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

STRONG
Artificial Intelligence

RAPPORT TECHNIQUE

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INTRODUCTION

As part of my first year of engineering training in the ITI cycle, 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, from computing and medicine to defense and industry. Thanks to this evolution, scientists want to go one step further by creating an AI capable of reproducing the same reasoning as humans, and that can learn by itself.

Are we capable of creating such a technology? And if we dowill this AI be able to rival or support man?

The challenges, mysteries and limits of this AI, as well as its impact on the future, will be discussed next.

I. GENERAL

Artificial intelligence (AI) dates back some sixty years. It was inspired by science fiction (robots that talk like humans, perform household chores, war robots, etc.). It was all this, then, that prompted scientists to create this technology.

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

It's the search for ways to endow computer systems with intellectual capacities comparable to those of human beings: understanding, reasoning, dialogue, adapting to new situations, learning, and so on.

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 a number of scientific topics such as neural networks and computational theory.

Nevertheless, it all began in **1950** with **Alan Turing**, one of the pioneers of artificial intelligence, with his article entitled "Computing Machinery and Intelligence" published in the magazine "Mind". In this article, he explores the problem of artificial intelligence, which is not very well defined. 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. The appendix contains a definition of AI.

There are two main categories AI:

- Weak or descending AI.

- Strong or ascending AI.

II. TECHNICAL SECTION

II.1. Low AI (descending)

AI imitates human intelligence. These are programs that always execute pre-programmed tasks, so they don't evolve.

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

Its operating principle is based on the expert system.

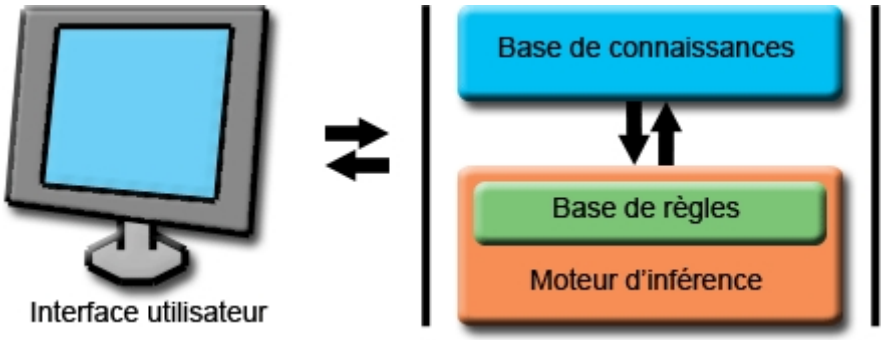


Figure 1. expert system

An expert system consists of three essential components:

1) A very precise **database** on a specific 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 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 or her question or problem, or adds to it if the system does not have sufficient 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 reformulating most of the 's statements into questions, and then asking them.

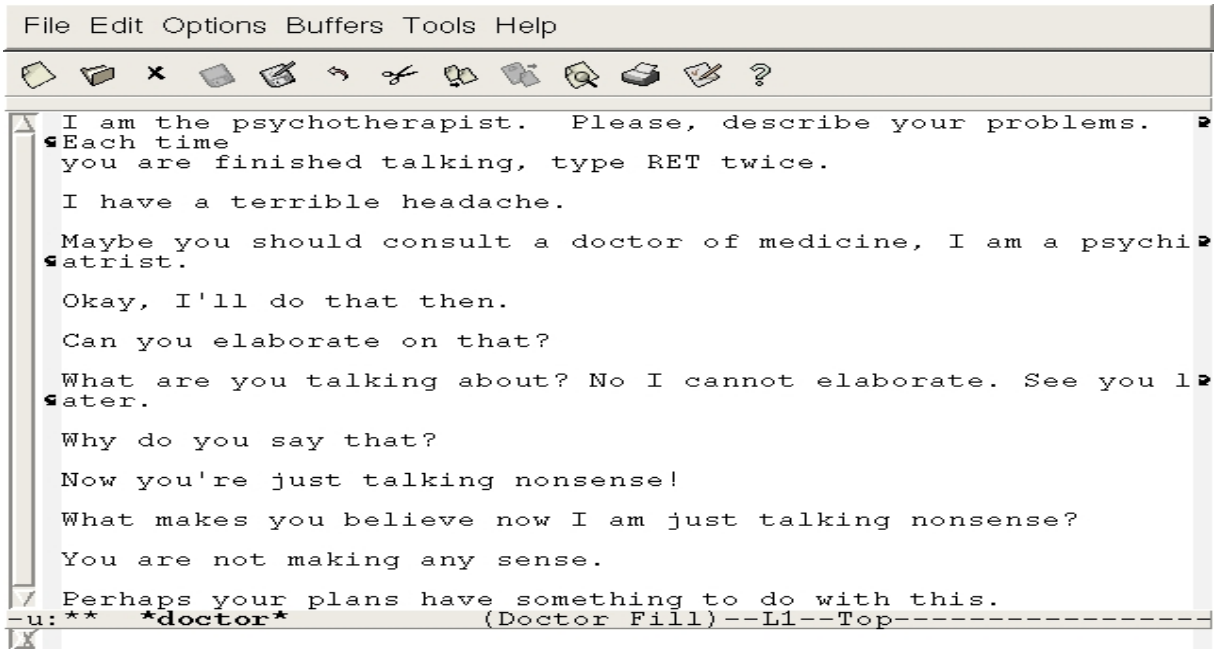


Figure 2: A screenshot of the conversation with ELIZA in Emacs.

