



Introduction to Artificial Intelligence

Concepts, Subfields, Applications, Advances

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Artificial Intelligence:

Concepts, Subfields, applications, Perspectives

Preface

1. What does mean the term intelligence?

2. Is the computer intelligent? Why?

3. What about the Human?

1. What does means the term intelligence?

- Intelligence is the ability to solve problems.
- Intelligence is the ability to solve complex problems efficiently and in a short time.
- Intelligence is the ability to innovate and make decisions at any time regarding a given problem.

2. Is the computer intelligent? Why?

- **The computer is not Intelligent !!!**
- ⇒ It does nothing but execute a sequence of program instructions given by the human.
- It cannot innovate or make new decisions (old generations). (Old generations of computers)

3. What about the Human?

- **Intelligence is one of the most important characteristics of human.**
- He is able to make new decisions at any time and adapt itself to the environment changes.

Comparison Between Human and Computer

Characteristics	Human	Computer
<i>1. Speed</i>		
<i>2. Tiredness</i>		
<i>3. Forgetting.</i>		
<i>4. Precision</i>		
<i>5. Memorization</i>		
<i>6. Learning</i>		
<i>7. Innovation et adaptation</i>		

Comparison Between Human and Computer

Characteristics	Human	Computer
<i>1. Speed</i>	<i>Slow</i>	<i>Very quick</i>
<i>2. Tiredness</i>	<i>It may get tired</i>	<i>Never</i>
<i>3. Forgetting.</i>	<i>He can Forget</i>	<i>Never</i>
<i>4. Precision</i>	<i>He can be wrong when calculating.</i>	<i>Very precise (accurate)</i>
<i>5. Memorization</i>	<i>Relatively unlimited.</i>	<i>Limited by the capacity of its storage devices.</i>
<i>6. Learning</i>	<i>Strong</i>	<i>Bad → requires AI</i>
<i>7. Innovation et adaptation</i>	<i>Strong</i>	<i>Bad (it follows program instructions) → Requires AI</i>

Definition of Artificial Intelligence (Specialists)

- *Make the machine acts, thinks like a human.*

- Having more or less intelligent machines and programs.

- *AI is the science and engineering of making intelligent machines and programs.*

- *A general mental capability that involves the ability to reason, plan, solve problems, think abstractly, comprehend ideas and language, and learn.*

- *Artificial Intelligence (AI) refers to the ability of machines to perform cognitive tasks like thinking, perceiving, learning, problem solving, and decision-making.*

Brief Early History of AI

- **Aristotle** – 2000 years ago (B.C/B.C.E)
 - Logic
 - Reasoning system
- **Calculating machines**
 - Old Chinese Abacus (4000 years ago)
 - John Napier (1614): multiplication and exponents.
 - Pascal ((1642, 1670): Pascaline
 - Leibniz (1694): Leibniz Wheel (1694)
- **AL-KHAWARIZMI** (الخوارزمي 825)
 - Formal Logic.
 - Proof of theorems.
 - Algorithms.
 - Probability
- **Descartes** (1680)
 - Thought and mind (Pensée et esprit).
 - How to separate the mind from the physical world?

Brief Modern History

- **Formal logic**
 - Charles Babbage (First Computer Design)
 - George Boole (Boolean Algebra)
 - Turing (1950): Turing machine, Turing test
 - Frege (First-Order Predicate Calculus)
- **Graph theory**
 - Euler, Hamilton, Dijkstra, Bellman, Ford, and others
 - State Space Search
- **McCulloch and Pitts (1943)**
 - Birth of ANNs (Artificial Neural Networks).
- 1950 : - Hebb Learning Low
 - Turing Machine

➤ 1956 :

- Birth of the term AI for the first time (meeting of M.Minsky, McCarthy, Newell&Simon/Dartmouth College, New Hampshire, USA)
- Appearance of the first intelligent program “LogicTheorist” (automatic theorem demonstration)
- Official birth of the first AI workshop at Dartmouth.

➤ 1960 :

- McCarthy developed LISP language.

➤ 1967–1979: Apparition of expert systems

- MACSYMA (1967) - DENDRAL (1969)
- MYCIN (1977) - HEARSAY II
- PROSPECTOR (Geology).

