What is Artificial Intelligence?

Prof Christophe Roche

ERA Chair Holder - University of Crete

https://christophe-roche.fr/

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https://talos-ai4ssh.uoc.gr/

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"The question of whether computers can think is just like the question of whether submarines can swim."

— EDSGER W. DIJKSTRA

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What is intelligence?

Is a chess computer intelligent?

1. Introduction

What is intelligence?
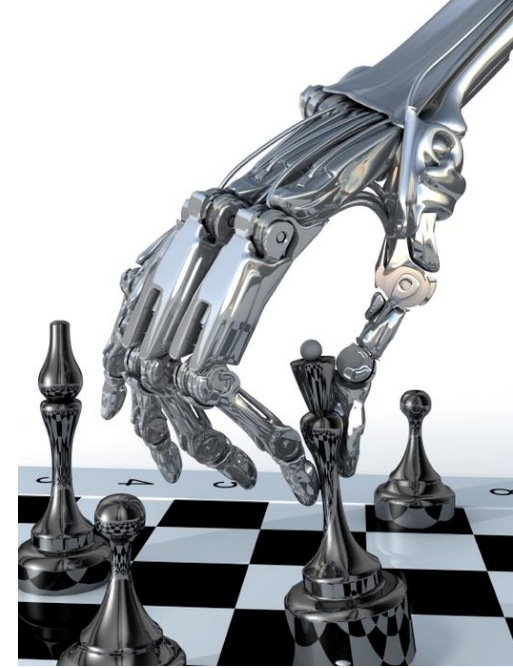
Is a chess computer intelligent?

It can:

- **Represent (the world)**

- **Reason (on the representation of the world)**

- **Act (on the representation of the world)**

1. Introduction

What is intelligence?

Is a chess computer intelligent?

It <u>can</u>:

- **Represent (the world)**

- **Reason (on the representation of the world)**

- **Act (on the representation of the world)**

But… dedicated to one task

1. Introduction

What is Human Intelligence?

"The ability to acquire and apply knowledge and skills" Oxford Dictionary

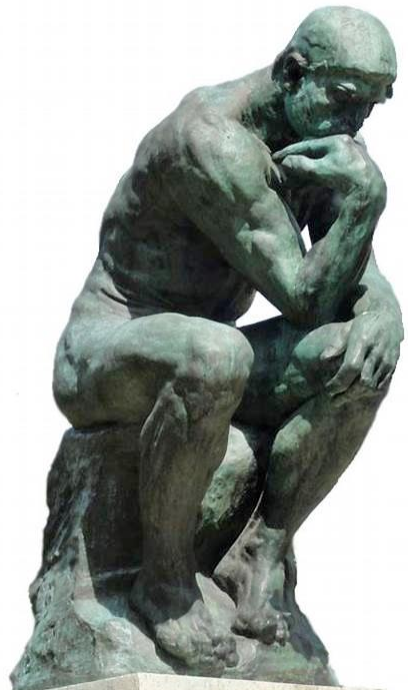"the ability to learn or understand or to deal with new or trying situations" Merriam-Webster

"the ability to learn, understand, and make judgments or have opinions that are based on reason" Cambridge

ChatGPT

Human intelligence is a complex and multifaceted concept that refers to the cognitive abilities and mental capacity of human beings.