II.1.1 Limits

The limits of this AI are that these programs don't really have a conscience, they just do what they're told.

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

II.1.2 IT approaches :

Today's computers are increasingly powerful, but they 't always solve every problem. The hardware may not be to blame, but 's often the software that needs improving.

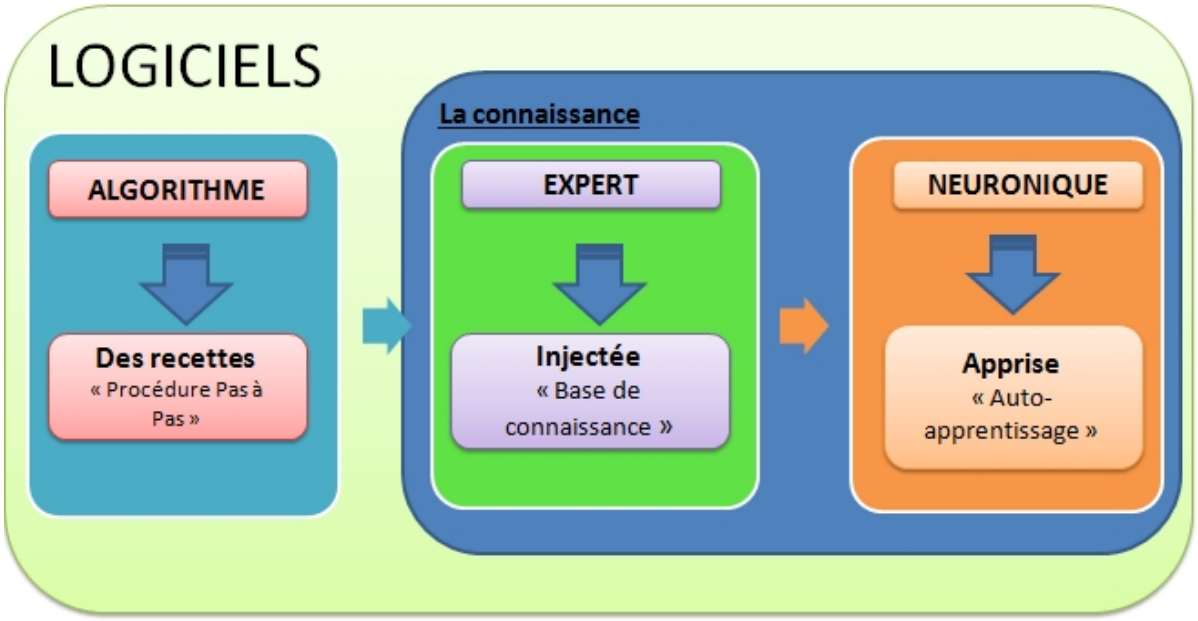


Figure 3. Scientific approach to AI

- 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)

Features of the neural network approach :

- Non-algorithmic calculation.
- Distributed information and memory in the network.
- Globally parallel architecture (interconnected elementary processors).
- Learning by practicing on examples.
- Inspired by the way the brain works.

II.2. Strong I.A (ascending)

The aim of this technology is to create an intelligent program capable offering logical reasoning. Program simple tasks and then perform complex ones, to understand its own workings and arrive at its own reasoning.

