

Artificial Intelligence: Past, Present and Future

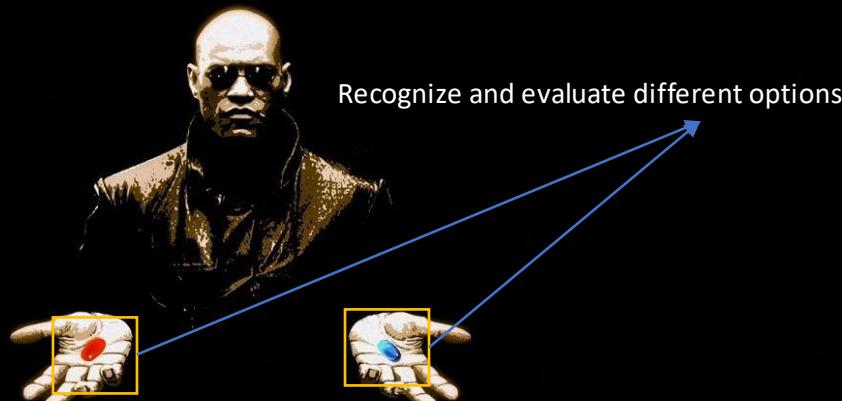
LICENCIATURA EM ENGENHARIA INFORMÁTICA
MESTRADO integrado EM ENGENHARIA INFORMÁTICA
Inteligência Artificial
2025/26

Wachowski, 1999



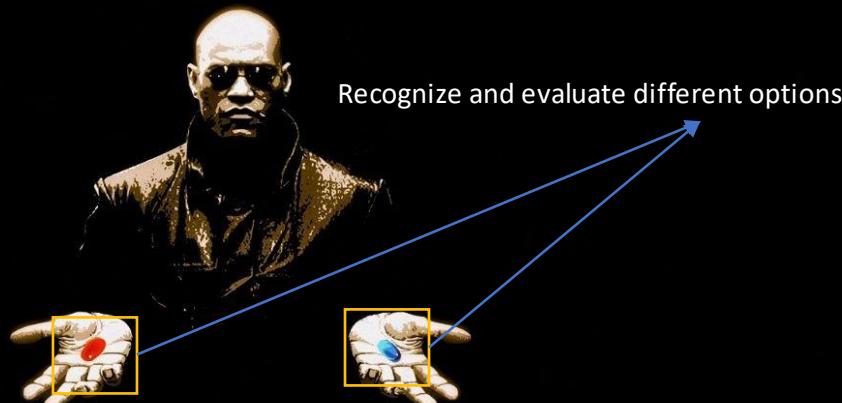
This is your last chance. After this, there is no turning back. You take the blue pill - the story ends, you wake up in your bed and believe whatever you want to believe. You take the red pill - you stay in Wonderland and I show you how deep the rabbit-hole goes.

Matrix (1999), Morpheus to Neo



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Matrix (1999), Morpheus to Neo