It involves the ability to <u>reason</u>, <u>think</u> abstractly, <u>solve</u> problems, <u>learn</u> from experience, <u>understand</u> complex ideas, <u>communicate</u> effectively, and <u>adapt</u> to new situations.
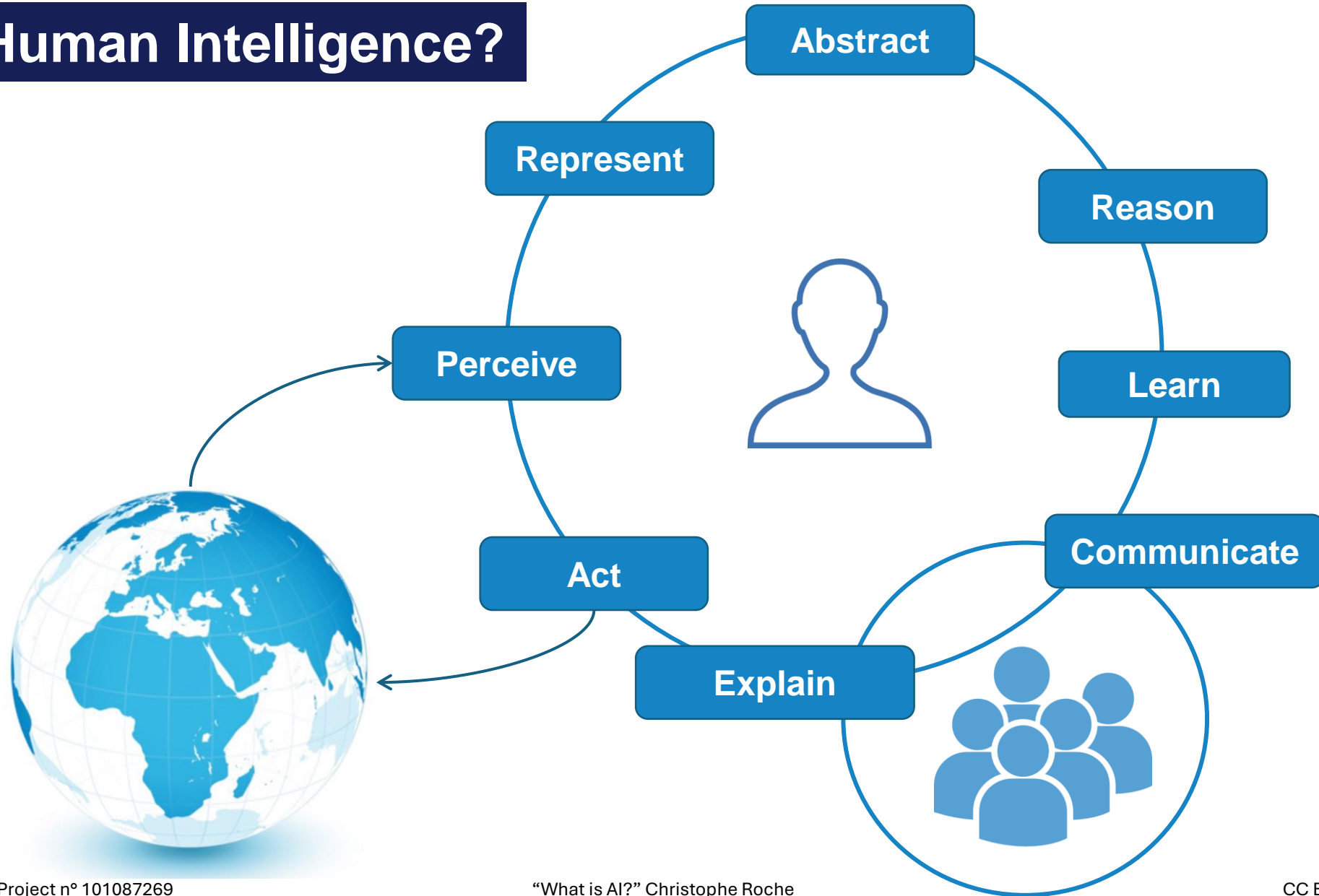
Rodin Thinker
Paris (France)

What is Human Intelligence?

1. Introduction

What is Artificial Intelligence?

"**Artificial Intelligence** (AI) is the part of **computer science** concerned with designing intelligence computer systems, that is, systems that exhibit the **characteristics we associate with intelligence in human behavior** – understanding language, learning, reasoning, solving problems, and so on"

(The Handbook of Artificial Intelligence)

1. Introduction

What is Artificial Intelligence?

"**Artificial Intelligence** (AI) is the part of **computer science** concerned with designing intelligence computer systems, that is, systems that exhibit the **characteristics we associate with intelligence in human behavior** – understanding language, learning, reasoning, solving problems, and so on"

(*The Handbook of Artificial Intelligence*)

Strong A.I.
Computer is a model of brain
AI system can *think* as human does

Weak A.I.
AI System whose *behaviour* can be said to be intelligent

"The question of whether computers can think is just like the question of whether sub-marines can swim."

