1. Definitions and fields of application of Artificial Intelligence

1.1 Definition of Artificial Intelligence

Artificial Intelligence (AI) is a field of computer science that aims to design systems capable of replicating certain capabilities of human intelligence. These abilities include perception, reasoning, learning, decision-making, and adapting to an environment.

According to John McCarthy, one of the founders of the field, AI is "the science and engineering of making intelligent machines." An intelligent machine is therefore a system capable of analyzing data, extracting knowledge from it and acting autonomously to achieve a goal.

Unlike conventional programs, which execute fixed instructions, AI systems can learn from experience. They use algorithms that can improve their performance over time, especially through the data they process.

There are often two main categories of AI:

- **Weak (or narrow) AI** : specialized in a specific task (speech recognition, recommendation, vision, etc.).
- **Strong (or general) AI** : which would aim to reproduce global human intelligence. It remains a research objective today.

AI is based on several disciplines such as computer science, mathematics, statistics, neuroscience and automation.

1.2 Objectives and principles of AI

The main goal of AI is to enable machines to:

- Perceive their environment,
- Understand complex information,
- Learning from data,
- Reasoning and solving problems,
- Make decisions,
- Interact with humans.

To do this, AI uses techniques such as:

- Research and optimization,
- The representation of knowledge,
- Machine learning,
- Natural language processing,

- Computer vision.

Learning is a central element: the machine is no longer just programmed, it **learns from examples**, which allows it to be more flexible and efficient in real environments.

1.3 Scopes of AI

AI is now present in almost all sectors. Its use helps automate tasks, improve accuracy, reduce costs, and increase productivity.

(a) Health

In the medical field, AI helps to:

- Detect diseases from images (X-ray, CT scan, MRI),
- Assist in diagnosis,
- Predict the evolution of a patient,
- Personalize treatments,
- Manage medical records.

For example, some systems can analyze medical images faster than a human and spot anomalies.

b) Industry

In industry, AI is used to:

- Predictive maintenance,
- Quality control,
- Process optimization,
- Intelligent robotics,
- Production management.

Machines can anticipate breakdowns, automatically adjust parameters, and improve the overall performance of industrial systems.

(c) Transportation

In transport, AI is involved in:

- Autonomous vehicles,
- Traffic management,
- Smart navigation,
- Route optimization.

Self-driving cars use sensors and AI algorithms to perceive the road, make decisions, and avoid obstacles.

(d) Education

In education, AI makes it possible to:

- Personalized learning,
- Automatic evaluation,
- Teaching assistants,
- Analysis of learners' behaviour.

Each student can progress at his or her own pace thanks to adaptive systems.

(e) Finance and trade

In this field, AI is used to:

- Detect fraud,
- Analyze the markets,
- Recommend products,
- Automate customer service,
- Anticipate risks.

Banks are using AI to secure transactions and improve the relationship with customers.

(f) Communication and multimedia

AI is also used to:

- Voice recognition,
- Machine translation,
- Facial recognition,
- Search engines,
- Recommendation systems.

For example, the platforms offer content tailored to each user's preferences.

1.4 Importance and impact of AI

AI is profoundly transforming society. It improves the quality of services, facilitates decision-making and solves complex problems. However, it also poses challenges, including in terms of ethics, security, employment and data protection.

It is therefore essential to develop AI responsibly, respecting human values and safety rules.

2. Historical evolution of Artificial Intelligence

2.1 Origins and early ideas

The idea of creating machines capable of reasoning does not date back to the computer age. Since ancient times, man has been imagining automatons capable of imitating human behavior. However, modern AI really appeared in the twentieth century with the development of computer science.

In 1950, the British mathematician **Alan Turing** famously asked: *"Can machines think?"*. He introduced the **Turing test**, which consists of evaluating whether a machine can pass itself off as a human in a conversation. This idea marks the theoretical starting point of AI.

In 1956, at the **Dartmouth Conference** organized by John McCarthy, Marvin Minsky, Nathaniel Rochester, and Claude Shannon, the term **"Artificial Intelligence"** was officially adopted. This conference is considered the birth certificate of AI as a scientific discipline.

2.2 Early Golden Age (1950s–1970s)

After Dartmouth, the enthusiasm around AI is very strong. The researchers then thought that human intelligence could be reproduced quickly.

During this period, several important advances were made:

- Creation of the first programs capable of playing chess,
- Automatic theorem proof systems,
- First languages dedicated to AI such as LISP,
- Development of systems of symbolic reasoning.

The researchers mainly use a so-called **symbolic** approach, where the machine manipulates logical rules to simulate human reasoning.

However, despite progress, technical limitations quickly appeared: lack of computing power, little data available, difficulty in modeling the real world.

2.3 AI winters (1970s–1990s)

In the face of broken promises, funding for AI has fallen sharply twice, the so-called **"AI winters".**

The first winter came in the 1970s when systems became too expensive and underperforming in real-world environments.

In the 1980s, AI experienced a revival of interest thanks to **expert systems**, capable of reproducing the decisions of a specialist in a specific field (medicine, industry, finance). These systems use rule bases.