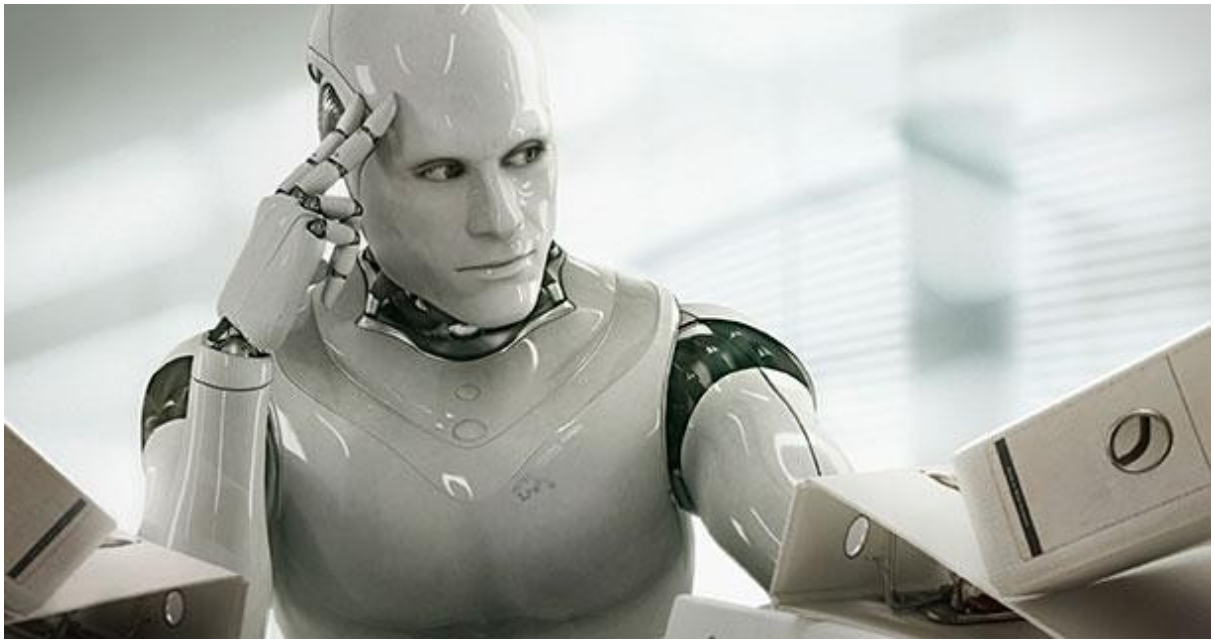


Figure 4. Approach based on the fiction a strong AI

This AI is based on **deep learning**, a set of automatic learning methods that attempt to model data at a high level of abstraction thanks to 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 paved the way for 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** created the **Perceptron**, the first technical model based on weight modification.
Three years later, **in 1960, Bernard Widrow** created **Adaline** (Adaptive Linear Element), a **perceptron-type** adaptive network.
1969 Marvin Lee Minsky and **Seymour** Papert criticize and demonstrate the limits of **perceptron-type** neural models.
Research came to a standstill for just over a decade, and it wasn't until **1982** that American physicist **John Joseph Hopfield** proposed a new approach to neural networks based on the analogy with large-particle media. This interest in neural networks, which since then has been growing in both artificial intelligence and computer science.

II.2.2. Human intelligence "HI

What is **human intelligence**?
That's what man is all about. From a non-material point of view (parallel to the soul). Human intelligence can also be associated with the specific ability to develop sophisticated behaviors in changing circumstances.

Figure 5: Human brain

The heart of human intelligence is the brain, an extremely unstable dynamic organ, constantly destroying all the messages it transmits, and capable of transformation on numerous scales of time and space.

Our **brain** is the most important organ, but also the most mysterious from a functional point of view: roughly 10% of our brain is used.
The brain processes information using neurons that are interconnected to form a neural network.

II.2.3. Biological neurons

The information in the neurons arrives via the **dendrites**, then passes through the **nucleus**, which processes it and sends it to another neuron, passing through the **axon** in the form of a small electric current to connect another neuron via **synapses**. This is how the message is sent to the brain, the **spinal cord** and the **nerves**. On average, each neuron is linked to 10 million other neurons.