— EDSGER W. DIJKSTRA

AI begins with Computers

Alan Turing

VOL. LIX. No. 236.] [October, 1950

MIND

A QUARTERLY REVIEW

OF

PSYCHOLOGY AND PHILOSOPHY

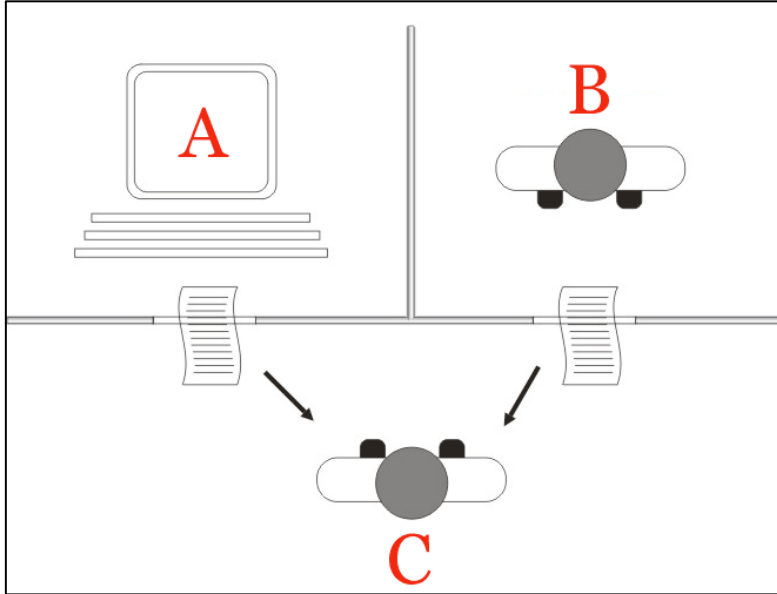### I.—COMPUTING MACHINERY AND INTELLIGENCE

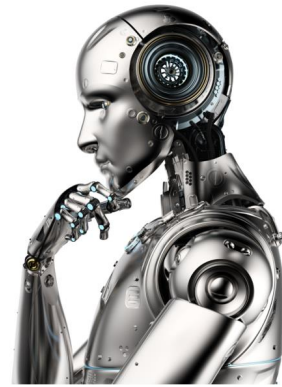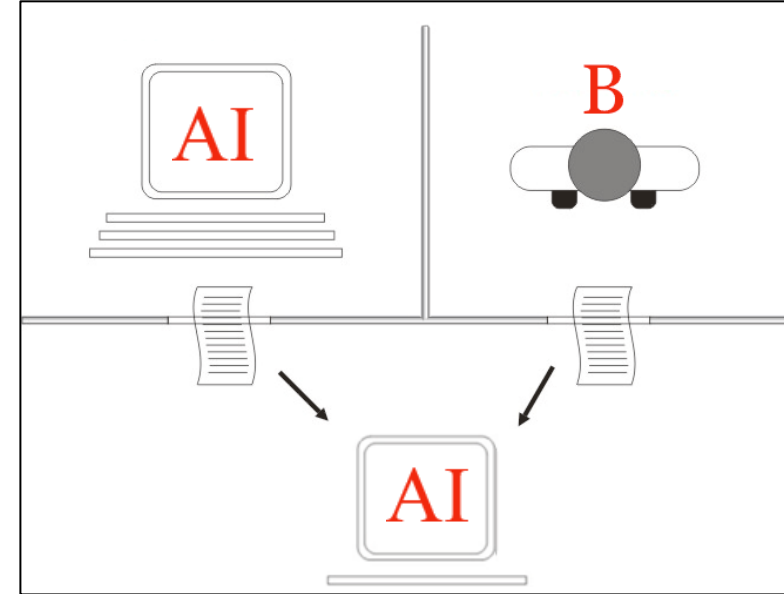#### BY A. M. TURING

1. *The Imitation Game.*

I PROPOSE to consider the question, 'Can machines think?' This should begin with definitions of the meaning of the terms 'machine' and 'think'. The definitions might be framed so as to reflect so far as possible the normal use of the words, but this attitude is dangerous. If the meaning of the words 'machine' and 'think' are to be found by examining how they are commonly used it is difficult to escape the conclusion that the meaning and the answer to the question, 'Can machines think?' is to be sought in a statistical survey such as a Gallup poll. But this is absurd. Instead of attempting such a definition I shall replace the question by another, which is closely related to it and is expressed in relatively unambiguous words.

'Can machines think?'

"Computing Machinery and Intelligence"
A.M. Turing
Mind, Volume LIX, Issue 236,
1st October 1950, Pages 433–460.