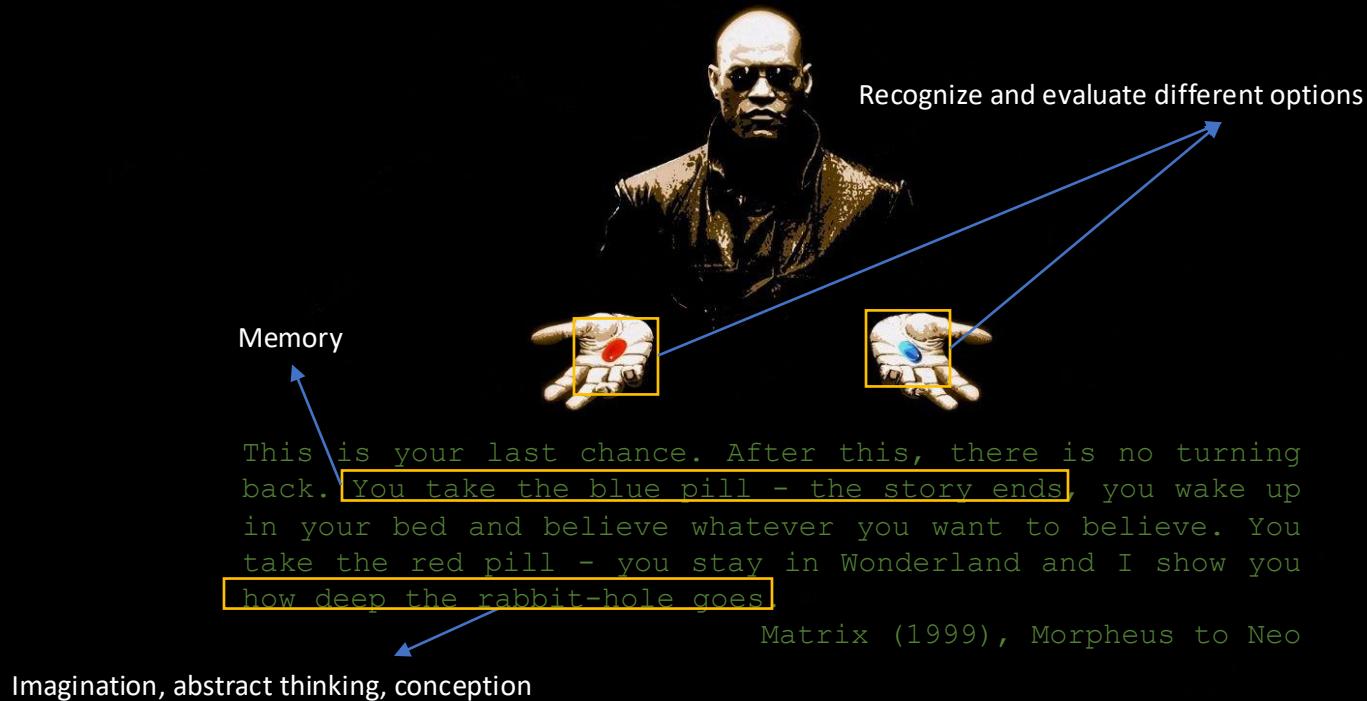


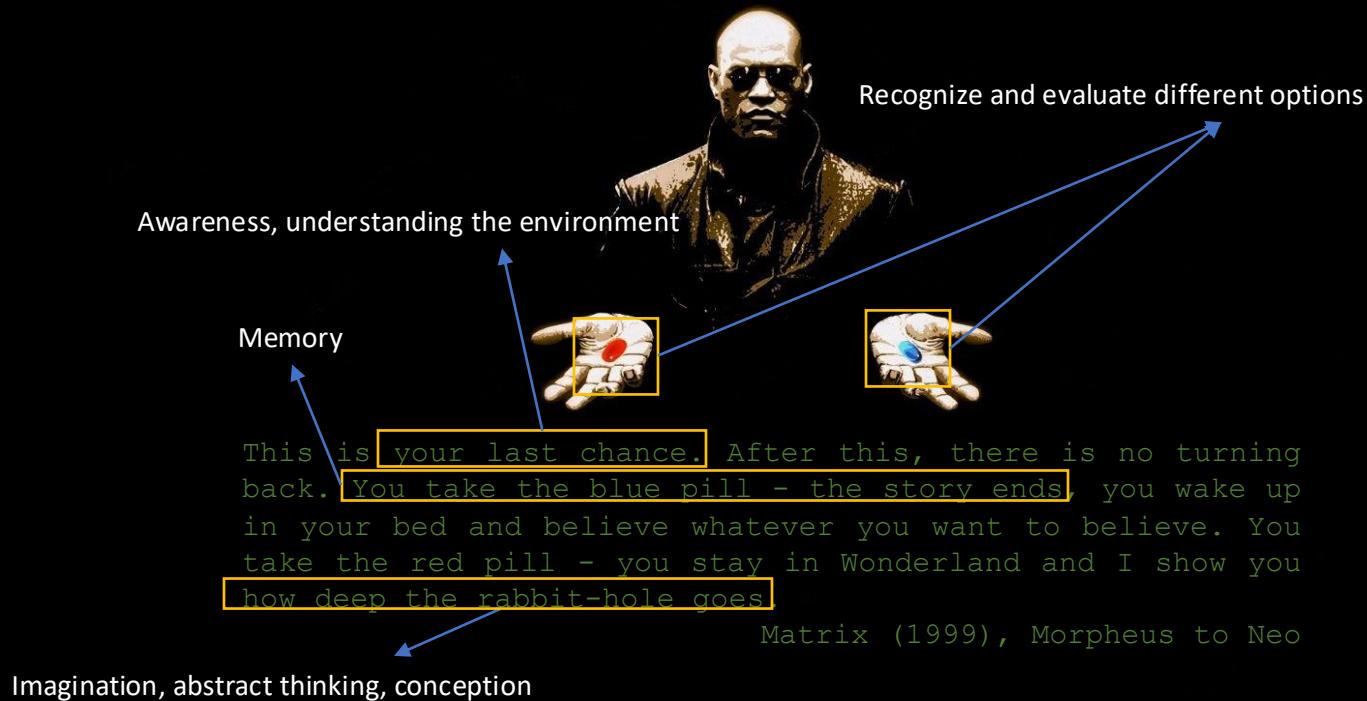
Recognize and evaluate different options

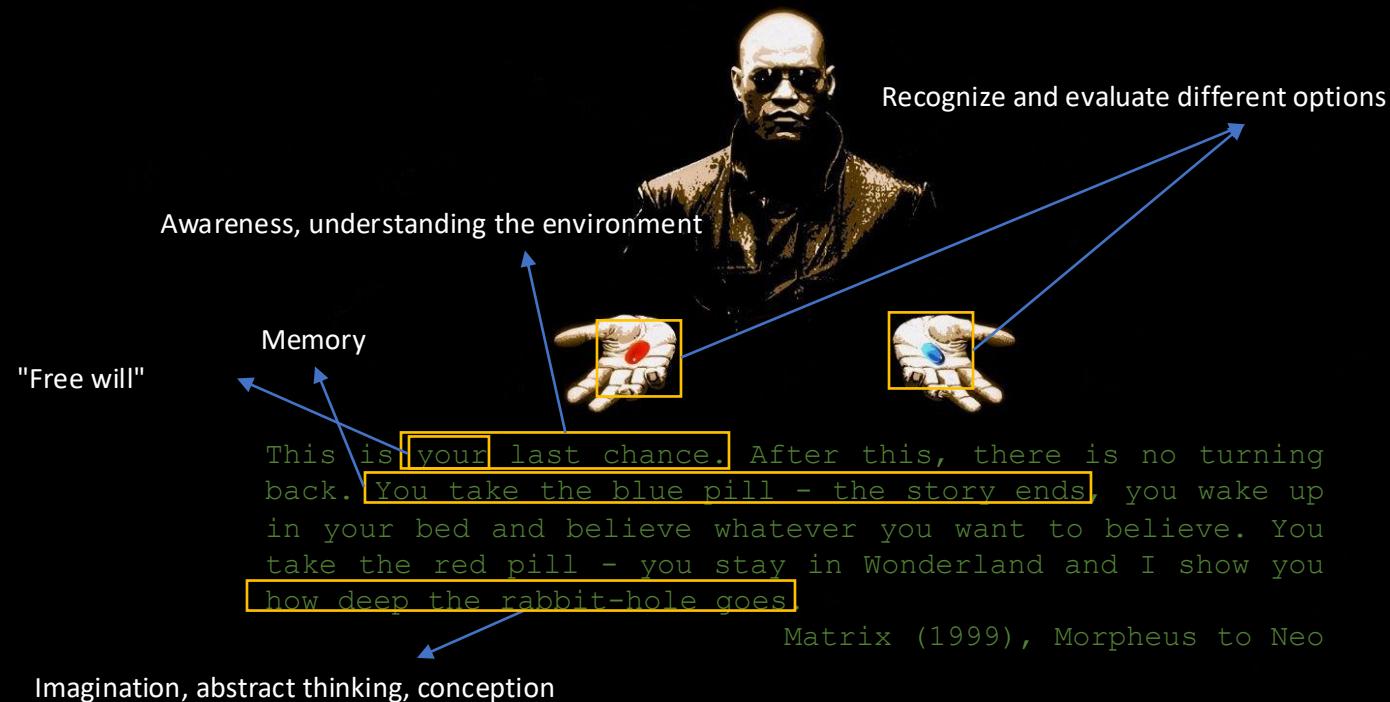
This is your last chance. After this, there is no turning back. You take the blue pill - the story ends, you wake up in your bed and believe whatever you want to believe. You take the red pill - you stay in Wonderland and I show you how deep the rabbit-hole goes