➤ 1971: Development of prolog language (Alan Colmeraur/Labo.LIF, Fr).

➤ Since 1980: Several techniques in Computer science have been developed:

- ANN, Genetic algorithms, Logic Inductive programming, Bayesian networks.

➤ 1986 : - ANNs again

➤ 1990-2000 :

- Apparition of the internet.
- Search engines (Altavista, Google, Bing, Bahth, etc) using AI techniques.
- Intelligent Agents

➤ 1995 : - First Automatic vision system ALVINN (Carnegie Mellon University, USA, placed on NAVLAB5).

➤ 1997: - at Philadelphie, USA, the “Deep Blue” machine beats the world chess champion Garry Kasparov.

➤ 1999: - an Intelligent Artificial Agent (NASA Agency) flew a satellite past the planet Mars for one day without any help from the earth.

AI Today: Interesting Topics

- Autonomous planning (NASA), logistics planning (army)
- Automatic control (self-Driving Cars, machine control, etc.)
- Diagnostics (expert level, especially in medicine)
- Robotics and vision (different generations of robots).
- Smart Houses and Smart-Cities.
- Image recognition and synthesis, speech, Natural Language, handwriting recognition (postal checks), assistant agents, etc.
- Agent-based and Multi-Agent Systems.
- Constraints satisfiability, and Search.
- Knowledge Representation, Reasoning, and Logic.
- Multidisciplinary Topics and Applications.
- Artificial life (study of ecosystems: Ants and Bees).
- Data Mining (decision making based on knowledge extraction).
- Natural-Language Processing NLP (ex: ChatGPT).
- Planning and Scheduling (Universities, Military services).
- Uncertainty in AI.
- Web and Knowledge-based Information Systems.
- E-Learning (distance learning).
- Electronic commerce. (e-commerce/e-business)
- Virtual reality VR, Augmented Reality AR, Mixed Reality XR
- Machine Learning
- Deep Learning

A more pleasant future for humans?

- The ultimate goal of artificial intelligence is not to replace humans, but to relieve them so that they can focus on increasingly creative or enjoyable tasks.

Tim Menzies said: *“I still dream of the day when my Word processor would write an article like this, while I go to the beach!”*

Will we ever get there? Maybe...

Classical Computing Vs Artificial Intelligence

➤ Classical Computing

Processes data (numerical and alphabetic information).

➤ Artificial Intelligence

Processes knowledge (symbolic information).

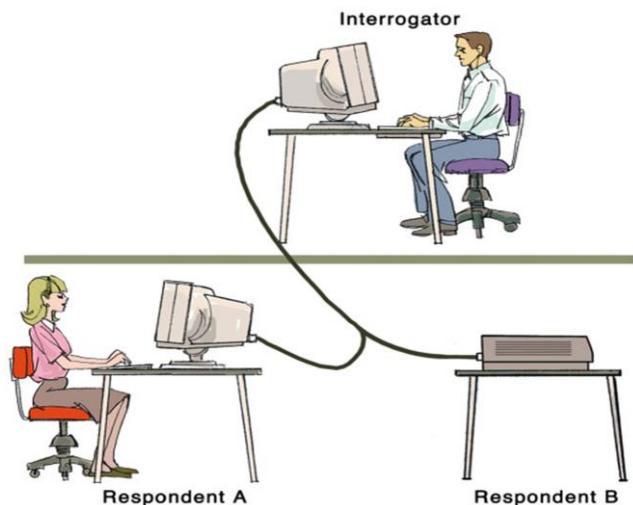
Comparison Between AI Methods and Classical Computing Methods

Classical Computing Methods	AI Methods
Close to machine operations (run simple instructions)	Close to human functioning (thinking, analyzing, reasoning)
Processing Numbers or texts (simple data)	Processing symbols (rules, logical assertions, ...)
Use a lot of calculations	Use a lot of inferences.
Follow rigid algorithms.	Rely on heuristics and uncertain reasoning
Can only be generalized to a small class of similar problems	Are generalizable to completely different domains.

How Check Machine Intelligence?