But their development is complex, their maintenance difficult, and they lack flexibility. This led to a second AI winter in the late 1980s.

During this period, AI progressed slowly but continued to evolve in laboratories.

2.4 Revival with machine learning (1990s–2000s)

From the 1990s, a new approach emerged: **machine learning**. Instead of explicitly programming the rules, we let the machine learn from the data.

Several factors explain this revival:

- Increased computer power,

- Increasing availability of data,
- Progress in statistics and optimization.

A landmark event was in 1997, when IBM's Deep Blue defeated world chess champion Garry Kasparov. This demonstrates the ability of machines to solve complex problems.

Algorithms such as neural networks, decision trees and support vector machines are starting to develop strongly.

2.5 The Deep Learning Era (2010s to Present)

Since the 2010s, AI has undergone a real revolution with the appearance of **Deep Learning**.

This change is due to:

- The explosion of Big Data,
- The use of GPUs for parallel computing,
- Improving neural network architectures.

In 2012, a deep neural network won an image recognition competition, marking a historic turning point.

Since then, AI has advanced in many areas:

- Voice recognition,
- Computer Vision,
- Machine translation,
- Intelligent assistants,
- Autonomous vehicles.

In 2016, **AlphaGo** beat the world champion of the game of Go, a feat long considered impossible for a machine.

Today, AI is integrated into smartphones, industries, medicine, education, and autonomous systems.

2.6 Current Issues and Prospects

The evolution of AI is not only about technology, but also about society. Current challenges include:

- Ethics,
- Transparency of algorithms,
- Data protection,
- The impact on employment,
- The security of intelligent systems.

Researchers are now working on a more responsible, explainable and reliable AI.

In the future, AI will continue to evolve into more autonomous systems that can cooperate with humans and help solve complex problems across the board.

3. Introduction to the main areas of Artificial Intelligence

Artificial Intelligence includes several subfields, the most important of which today are **Machine Learning** and **Deep Learning**. Both approaches allow machines to learn from data to improve their performance without being explicitly programmed for each task.

3.1 Machine Learning

3.1.1 Definition

Machine learning is a branch of AI that allows a system to learn automatically from data. Instead of writing fixed rules, the machine is provided with examples, and the machine builds a model that can make predictions or make decisions.

In other words, the machine discovers hidden relationships in the data and improves its results with the experiment.

For example, a system can learn to recognize unwanted emails by analyzing thousands of messages that have already been filed.

3.1.2 Types of Learning

There are three main types of learning:

a) Supervised learning

b) Unsupervised learning

c) Reinforcement learning

3.1.3 Common Algorithms

Among the most widely used algorithms in Machine Learning are:

- Linear regression,
- Decision trees,
- Random forests,
- Support Vector Machines (SVM),
- k-nearest neighbours (KNN),
- Simple neural networks.

These methods are used to analyze, predict, and automate many tasks.

3.1.4 Applications of Machine Learning

Machine learning is present in:

- Pattern recognition,
- Fraud detection,
- Recommendation systems,
- Predictive analytics,
- Industrial maintenance,

- Financial analysis.

It makes it possible to efficiently exploit large amounts of data.

3.2 Deep Learning

3.2.1 Definition

Deep Learning is a sub-branch of Machine Learning based on **deep artificial neural networks**, i.e. composed of several layers.

These networks are inspired by the functioning of the human brain. Each layer gradually extracts increasingly complex features from the data.

Unlike traditional machine learning, deep learning can automatically learn useful representations without significant human intervention.

3.2.2 Neural Network Architecture

A deep neural network consists of:

- An input layer,
- Several hidden layers,
- An output layer.

Each neuron performs a weighted combination of inputs, followed by an activation function.

There are several architectures:

- Fully connected networks,
- Convolutional Networks (CNN),
- Recurring networks (RNN),
- LSTM networks,
- Transformers.

These architectures are adapted to different types of data: images, text, audio, time series.

3.2.3 How Learning Works

Deep learning uses a mechanism called **backpropagation to** adjust network weights.

The model compares its output with the actual value, calculates the error, and then modifies its parameters to gradually improve its predictions.

This process requires:

- Lots of data,
- Significant computing power,
- Training time.

3.2.4 Applications of Deep Learning

Deep Learning is now essential in:

- Computer vision,
- Facial recognition,
- Machine translation,
- Voice recognition,
- Intelligent assistants,
- Autonomous driving,
- The analysis of medical images.

Thanks to it, machines achieve performance close to, or even better than, humans in certain tasks.

3.3 Differences between Machine Learning and Deep Learning

Criterion	**Machine Learning**	**Deep Learning**
Data	Averages	Very large
Feature extraction	Often manual	Automatic
Complexity	Moderate	High
Calculation	Low to medium	Very important
Accuracy	Good	Very high
Domains	Structured data	Images, sound, text

Deep Learning is therefore an evolution of Machine Learning, adapted to complex and large problems.

3.4 Importance in Modern AI

Machine learning and deep learning are now at the heart of intelligent systems. They allow machines to learn, adapt, and improve their performance without constant reprogramming.

They are used in almost all scientific, industrial and economic fields, making them fundamental pillars of modern Artificial Intelligence.