Matrix (1999), Morpheus to Neo

Imagination, abstract thinking, conception







Definitions

- **Intelligence**

(...)

from Latin 'intelligentia', 'faculty of understanding, talent'.

Artificial

that is done by art or industry; that is not natural (...)

Will computers replace man?

Will computers, intelligent machines,
humanoid robots have the ability to think
and decide to make them capable of
replacing man?



Will computers replace man?



Will computers replace man?

No

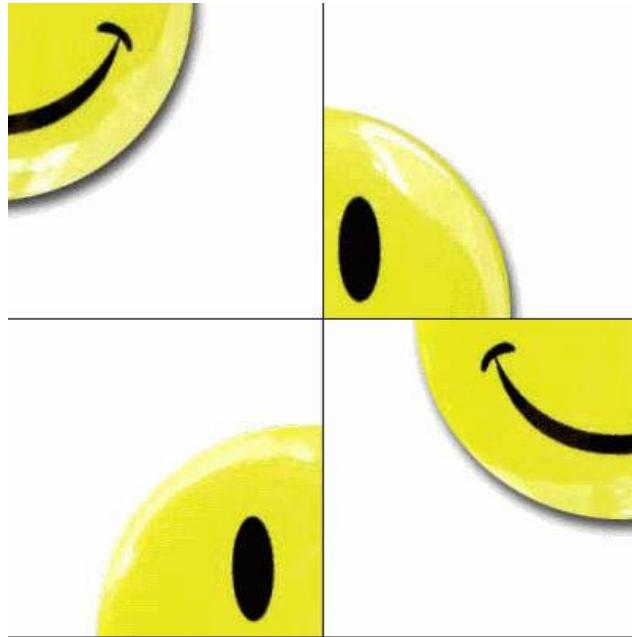
Computers are ALREADY replacing man!

And it is not just about doing the same thing as man.

Computers are able to do better than man.

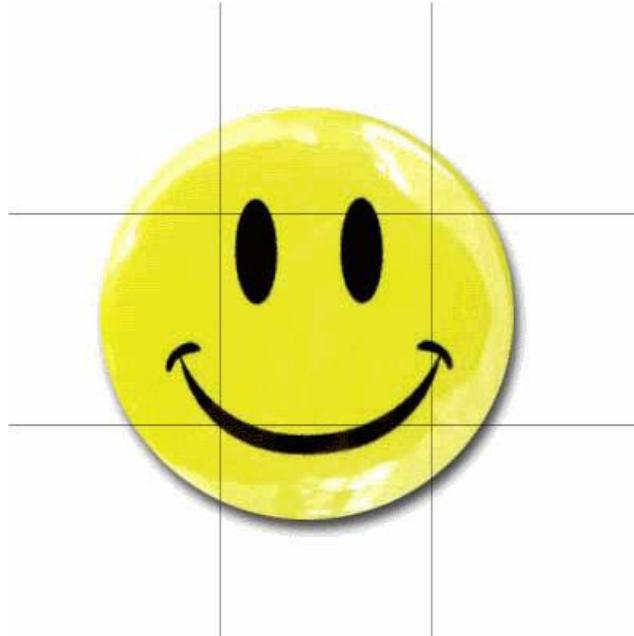


2 dimensional Square Puzzle of 2 x 2 24 possible combinations



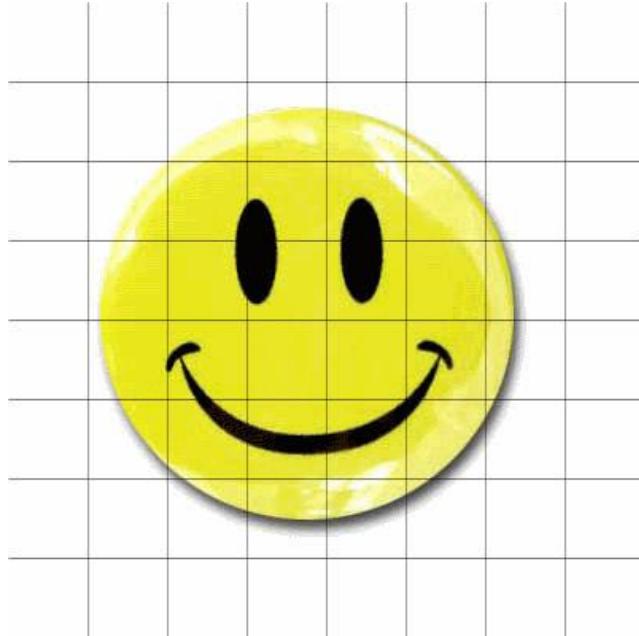
- Cálculo do fatorial de $2*2=4$
 - $4! = 4*3*2*1 = 24$
 - O fatorial de 4 é igual a 24