1912-1954

Turing is widely considered to be the father of theoretical computer science and artificial intelligence

Alan Mathison Turing was an English mathematician, computer scientist, logician, cryptanalyst, philosopher, and theoretical biologist. Turing was highly influential in the development of theoretical computer science, providing a formalisation of the concepts of algorithm and computation with the Turing machine, which can be considered a model of a general purpose computer.

2. History

AI begins with Computers

Alan Turing

The Turing test, developed by Alan Turing in 1950, is a test of a machine's ability to exhibit intelligent behavior equivalent to, or indistinguishable from, that of a human.

Games & Logic

Game software are used as a measure of progress in AI.

In 1951, Christopher Strachey wrote a checkers program and Dietrich Prinz wrote a program for chess.

The computer is the Mark I machine of the University of Manchester.

"Logic Theorist is a computer program written in 1955 and 1956 by Allen Newell, Herbert A. Simon and Cliff Shaw. It was the first program deliberately engineered to mimic the problem solving skills of a human being and is called "**the first artificial intelligence program**". It would eventually prove 38 of the first 52 theorems in Whitehead and Russell's Principia Mathematica, and find new and more elegant proofs for some" (Wikipedia)

2. History

The Dartmouth Conference

In 1956 John McCarthy regarded as the father of AI, organized a conference to draw the talent and expertise of others interested in machine intelligence for a month of brainstorming. He invited them to Vermont for "The Dartmouth summer research project on artificial intelligence."
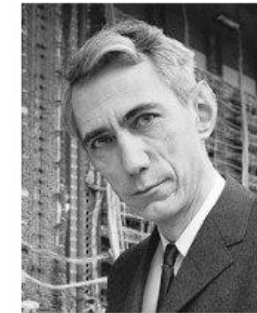

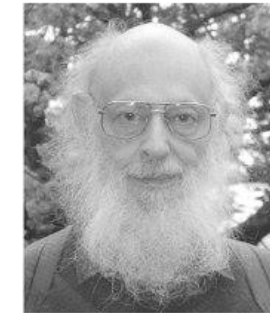1956 Dartmouth Conference: The Founding Fathers of AI

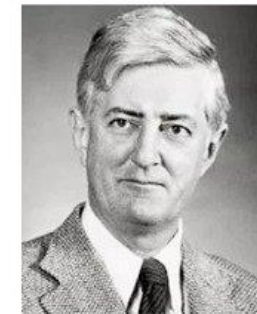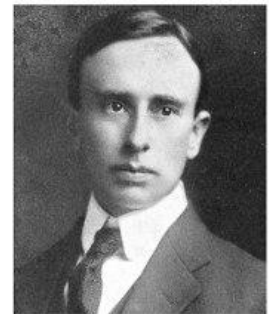John MacCarthy · Marvin Minsky · Claude Shannon · Ray Solomonoff · Alan Newell

Herbert Simon · Arthur Samuel · Oliver Selfridge · Nathaniel Rochester · Trenchard More

AI Periods

■ **Euphoric period (1952-1969)**

- General Problem Solver
- Lisp
- Robinson's Resolution Principle

■ **Return to reality (end of 60's – beginning of 70's)**

- Machine Translation (English-Russian)

■ **Expert Systems (1970's)**

- DENDRAL: molecule structure identification
- Mycin: medical diagnosis
- PROSPECTOR: drilling site choice

■ **Industry of AI (1980's)**

- Japan's 5th generation project
- Software tools for expert systems
- LISP-specific hardware

■ **Dark ages (end of 1980's – 1990's)**

Strong AI did not reach its promises

"*It is not my aim to surprise or shock you – but the simplest way I can summarize is to say that there are now world machine that think, that learn and that create*" Simon (1957)

■ **Triumph of AI**

- Return of AI mainly due to the hardware progress and the availability of massive data
- AI embedded in everyday life

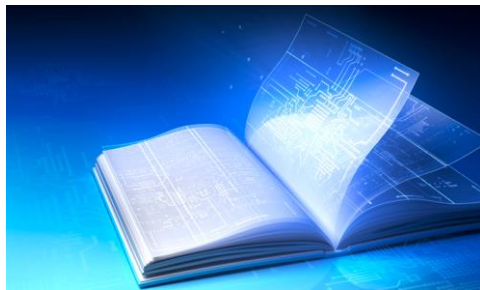# 3. Domains of Application

Medicine

Smart City

INTERNET OF THINGS

Facial recognition

Robotics (Cobots)

