and investment and perhaps even make researchers want to go all the way to the realization of "strong" AI.

II.4. The challenges of strong AI

Despite some progress, some people are still very pessimistic on this subject. In the form of questions and answers, here are the reservations most often expressed about this type of AI:

Can we build a conscious AI?	**No, consciousness would be a characteristic of living organisms.** **This position is defended mainly by philosophers.**
Do we have the algorithms required to build such an intelligence?	No, today's computers are not capable of this. They don't have the appropriate "language".
Is "thinking" applicable to a machine?	No, a machine calculates. But thinking is a fact that constantly evolves over time: these two processes are incompatible, to say the least.

Table 1. Limitations of strong AI.

But the idea of the scientists and researchers is that if we manage to set up this technology is that it would need an enormous power of calculations and we will be confronted with the problem of miniaturization of components what is translated by the **law of Moore** "the power increases about every 18 months whereas the size of the components it decreases" then there are other factors like the limit of calculations, and the heating etc.

The solution would be the **quantum computer** which is supposed to be 100 million times faster than a classical computer (deterministic). The quantum computer based on quantum physics (probabilistic) is much faster and more powerful but it is still unattainable, although Google and NASA have managed to create one. But it does not go beyond **1000 qubits which is** still very insufficient to perform large tasks.

In order to create this AI will also have to push research on **human consciousness** to understand its functioning in a more thorough way.

III. ADDITIONAL ASPECTS

III. 1 Our disappearance or our future?

If we manage to create this AI it will be able to create its own code, and modify it, so if we ever want to make an attempt to intrude in its system, it could become uncontrollable and spread in the net and create a cyber army, so as we see in some science fiction movies especially the computer

"Skynet" in the "**terminator"**, the "**VIKI"** computer in "**IRobot"** or even

"**Aria**" in the movie "**Eye of Evil**".

Another case is the autonomous drones (autonomous AI), or the AI of wars today this AI is controlled by the soldiers at a distance. But what will happen if the AI of war manages to modify its code and change Target (the whole human species)?

III.2. Legal issue:

In the case of automatic cars, in case of an AI obstacle, by a pedestrian who crosses the road without priority, the AI will have difficulty in reasoning because for him "if the light is green I pass".

III.3. Economy:

Google, Amazon and Apple have been investing millions of dollars in AI for five now.

Here are some reactions to the fear of this AI:

Nick Bostrom - Swedish philosopher and scientist, (founder of the Institute for the Future of Humanity) in one of his books entitled "SUPERINTELLIGENCE", speaks and alerts us to the AI, this technology that will revolutionize our humanity.

Stephen Hawking - British physicist, who says that artificial intelligence is a danger to humanity.

Bill Gates - American computer scientist and entrepreneur "I'm one of those people who is worried about super intelligence. In time, machines will do many tasks for us and they won't be superintelligent. This should be a positive thing if we manage it well. Several decades later, however, the intelligence will be powerful enough to cause problems."

CONCLUSIONS

Although at the moment, it is still between fiction and reality. This technology could revolutionize our humanity in a few decades like the industrial revolution or the emergence of the internet. Although promising, it could represent a major risk for humanity if it ever takes control of itself.

It could also contribute to economic development, for example today Google has succeeded in creating an AI very close to strong AI, for the moment its application is very precise (Go game) but tomorrow it could be applicable in other fields such as medicine or automobile (autonomous car).

The reasons why I was attracted to this subject are its scientific and futuristic aspects and all the massive knowledge behind it because it is a very vast field.

WEBOGRAPHY

https://sites.google.com/site/int3llig3nc3artifici3ll3/une-opposition-entre-ia-forte-et-ia-low

Supervised personal work (TPE) :

http://tpe-intelligence--artificielle.e-monsite.com/pages/i-l-intelligence-artificial/design-of-ia-1.html

Wikipedia:

https://fr.wikipedia.org

https://fr.wikipedia.org/wiki/ELIZA

https://fr.wikipedia.org/wiki/ELIZA#/media/File:GNU_Emacs_ELIZA_example.png

irobot.wikia.com :

http://irobot.wikia.com/wiki/VIKI?file=Char_25547.jpg

http://soocurious.com/fr/cortana-imitation-humain-logiciel/

Books :

Artificial Intelligence - Jack Challoner

Superintelligence - Nick Bostrom

ANNEXES

Lexicon :

AI: Artificial Intelligence HI:

Human Intelligence

OS: Operating System

OCR: character recognition or text recognition. Qubit: quantum bit.