2 dimensional Square Puzzle of 3 x 3 362 880 possible combinations



- Cálculo do fatorial de $3*3=9$
 - $9! = 9*8*7*6*5*4*3*2*1 = 362\ 880$
 - O fatorial de 9 é igual a 362 880

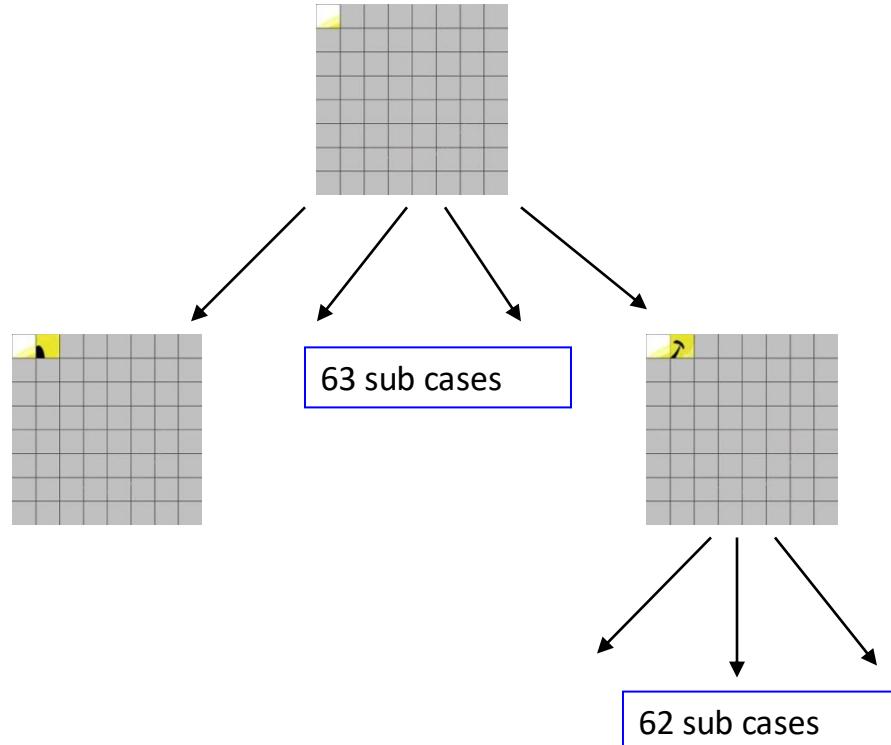
**2 dimensional Square Puzzle of 8 x 8
 $\cong 1.2688 \times 10^{89}$ possible combinations**



▪ Cálculo do fatorial de $8*8=64$:

- $64! = 64 * 63 * \dots * 2 * 1 = 1.2688693218588E+89$
- O fatorial de 64 é igual a $1.2688693218588E+89$.

**2 dimensional Square Puzzle of 8 x 8
 $\cong 1.2688 \times 10^{89}$ possible combinations**

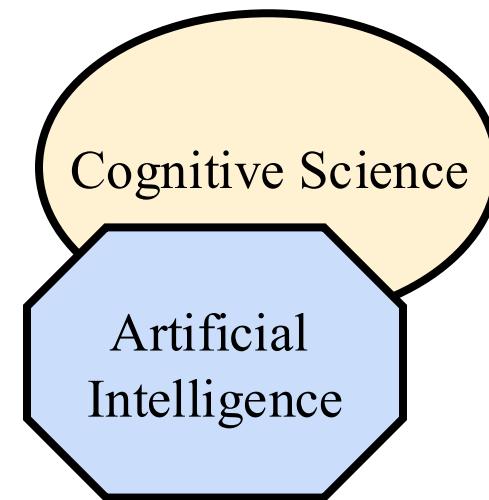


- $(8 \times 8)! \approx 1.2688 \times 10^{89}$ possible combinations.
- 1,000,000,000 of combinations per second would take $4 \times 1,069$ millennia to test all combinations !!!

- But...
why can humans solve the problem in a short time?
- The answer is simpler than we think:
because we use knowledge about the problem intelligently.

- Can we program a computer to use knowledge of a problem intelligently?
- The answer is in **Artificial Intelligence**.

- Perception and Action
- Memory, Attention and Consciousness
- Nuclear knowledge
- Categorization, Lexicon and Ontology
- Learning
- Language and Representation
- Choice, Rationality and Decision
- Culture and Social Cognition



AI = Study of intelligence as computing

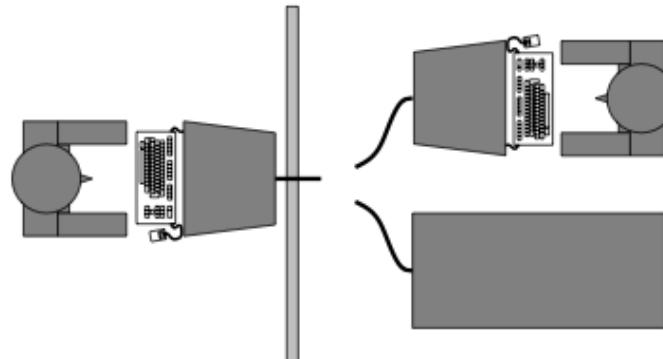
- It is one of 14 core areas of computer knowledge, according to the ACM Computing Curriculum.