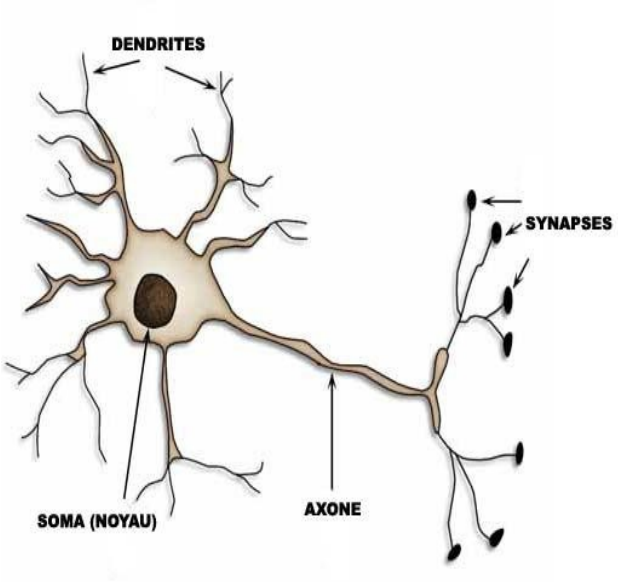


Figure 7. Biological neuron

II.2.4. Focus on the connection between two neurons

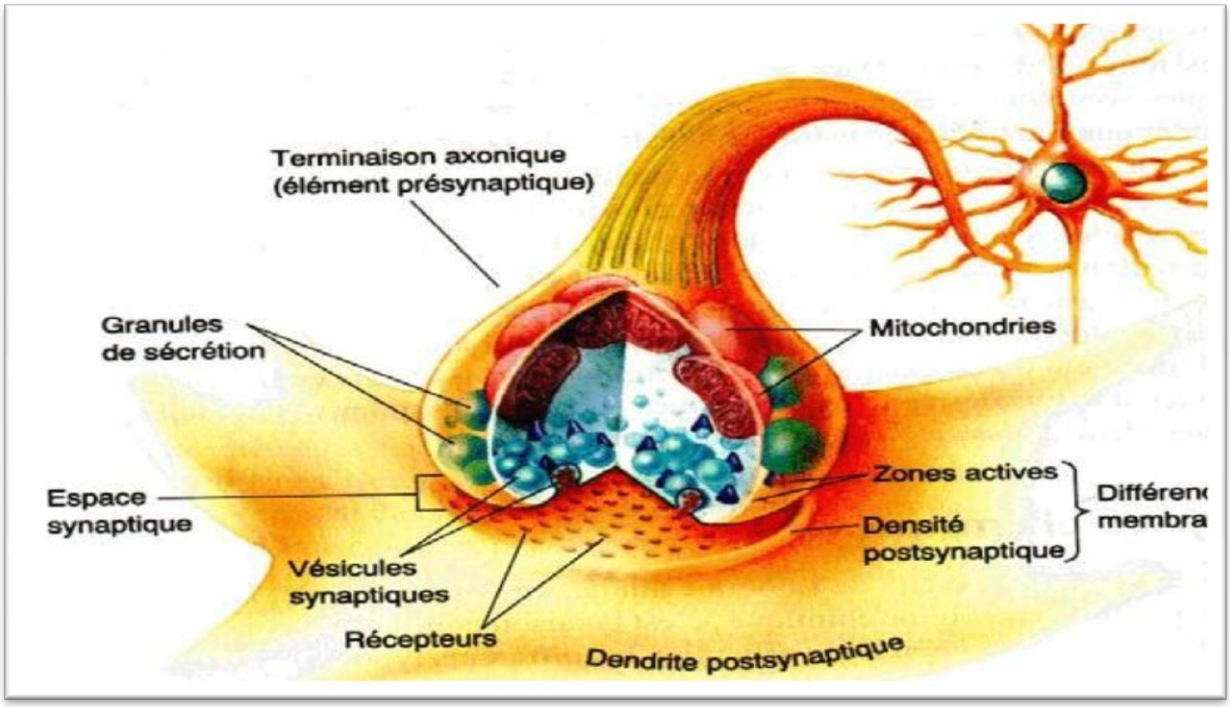


Figure 8. Connection between two neurons

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

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

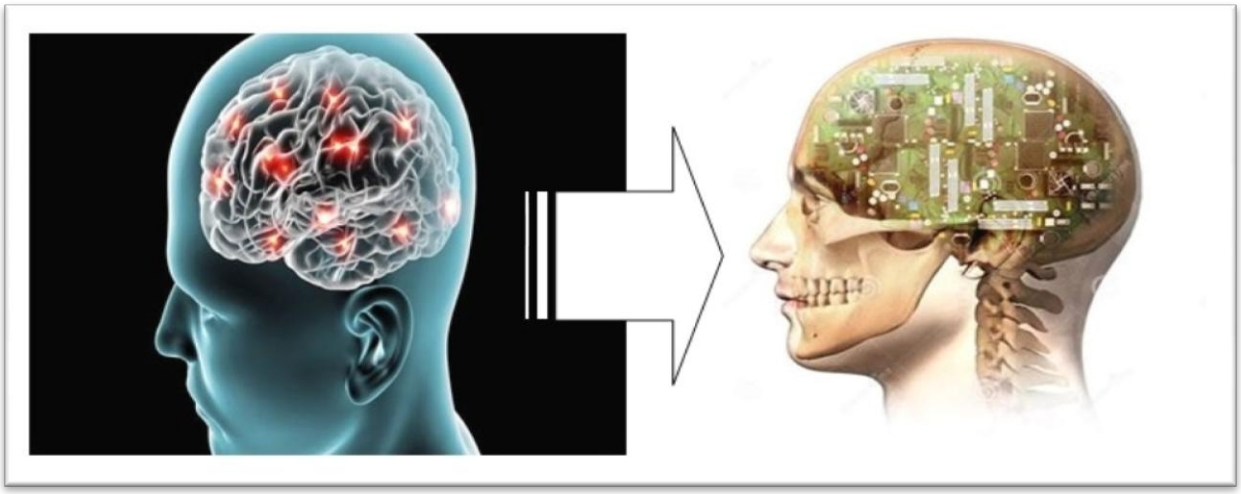


Figure 9. Defines formal brain

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 classic calculator. It has a simple or complex, low-speed or high-speed **processor**. A formal neuron may have one or more processors. It also has separate or integrated content-addressable **memory**. In terms of reliability, these neurons are highly vulnerable and 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. Neural modeling level

The diagram below illustrates different levels neuron modeling.