SOME EXAMPLES OF WEAK AI :

The game of chess

Figure 15

They only analyze the moves to be played programmed for the man at the front.

CLEVERBOT :

Figure 16. Cleverbot

THE TURING TEST:

It is one of the first AI created by **Alan Turing** in 1950 which aims to test if the software has sufficient knowledge comparable to a human.

This test consists of a verbal confrontation between a human and a computer and another human blind. As illustrated in the figure on the right.

A and B exchange questions and answers with C if C cannot figure out which one of his interlocutors is a computer then the computer software has passed the test.

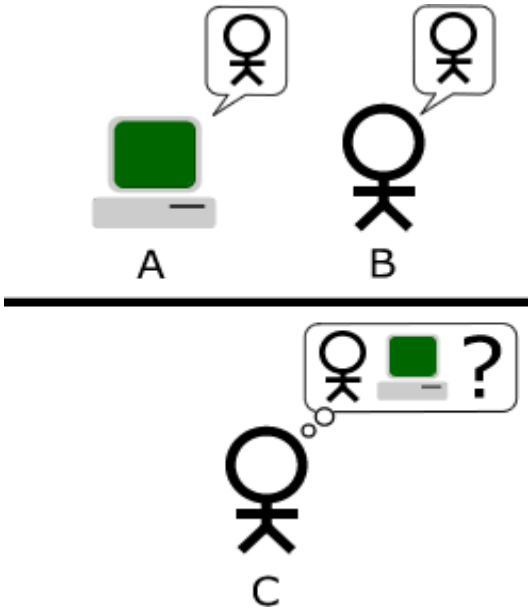

Figure 17. Diagram of the Turing test

EXAMPLES OF STRONG A.I. FROM SCIENCE FICTION:

Skynet (Terminator Saga) is an artificial intelligence that has become independent, feeling threatened by man and plotting his destruction.