Finance

AI Coding Assistant
AI Writing Assistant

Information Retrieval

Sentiment Analysis

Information Extraction

Machine Translation

Natural Language Processing

QuestionAnswering

Digital Humanities

Chatbot)

4. Scalability

Hardware & Data

Computers

Big Data

Storage

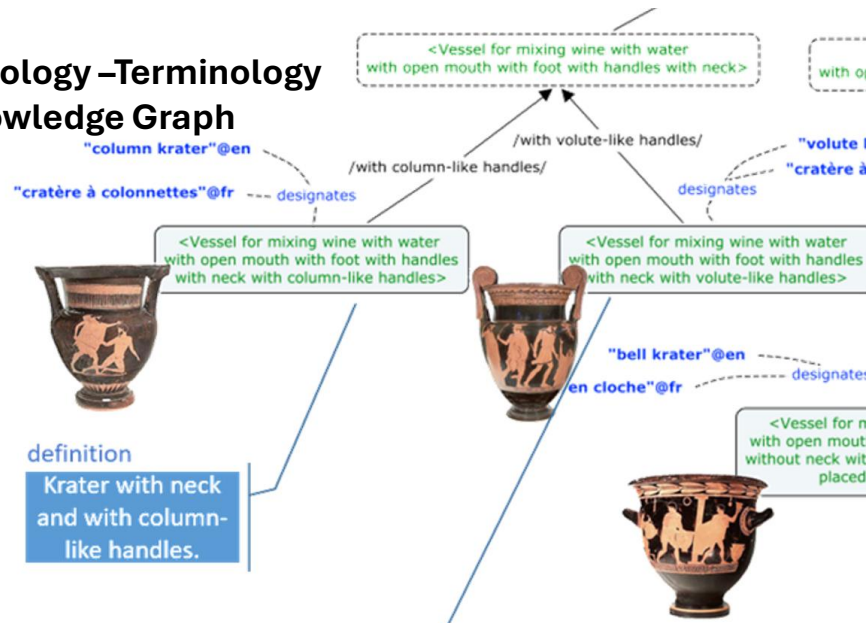

Linked and Open Data

5. Symbolic A.I.

Symbolic AI (or Classical AI) is the branch of artificial intelligence which aims to **explicitly represent** **human knowledge** in a **declarative form** (i.e. facts and rules)

Epistemological Principles

Human- & computer-readable form

✓ Symbolic AI was the dominant paradigm of AI from the mid-1950s until the late 1980s

✓ The most successful form of symbolic AI is **expert systems**, which use a network of production rules. Production rules connect symbols in a relationship similar to an If-Then statement.

Ontology –Terminology Knowledge Graph

Expert Systems (reasoning)

If the soil pH *is less than* 6.0
   and
   the soil *has a high level of* aluminum
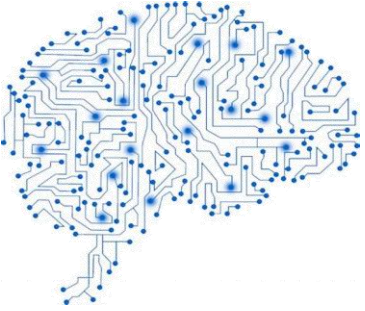**then** it is not suitable for growing most crops.

Logic

Definition: Pocket-Watch(x) ::= Time-Piece(x) ∧ Portable(x) ∧ Pocket(x)
Properties: ⊨ ¬ (Pocket(x) ∧ Wrist(x))
Reasoning: Portable(x) ➞ (Wrist-Watch(x) ∨ Pocket-Watch(x))
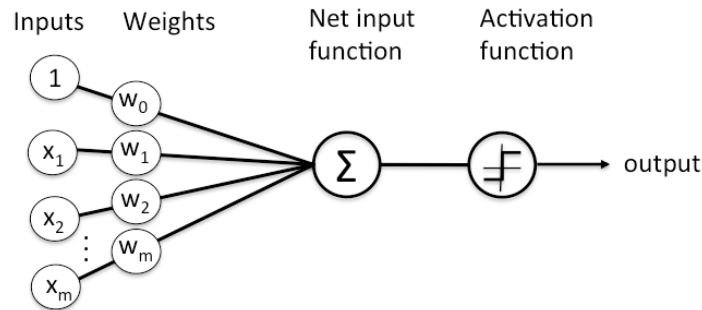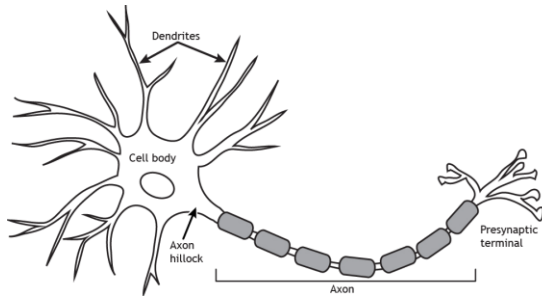
6. Connectionist A.I.