1. Turing Test (1950)

- An interrogator communicates with a person and a machine.
- The interrogator cannot see them and speak to either
- Does not know which is actually machine
- May communicate with them solely by textual device
- If the interrogator cannot distinguish the machine from the human, then the machine may be assumed to be intelligent.



Human:

Question : "What is 35,076 divided by 4,567?"

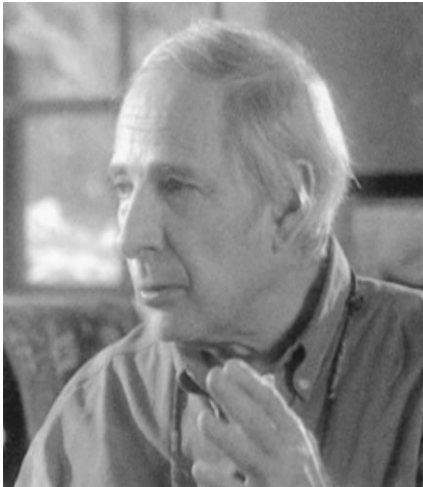
Answer : ????

Machine:

Question : "What is 35,076 divided by 4,567?"

Answer : 7.6803153

2. Chinese Room (Minds, Brains and programs/John Searle, Prof in Philosophy/Berkeley; 1980)



- John Searle is locked in a room.
- Communicating with the outside world only through a window.
- Uses a very large book in which is written a series of questions and their relevant (suitable) answers written in Chinese.
- An experimenter transmits messages to him through the window, sometimes in English, sometimes in Chinese.
- Searle responds directly to messages written in English.
- For messages written in Chinese, he is forced to consult the book until he finds a question identical to the message, he then copies the associated answer.
- The same thing can be done by replacing the human who answers the questions with a machine to test its level of intelligence (Do an experiment in TD).

Conclusion: A machine will be considered intelligent if it reproduces the behavior of a human being in a specific domain or if it models the functioning of a human being.

AI Application Areas

✦ Machine Learning

- Give the machine the ability to perform tasks that could not be performed before or that were exclusive to humans.

✦ Knowledge Representation

- A very important area of AI research.
- Consist in finding an adequate formalism to represent knowledge and make it available to intelligent software.
- Several formalisms are proposed:
 - Propositional logic
 - 1st order predicate logic
 - Semantic networks.
 - Neural Networks (ANNs).
 - Ontologies, etc.

✦ Natural Language Processing

- ✓ Understanding of natural language.
- ✓ Automatic translation.
- ✓ Text Summarizing.
- ✓ Human-machine interaction (replace high-level languages).

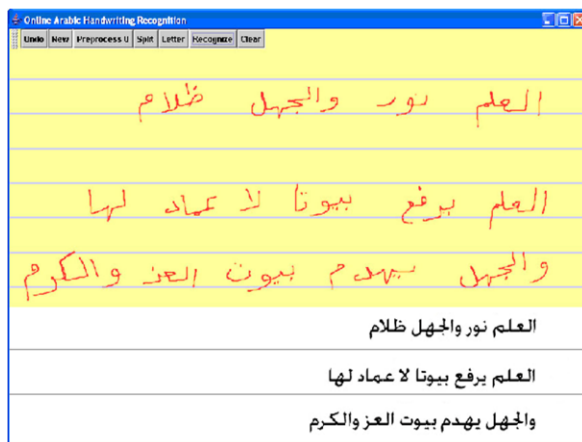


✦ Images & Pattern Recognition

- Acquire images from various sources (scanner, camcorder, satellite, etc.) and identify the objects represented by these images.
- **Applications:**
 - Vision (object detection by robots/Autonomous vehicles).
 - Optical reading of documents (OCR).
 - Face recognition (Scientific police).
 - Image synthesis.
 - DNA sequences recognition and prediction.

✦ Handwriting Recognition

- Recognize (identify) numbers and handwritten texts.
- **Applications :**
 - ✓ Archeology
 - ✓ Credit Fraud detection for checks.
 - ✓ Police investigations.
 - ✓ Correction of exam papers, ...



✦ Speech Recognition

- Design and create software that can recognize any speaker's words.
- Requires understanding of the context of the spoken text, knowledge of the universe of discourse, etc.