- He worked with Kurt Gödel, Alonzo Church, and John von Neumann on the problem of decision, universal (Turing) machines, the breaking of the Enigma code, and the artificial brain.
- 1950: article “Computing Machinery and Intelligence ”and the Turing test.
- Program that plays chess (1953).



- “In the next 50 years, we will be able to build computers that will be good at playing the imitation game that an average questioner has only 70% opportunity to correctly identify if he or she is a person or a machine.”

in A. M. Turing “Computational Machinery and Intelligence”, Mind, 1950.



The term Artificial Intelligence gained its meaning in 1956 at the Dartmouth Conference, when it was defined as:

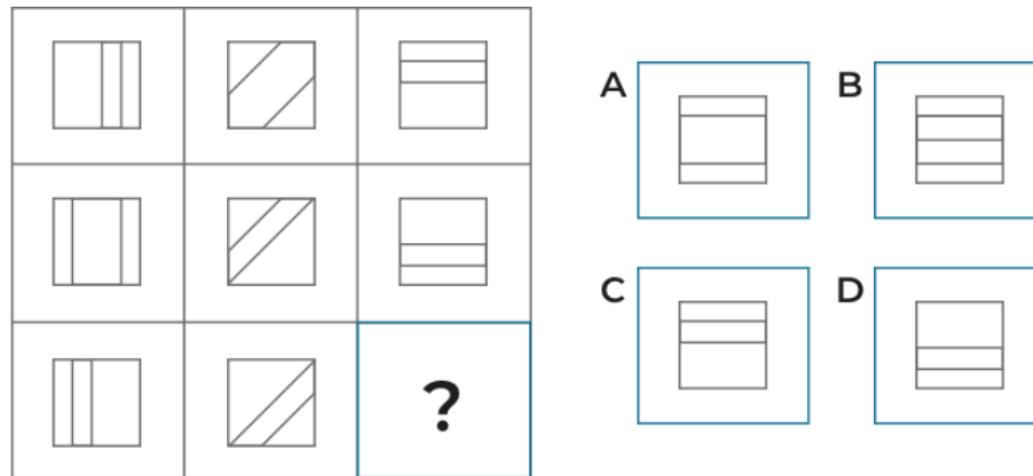
“(Artificial Intelligence is) making a machine behave in ways that would be called intelligent if a human were so behaving.”

John McCarthy.

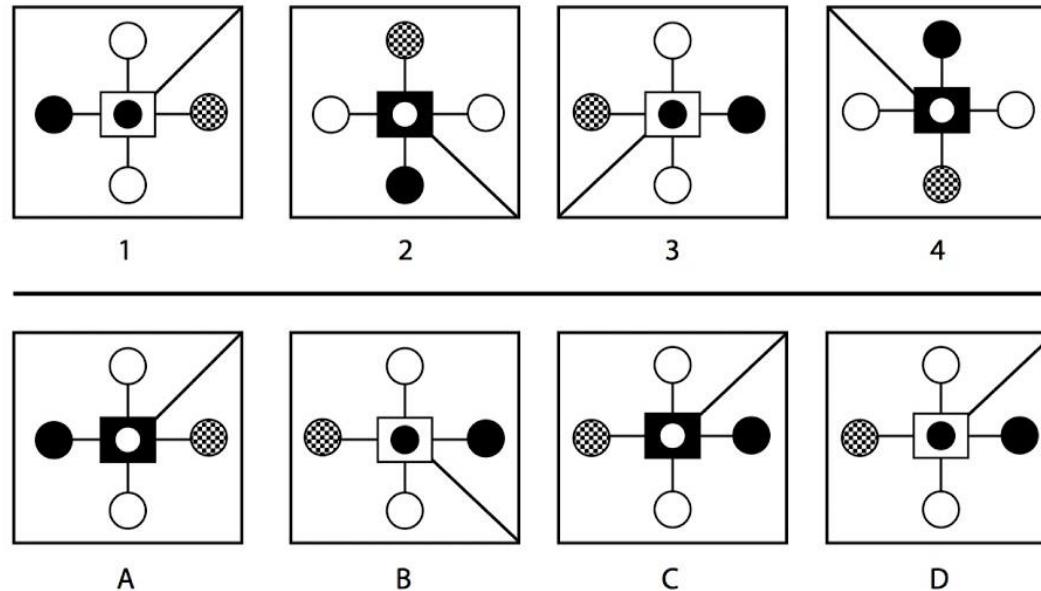
What is Artificial Intelligence (AI)?

It is **the science and engineering of making intelligent machines, especially intelligent computer programs**. It is related to the similar task of using computers to understand human intelligence, but **AI does not confine itself to methods that are biologically observable**.

John McCarthy, 2003



Source: <https://www.assessment-training.com>



Source: <https://www.youtube.com/watch?v=Ygi1HRgK4oM>

- There are several different ways to categorize AI.
- One of the most used divides AI into two strands
 - Weak AI
 - Strong AI

- Weak AI or Narrow AI
- Includes systems designed and trained to solve very specific tasks.
 - Deep Blue - Won chess in 1996, Garry Kasparov. Is Deep Blue smarter than Garry Kasparov?



- Weak AI or Narrow AI
- Includes systems designed and trained to solve very specific tasks.
 - Dendi vs. IA - Bot IA beats Dendi, DOTA 2. AI more intelligence than Dendi?