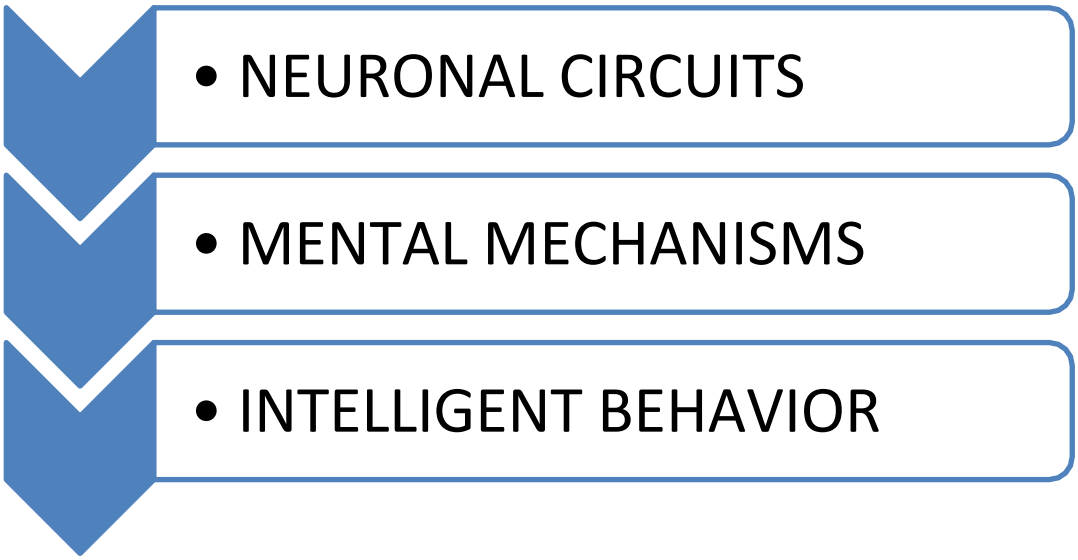


Figure 11. Neural modeling level

II.2.7. Graphical representation and transfer functions

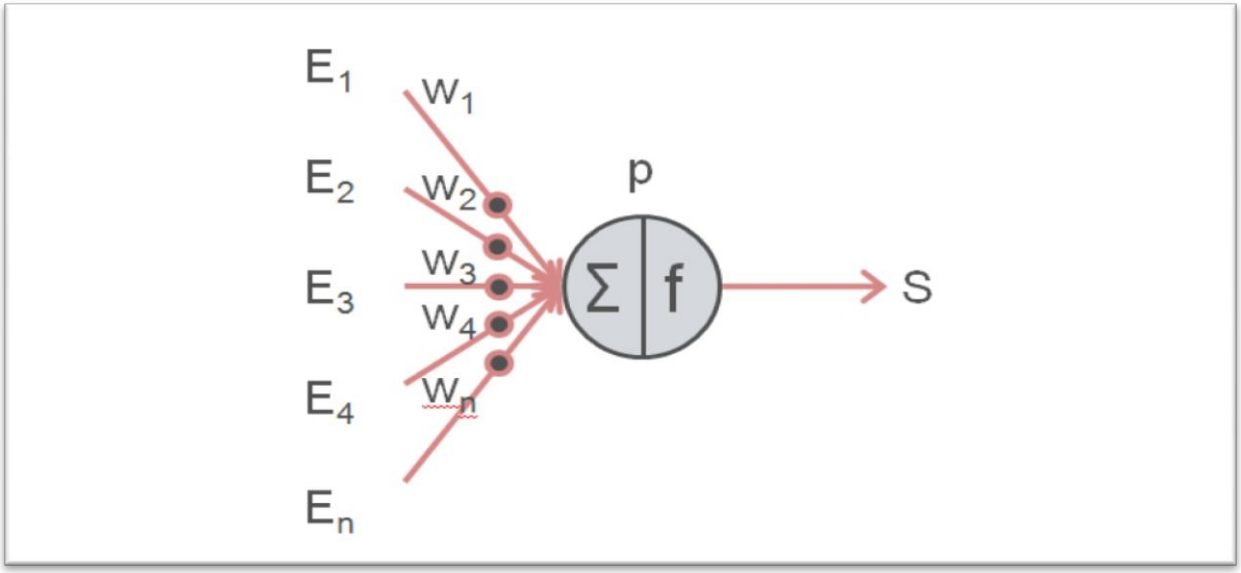


Figure 12. Graphical representation a formal neuron modeled by McCulloch and Pitts.

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

W: neuron weights that 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 up the weighted inputs