Connectionist A.I. is the branch of artificial intelligence which aims to understand how the **human brain works at the neural level** and, in particular, how people learn and remember.
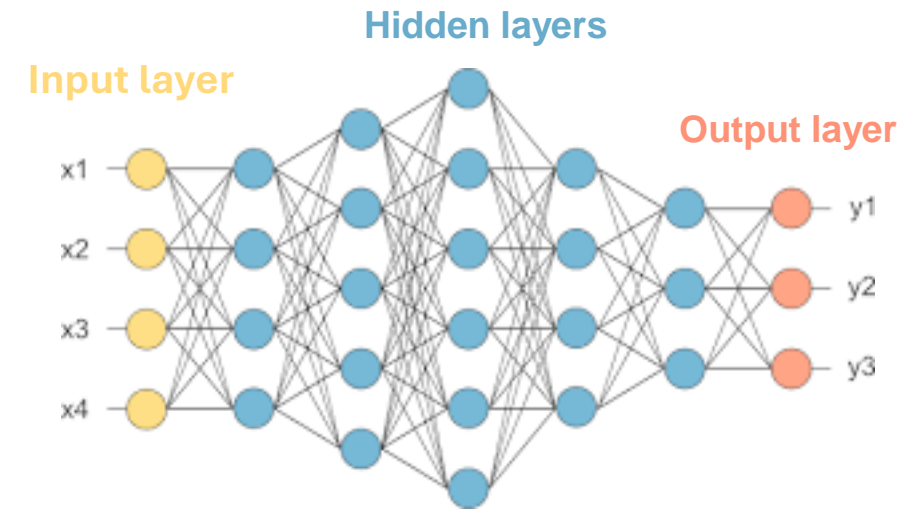
AI is nowadays most often associated with Deep Learning based on neural networks.

Deep Learning - Neural Network

Artificial Neural Networks are computing systems inspired by biological neural networks.

Input layer   **Hidden layers**   **Output layer**

Such systems "**learn**" to perform tasks by considering **examples**. For example, in image recognition, they might learn to identify images that contain cats by analyzing example images that have been **manually labeled** as "cat".
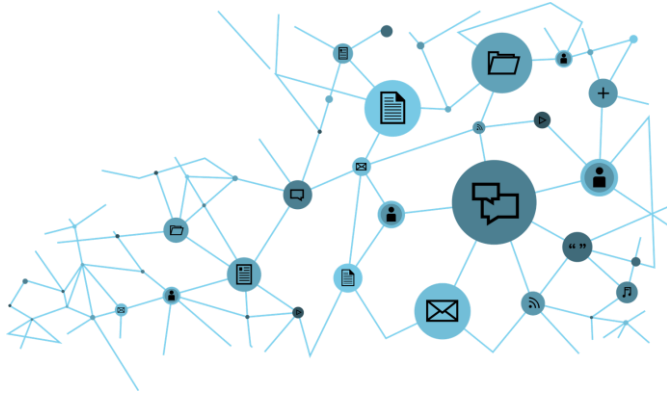
Finding correlations between inputs and outputs

6. Connectionist A.I.

■ Large Language Models (LLMs)

Deep learning models trained on massive amounts of text data to:
- understand,
- generate (predict the next word in context),
- manipulate human language

Specific tasks: summarization, translation, Q&A, chat, etc.

■ Generative A.I.