Danil "Dendi" Ishutin is a professional Dota 2 player on Natus Vincere. Well known for his solo mid skills, he is regarded as one of the most creative players in the scene today, and is renowned for his unorthodox play style and unconventional skill and item builds

- Weak AI or Narrow AI
- Includes systems designed and trained to solve very specific tasks.
 - DeepMind (Google) learns to run



- Weak AI or Narrow AI
- Includes systems designed and trained to solve very specific tasks.
 - Siri - personal assistant who answers questions through a natural language interface. Fits the user with use



- Known as General Artificial Intelligence (General AI);
- System that works at the level of a Human, in the sense that it will be able to feel, have the same sensory perception, be aware, etc...
- It is not expected to be programmed for it, it is expected to learn and evolve over time;
- Will be able to solve any problem.

- “Strong AI's ultimate goal is to make an intelligent computer that can think and understand”
 - What is thinking?
 - How do we think?
 - What does it mean to realize something?
 - How do we perceive?
 - What is being smart?
- If we can't define / understand these concepts
 - How are we going to use them?
 - How do we measure success?
 - How will we recognize intelligence / thinking / recognition / awareness?

~ 3000 BC - In Egypt, a papyrus was written associating observation of symptoms with diagnoses and their treatments in the human head. The observations resemble IF-THEN rules, common in today's Expert Systems.

~ 450 BC - Plato states that all knowledge can be established through explicit definitions, which could later be applied.

~ 322 BC - After Aristotle's death, his disciples compile the first systematic treatments on logic (Organon).

10th Century: Pope Silvester II, legend has it that had a machine that answered questions.

13th Century

Ramón Lull invents Ars Magna from the idea of Zairja, the first mechanical device that tries to generate ideas.

17th Century

Leviathan is published by Thomas Hobbes, where it is suggested that humans through their organizations or machines could create new intelligence (1651).

At only 19, Blaise Pascal invented Pascaline, an 8-digit mechanical calculator (1642).

Blaise Pascal does work on probabilistic calculus (1654).

The Leibnitz Mechanical Computer appears, which makes a multiplication by successive additions.

- **18th and 19th century**

A book with Thomas Bayes's theory of conditioned probability reasoning (1763) is published posthumously.

Charles Babbage designs his programmable mechanical computer (1832).

George Boole develops Symbolic Logic, Boole Algebra (1847).

English naturalists Charles Darwin and Alfred Wallace set out their theory of species evolution on the basis of natural selection (1858).

- Still 19th Century

Augustus De Morgan proposes a systematic treatment of logical relations (1864).

Gottlob Frege creates the Predicate Logic (1879).

The first manual mechanical calculators (1890) began to appear on the market.

Herman Hollerith patents a machine that processes census data stored on punched cards. His company, Tabulating Machine Company, originated with IBM (1890).

In the late 19th century Leonardo Torres y Quevedo invented a relay-based electric automaton that plays chess.

■ 20TH CENTURY

1913 - Andrei Markov works on sequence analysis in texts.

1915 - Leopold Lowenheim performs the systematic treatment of Model Theory in Logic.

1926 - The fiction movie Metropolis appears with the robot Maria.

1928 - John von Neumann introduces the Minimax method, used by gaming programs.

1931 - Kurt Godel presents the Incompleteness Theorem.

1937 - Alan Turing designs the Universal Turing Machine.

1937 - Alan Turing and Alonzo Church independently propose that every problem a human being solves can be reduced to a set of algorithms.

1939 Isaac Asimov writes the book "I Robot" and introduces the term Robotics.

1940 - The Robinson relay computer is used by the English to decode the messages from the German Enigma coding machine.

1945 - John Von Neumann designs the basic architecture of computers.

1945 - John Mauchley and John Presper Eckert create the Electronic Numerical Integrator and Calculator (ENIAC), the first general-purpose programmable computer.

1949 - Claude Shannon proposes Information Theory.

1950 Alan Turing proposes the Turing Test.

1951 - Marvin Minsky and Dean Edmonds build the first artificial neuronal network that simulates a mouse finding a way through a maze.

1956 - Dartmouth College meeting takes place.

- John McCarthy
- Marvin Minsky
- Ray Solomonoff
- Oliver Selfridge
- Claude Shannon
- Nathaniel Rochester
- Trenchard More
- Arthur Samuel
- Allen Newell
- Herbert Simon



- Main proponent of the Dartmouth Summer Research Project on Artificial Intelligence;
- Author of the term “Artificial Intelligence”;
- Creator of the LISP programming language in 1958.

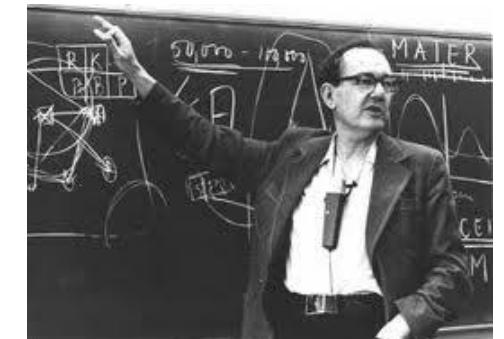


- In 1951 he built SNARC, the first simulator of a Neuronal Network;
- Develops the Blocks Microworld Project in 1967;
- MIT co-founder;
- Consultant for the 2001 Space Odyssey where the HAL 9000.



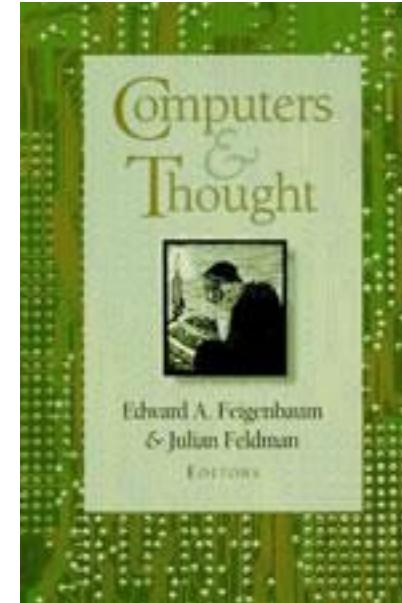
Photograph: Alamy

- Participated in the Dartmouth Summer Research Project on Artificial Intelligence;
- Created, along with Allen Newell, the Logic Theory Machine and the General Problem Solver system;
- He received the Nobel Prize for Economics for his work in the area of Decision Making in Economic Organizations.