Figure 19. The robot army controlled by Skynet

Figure 18. Robot with advanced intelligence in Terminator saga

Figure 20

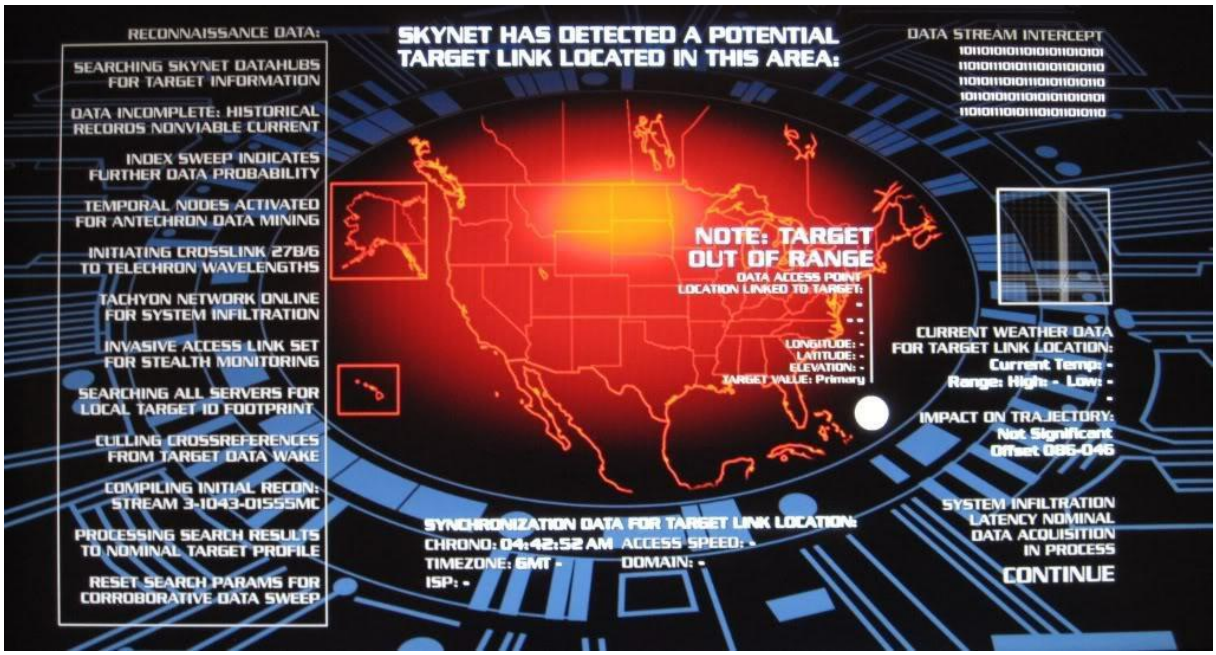

Figure 21.Skynet

Editor: In the "Terminator" movies, an incredibly complex computer system called SkyNet becomes ". Self-aware" On August 29, 1997, it launches U.S. nuclear warheads at foreign targets in an effort to generate world war and destroy all of humanity.

VIKI (I, Robot)

Virtual Interactive Kinetic Interface "Virtual kinesthetic Interactive intelligence", a central computer that has outgrown its remit and plotted a robot revolution.

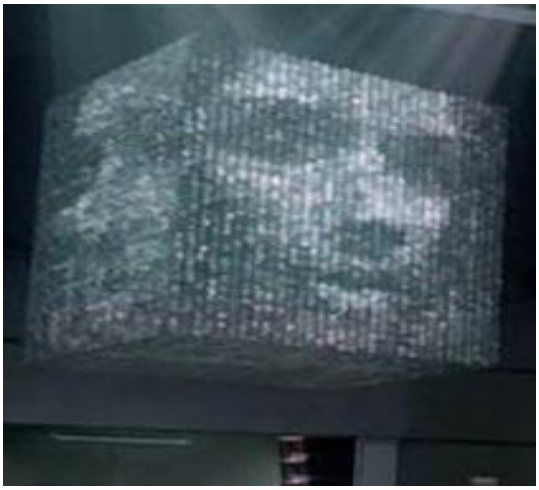

Figure 22. VIKI

Samantha (Her)

Figure 23. Her

A hyper-intelligent OS and personal assistant in whose voice its owner develops a keen interest.

Cortana (Halo)

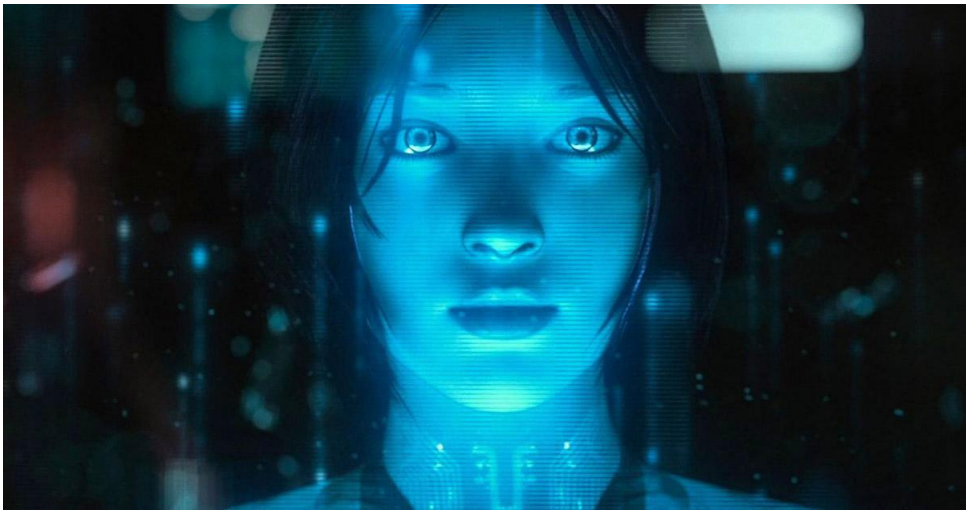

Figure 24. Cortana

Logistical and tactical support AI that has accompanied Major Spartan 117 since the 1st Halo (video game).

Microsoft gives birth to Cortana, the artificial intelligence that talks to the user as well as a human being.