$$p = \sum W_i E_i$$

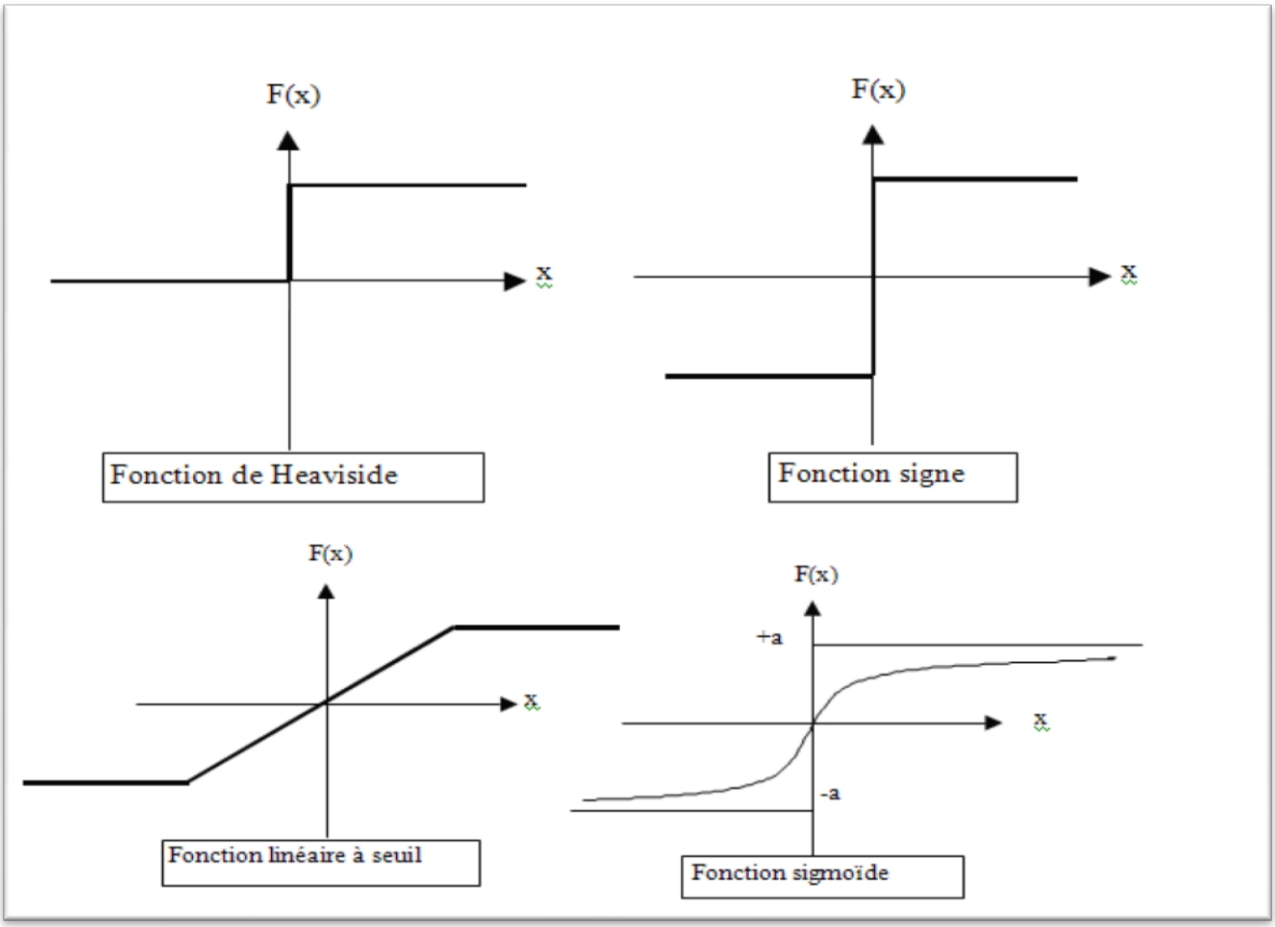
The output **S** is given by the transfer function as a function of the input combination.

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

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

E_i: signal input **i.**

The transfer function **' f ' ,** determines the state of the neuron (output). It can take



several forms.

Figure 13. Transfer function

II.3. Automatic learning

The aim of neural networks is learn to respond correctly to different inputs, by making modifications to the weights through two learning methods**: supervised** and **unsupervised** (less widely used).

- **Supervised learning**: a training system corrects incorrect answers.
- **Unsupervised learning:** the neural system learns by itself, 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). A calculation is made on each trial to correct the weights. Weights are modified down to the minimum error, or no error at all.

Supervised learning is the most widespread form of learning in both the biological and technical worlds.

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

Here we try to model the letter "a". Only one output vector needs to be activated

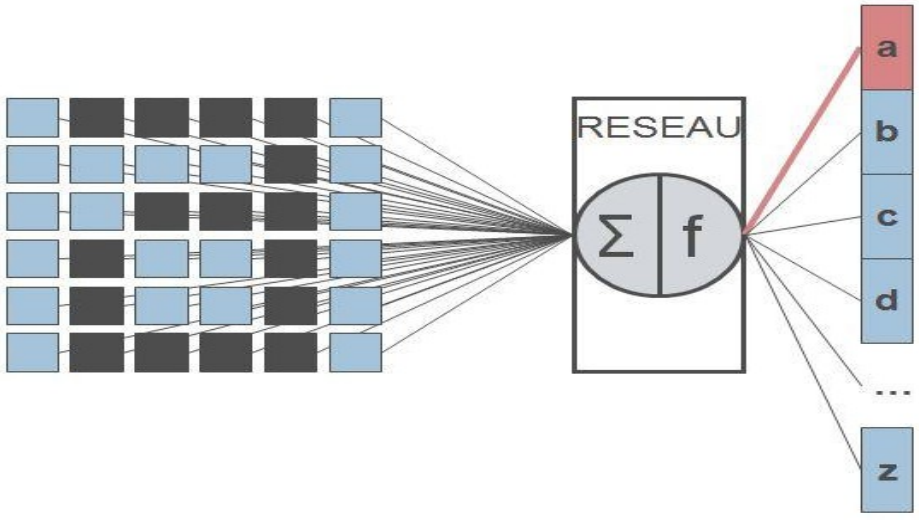


Figure 14. Character recognition with supervised learning.

The input shape may be more or less distorted. In this case, recognition is performed with a certain degree of accuracy.

Industrial applications:

Zip code recognition (AT&T, La Poste).
Process parameter control for industrial pulp production (Siemens).
Water consumption forecasting (Générale des Eaux).
Decision support software.
Weather forecast.
In the automotive industry (Autumn vehicle driving).
In defense: control or piloting of autonomous drones.
IT: voice recognition (Cortana new Window 10), image recognition (Facebook: photo identification, DeepDream Google: distinguishes between a human and a cat).
Medicine: Image . (disease from blood samples). Another topical application is the **AlphaGo** AI created by Google, which defeated the European Go champion **Fan Hui** of France in October 2015.