- Computers and Thought

Edited by Edward A. Feigenbaum and Julian Feldman
1963

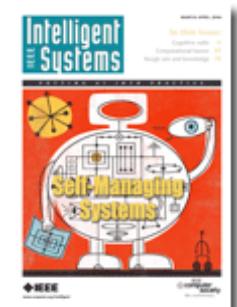


**THE DARTMOUTH
ARTIFICIAL INTELLIGENCE
CONFERENCE:
THE NEXT FIFTY YEARS**

Commemorating
the 1956 founding
at Dartmouth College
of AI as a research discipline

50th Anniversary Summit of Artificial Intelligence

Centro Stefano Franscini - Monte Verita - Switzerland
9-14 July 2006



- MIT AI Lab
- Stanford AI Lab
- CMU Robotics Lab
- Berkeley Robotics and Intelligent Machines Lab
- Edinburgh Department of AI (School of Informatics e AIAI)
- ...
- Google, Facebook, Amazon, etc
- Portugal: GIA-UMinho, CENTRIA, LIACC, LabMAg, GECAD, ...

- Symbolic: Psychology.
- Connectionist: Neurosciences.
- Reactive Robotics: Control Theory.
- Artificial Life: Biology.
- Social: Sociology, Economics.

- **Symbolic:** Linguistic Metaphor
 - e.g.: Expert systems, agents, ...
- **Connectionist:** brain metaphor
 - e.g.: Neural Networks.
- **Evolutionist:** Metaphor of Nature
 - e.g.: Genetic algorithms, artificial life.
- **Statistical / Probabilistic / Possibilistic:**
 - eg Bayesian networks, diffuse systems.

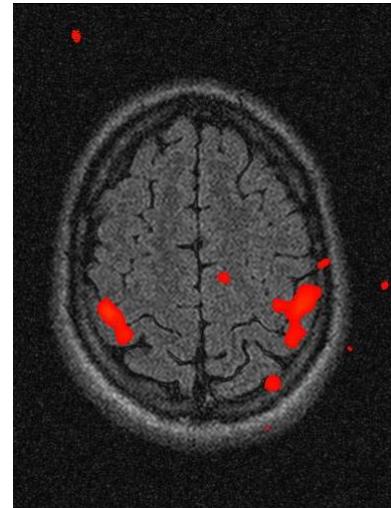
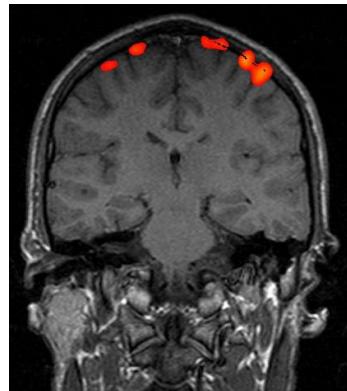
- Nobel: Lederberg (Chemistry - 1958), Simon (Economy - 1978).
- Medalha Benjamin Franklin 2003: John McCarthy
- ACM Turing: Minsky (1969), McCarthy (1971), Newell e Simon (1975), Sutherland (1988), Feigenbaum (1994), Kay (2003).
- IJCAI: Geoffrey E. Hinton (2005), Raj Reddy (2005)
- Loebner: Rollo Carpenter with “Jabberwacky” (2005)
- DARPA: Sebastian Thrun and Stanley (2005).
- Allen Newell: Jack Minker (2005).
- Software System: Robert S. Boyer, Matt Kauffman and S. Strother Moore (2005).
- MacArthur Genius Grant 2004: Daphne Koller.
- Chess 1997: Deep Blue II (IBM)

- How to predict the value of the Euro (or climate)?
- Which data is the most relevant?
- Can there be recurring behaviors?



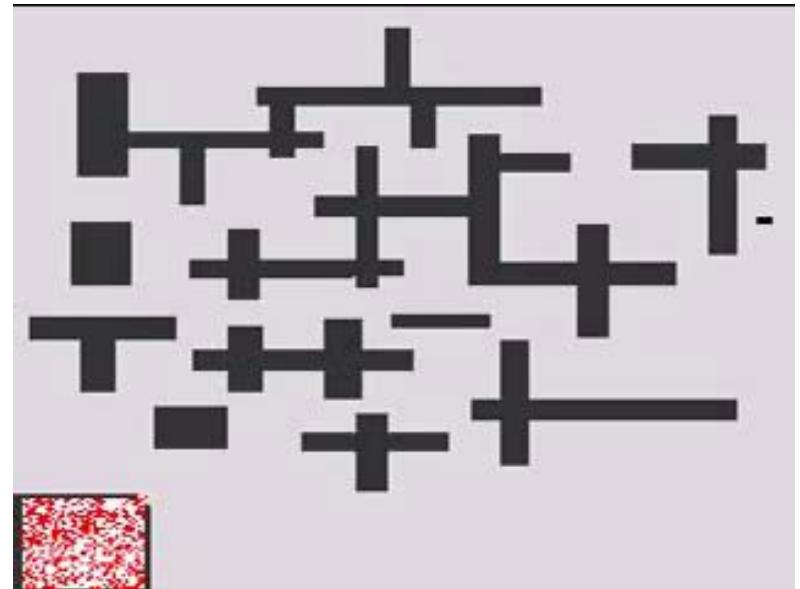
Computer vision:

Computer vision systems are widely used in both industry and medicine.