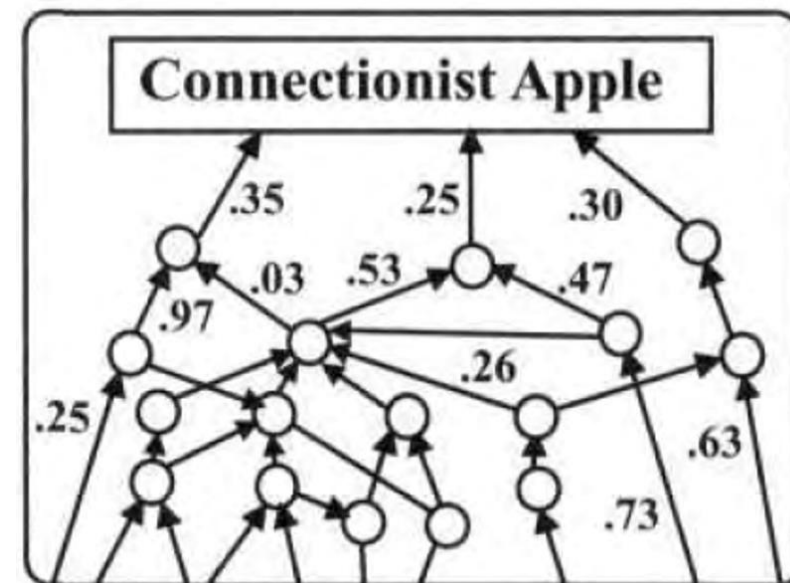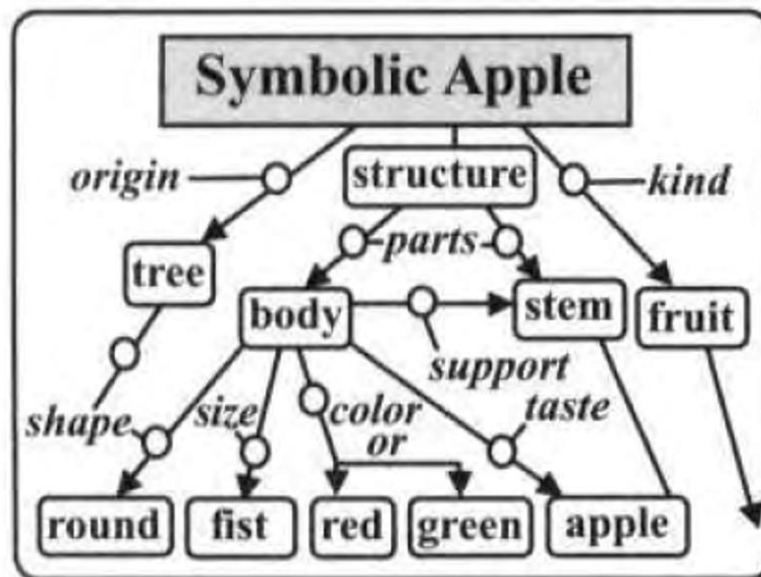**A.I. systems to create new content:**
- text,
- images, music,
- code, etc

Based on:
- deep neural networks
- LLMs

7. Symbolic A.I. *versus* Connectionist A.I.

The diagram on the left shows a Semantic Network that describes various features and relationships between various aspects or parts of an apple. The diagram on the right shows an example of what is called a *"Connectionist Network,"* which also displays some aspects of an apple, but does not have any simple way to distinguish between different relationships; it only shows numbers that represent how closely those features are "associated." It would take too long here to explain how such networks

8. Hybrid A.I. (Neuro-Symbolic A.I.)

Combining the strengths of:

✓ **Symbolic AI:**
- Knowledge Representation
- Reasoning
- Explainability

✓ **Connectionist AI :**
- Learning from Data
- scalability

➤ A Better Model for Leveraging Machine Learning and Human Expertise

➤ Solving the AI black box problem through transparency

8. A.I. Ethics

https://en.unesco.org/artificial-intelligence/ethics/cases

THE ETHICS OF ARTIFICIAL INTELLIGENCE

DATA ETHICS
AI ETHICS

There are many ethical challenges:

<u>Lack of transparency of AI tools</u>: AI decisions are not always intelligible to humans.

<u>AI is not neutral</u>: AI-based decisions are susceptible to inaccuracies, discriminatory outcomes, embedded or inserted bias.

<u>Surveillance practices</u>: data gathering and privacy.

Facial recognition

Protection?

Surveillance?

Autonomous weapons

select and engage targets without human intervention.

Autonomous weapons have been described as the third revolution in warfare, after gunpowder and nuclear arms.