At present, it will face the world GO champion, Korean **Lee Sedol.** Some say it's impossible for this AI to beat the world champion. But if we go back in time to 1997, when **Deep Blue**, an IBM-designed AI, beat the undisputed chess champion **Garry Kasparov** - considered the best chess player of all time - it was only weak AI.

Thanks to its AI based on deep learning and neural networks, will **AlphaGo** defeat **Lee Sedol** like **Deep Blue** did 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:
Firstly, because Go was the only game that had never been beaten by a human for years.
The **second is** that it will represent a major scientific advance, the fruit of 20 years of research and investment, and may even make researchers want to go all the way to achieve "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 the hallmark of living organisms. This position is defended mainly by philosophers.**
Do we have the algorithms needed to build such intelligence?	No, today's computers can't do it. It doesn't have the right "language
Can "thinking" be applied to a machine?	No, a machine calculates. And thinking is something that constantly evolves over time: these two processes are incompatible, to say the least.

Table 1. limits of strong AI.

But the idea of scientists and researchers is that if we manage to implement this technology, we'll need enormous computing power, and we'll be faced with the problem of miniaturization of components, which is translated by **Moore's law**: "power increases approximately every 18 months, while the size of components decreases", and then there are other factors such as the limit of calculations, and heating, etc.

The solution is the **quantum computer**, which is supposed to be 100 million times faster than a classical (deterministic) computer. The quantum computer, based on quantum physics (probabilistic), is much faster and more powerful, but still unattainable, although Google and NASA have succeeded in creating one. But it doesn't go beyond **1,000 qubits**, which is still not enough to perform large-scale tasks.

In order to create this AI, we'll also need to carry out further research into **human consciousness** to understand how it works in greater depth.

III. COMPLEMENTARY ASPECTS

III. 1 Our disappearance or our future?

If we manage create this AI, it will be able to create its own code, and modify it, so if we ever try to intrude into its system, it could become uncontrollable and spread the net and create a cyber army, so as we see in some science fiction films, notably the computer

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

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

Another case is that of autonomous drones (autonomous AI), or war AI, which today is controlled remotely soldiers. But what will happen if war AI manages to modify its code and change Target (the whole human species)?

III.2. Legal problem:

In the case of self-driving cars, in the event an AI obstacle such as a pedestrian crossing the road without priority, the AI will have difficulty reasoning, because for him "if the light is green, I'll go through".

III.3. Economy:

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

Here are a few 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", talks and alerts us to AI, the 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 worry about super intelligence. In time, machines will perform many tasks for us, and they won't be superintelligent. This should be positive if we manage it well. Several decades down the road, however, intelligence will be powerful enough to cause problems."

CONCLUSIONS

Although, at present, it's still somewhere between fiction and reality. In a few decades' time, this technology could revolutionize humanity in the same way as the Industrial Revolution or the advent of the Internet. While promising, it could represent a major risk to 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 the 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's such a vast field.

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APPENDICES

Lexicon :

AI: Artificial Intelligence

HI: Human Intelligence

OS: Operating System

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

SOME EXAMPLES WEAK I.A. :

The chess game

Figure 15

All they do is analyze the moves programmed for the man at the front.

CLEVERBOT:

Figure 16. Cleverbot

THE TURING TEST:

This was one of the first AIs created by **Alan Turing** in 1950, with the aim of testing whether the software possesses sufficient knowledge comparable to that of a human.

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

A and B exchange questions and answers with C. If C can't work out which of his interlocutors is a computer, then the computers software has passed the test.