- **Applications :**

- ✓ Automatic Voice Recorder AVR (Dictaphones automatiques)
(First AVR in 1994, Commerce).

- ✦ **Automated Reasoning and Theorem Proving**

- ✓ LogicTheorist

- ✦ **Formal Computing ($\neq$ Numerical Computing)**

- ✓ Calculating of the derivative function.
- ✓ Calculation of the integral.

- ✦ **Simulation of human reasoning**

- Develop logics that formalize modes of reasoning for machines (mathematical logic, fuzzy logic, modal logic, monotonic logic, etc.)

- ✦ **Expert Systems**

- An Expert System is a software capable of simulating the behavior of a human expert performing a specific task in a given domain.
- One of the areas where the success of AI is indisputable.
- Several areas have benefited from this discipline, to note:
 - ✓ Medicine (Mycin)
 - ✓ Chemistry (Dendral)
 - ✓ Geology (Prospector)
 - ✓ Financial analysis.
 - ✓ Device configuration.
 - ✓ Diagnostic.
 - ✓ Monitoring or troubleshooting task of industrial installations.

✦ Robotics

- Robotics is the intelligent interconnection of perception, action, as well as many other tasks.
- Robots have the ability to sense, move, reasoning and communicating in natural language.
- There are many generations of robots



Different models of robots



Examples of Domestic robots



Advantages (benefits of robotics)

- Increasing the productivity (the robot is faster than a man)
- Improving the quality of operations (robot precision)
- Less employees (==> less cost).
- Avoid risks (caused by dangerous tasks: (nuclear stations, etc)).



Virtual Reality VR

- New forms of human-machine interaction.
- Provides the sensory information needed to convince users that they are immersed (involved in the scene).
- Pr. Larry Hedges (at Georgia Institute of Technology) used virtual reality VR to cure some phobias (those of the elevator or those of spiders).

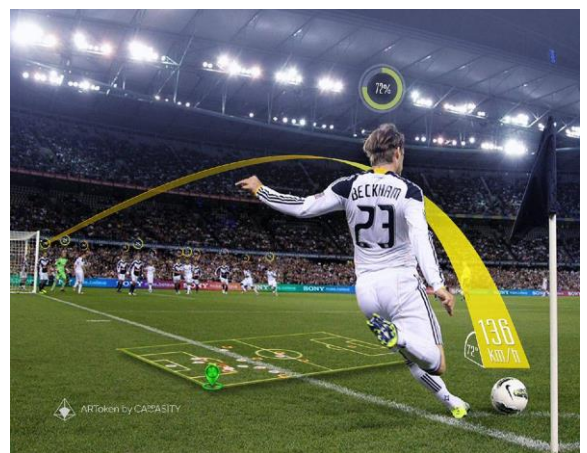
Require specific equipment

- ✓ Powerful computers (Fast CPUs)
- ✓ Impressive three-dimensional graphics capabilities (screens)
- ✓ Visualization and interaction devices (helmet, glove, glasses, etc.).



✦ **Augmented Reality AR**

Enriches reality with new virtual elements.



✦ Object Classification

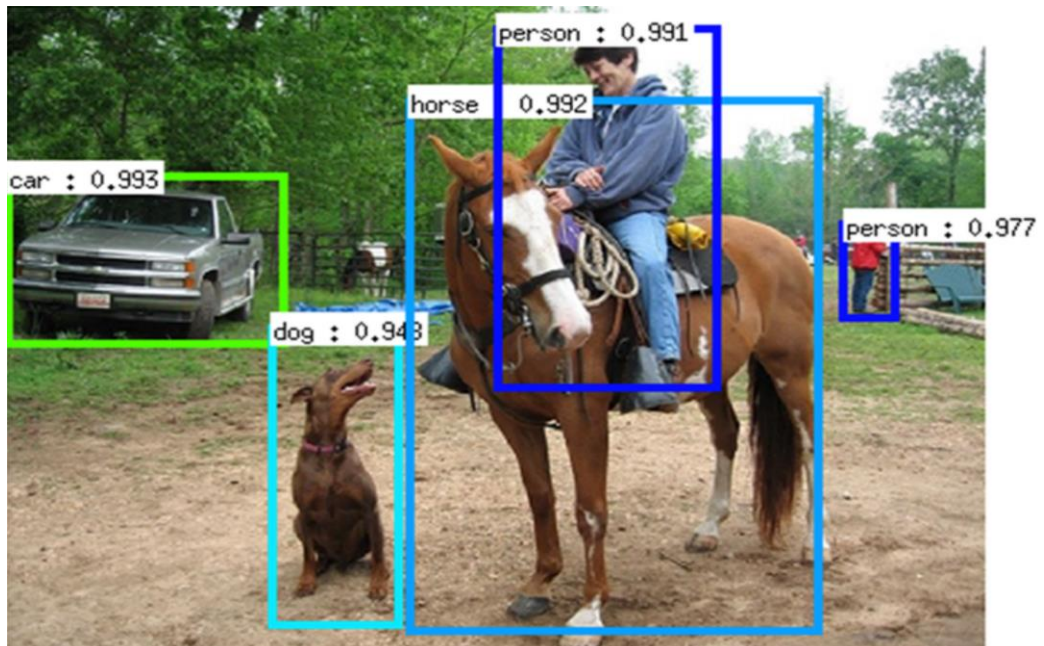


Dog:	94%
Cat:	31%
Bird:	2%
Boat:	0%



Dog:	37%
Cat:	91%
Bird:	21%
Boat:	1%

✦ Object Detection (in composed scenes)



✦ Games (Game Playing)

- ✓ Chess
- ✓ AlphaGO



10^{123} Combinations



10^{761} Combinations ==> 10^{79} atoms (Univers)

✦ Healthcare

- ✓ Diagnosis, Medical images (MRI, Scanner)
- ✓ Using robots for surgery.

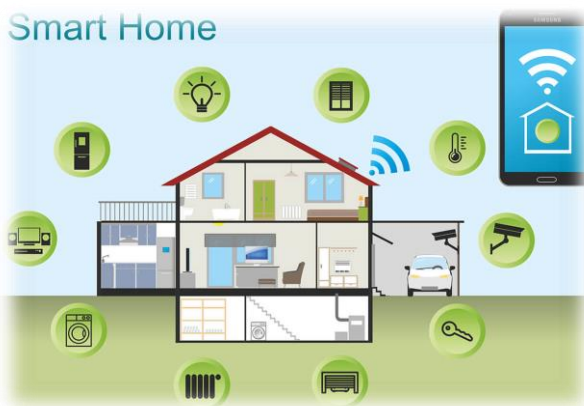


✦ Smart Agriculture

- ✓ Prediction (time, weather, harvest, water needs, diseases, ...)
- ✓ Use of robots and drones for some tasks in agriculture (smart irrigation, soil fertilizing, ...), etc.



✦ Smart houses and Smart cities



✦ Cybernetic (Hard&Soft Security)

- ✓ Attacks prediction (on networks)

✦ **Government services**

- ✓ Biometry, e-voting, etc

✦ **Military services**

- ✓ Simulation (battles, wars)
- ✓ Robots (for mine detection)
- ✓ Sensoring services
- ✓ Drones
- ✓ Radars



✦ **Finance**

- ✓ Fraud detection
- ✓ Financial prediction (Big Data)
- ✓ E-business and e-commerce
- ✓ Recommender Systems
- ✓ Needs prediction





Transportation

- ✓ Itinerary search (Google Maps)
- ✓ Smart transportation (Self-Driving Cars, IoT)



Decision Making



Education

- ✓ Self-education (Websites, Portals, Platforms)
- ✓ E-learning, distance learning.
- ✓ Expert systems (an automatic psychiatrist, a social agent.)
- ✓ Open-education (Virtual Classrooms)



Sentiment Analysis

- ✓ Sentiments are feelings, opinions, views, emotions, likes/dislikes, ...
- ✓ The process of extracting automatically the relevant information that expresses the opinion of the user about a given topic from texts.

Conclusion

- ✦ **AI is everywhere.**
- ✦ **We are heading towards fully intelligent societies.**
- ✦ **In a few years, our whole life will be artificial.**
- ✦ **We must join this evolution and this technological revolution as quickly as possible.**

Thank you for your attention