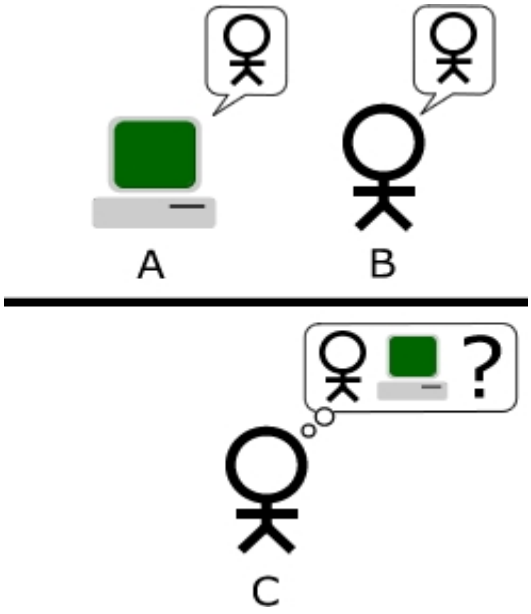

Figure 17. Diagram of the Turing test

EXAMPLES STRONG I.A. 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

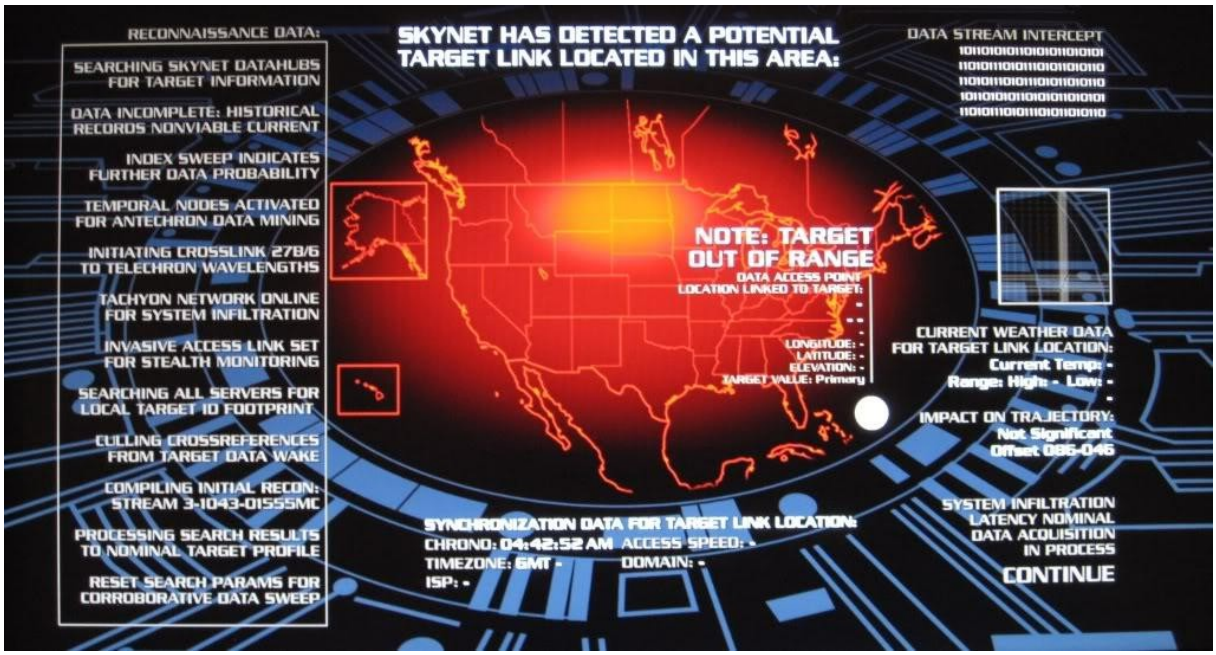

Figure 21.Skynet

Editor: In the "Terminator" films, 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 humanity.

VIKI (I, Robot)

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

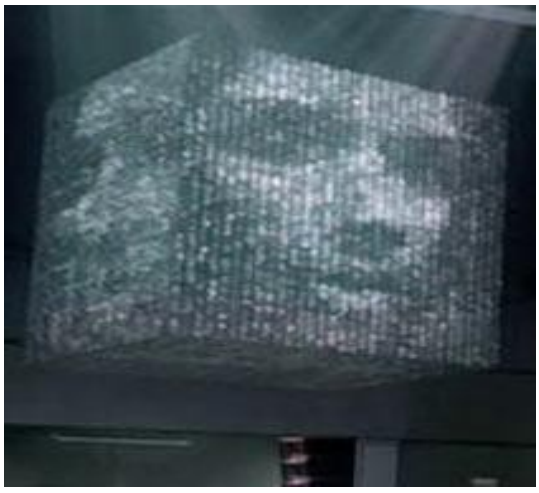

Figure 22. VIKI

Samantha (Her)

Figure 23. Her

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

Cortana (Halo)

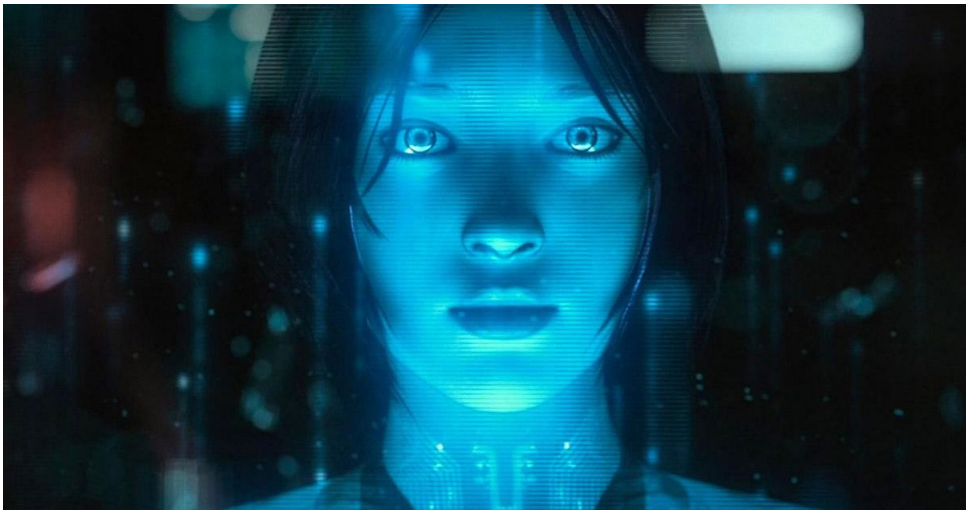

Figure 24. Cortana

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 converses with the user as well as a human being.