Optimization

Use of Genetic and Evolutionary Computing or Group Intelligence techniques to search for “possible” solutions rather than optimal solutions.



How to locate the relevant information?



The screenshot shows a Google search results page. The search query "artificial intelligence" is entered in the search bar. The "Pesquisar na Web" (Search the Web) radio button is selected. Below the search bar, there are links for "Pesquisa Avançada", "Preferências", and "Ferramentas de Idioma". The search results header indicates "Pesquisa de 'artificial intelligence' na Web. Resultados 1 - 10 sobre 1,170,000. A pesquisa" and a tip: "Dica: Na maioria dos navegadores, basta teclar Enter em vez de clicar no botão de pesquisa." The results list includes the MIT Artificial Intelligence Lab entry.

[MIT Artificial Intelligence](#) Lab - [Traduzir esta página]

... The **Artificial Intelligence** Laboratory has been an active entity at MIT in one form or another since at least 1959. Our goal is ...

Descrição: Aiming to understand the nature of **intelligence**, to engineer systems that exhibit such **intelligence**...

Categoria:

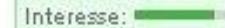
[Computers > Artificial Intelligence > Academic Departments](#)

www.ai.mit.edu/ - 22k - Em cache - Páginas Semelhantes

Links Patrocinados

[Will robots ever think?](#)

Here are the main models of cognition, so judge for yourself:
www.smithsrиска.demo

Interesse: 

[Veja a sua mensagem](#)

- How to make personalized product recommendations?
- How to model the profile of buyers?

personalogic™

START OVER

Total	2,408
Remaining	460

Type

Price

Characteristics

Components

Suspension

Manufacturer

Overall Opinion

Your Results ►

HERE ARE THE RESULTS FROM YOUR PROFILE

THINGS YOU CAN DO WITH YOUR PROFILE

SAVE PROFILE COMPARE ITEMS A # B WHY ITEMS MISSED HOW ITEMS SCORED COMBINE PROFILES

YOUR RATING - FROM THE MOST IDEAL ON DOWN
CLICK ON ANY ITEM FOR COMPLETE INFORMATION

1 [Novara Ponderosa - \\$895.00](#) YOUR PERSONALOGIC™ SCORE [progress bar]

2 [Scott Vail - \\$699.00](#)

3 [KHS Summit X - \\$699.00](#)

4 [VooDoo Erzulie - \\$799.00](#)

5 [KHS Descent X - \\$799.00](#)

6 [VooDoo Erzulie - \\$849.00](#)

7 [Alpine Designs XC-3.5 - \\$799.99](#)

8 [Dirt Research Bandelier - \\$880.00](#)

How important to you are the following characteristics?

Bicycle characteristics will be most important to people who want to ride aggressively. If you don't plan to ride fast or tackle trails, we suggest that you skip this page and continue to the next.

Frame durability is the bike frame's ability to resist denting, cracking, and bending. The type of material used in the frame determines its durability.

No Opinion ↓ Somewhat Very Extremely →



The **weight** of the bike includes the components and wheels, not just the frame.

No Opinion ↓ Somewhat Very Extremely →



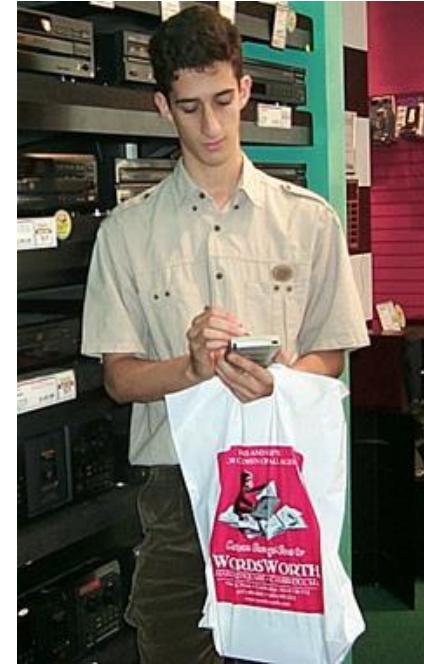


Grocer Project - Enabler

Personal Assistant in Automatic Transactions

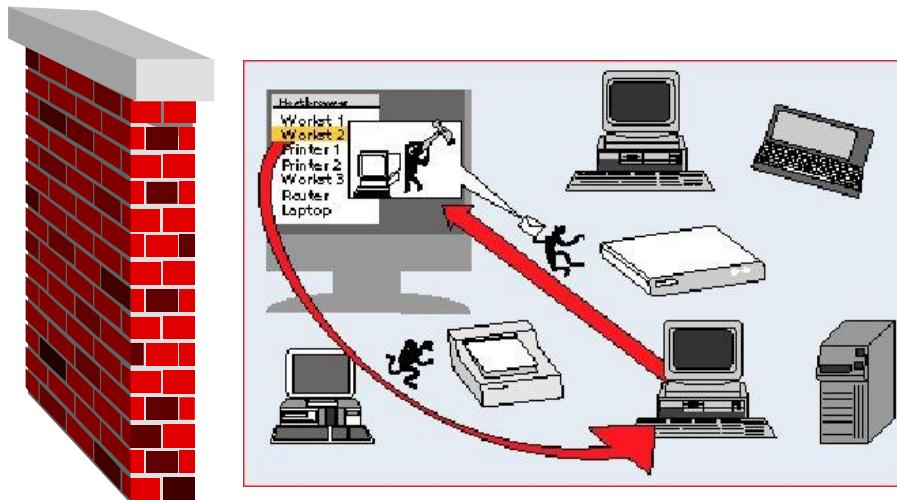


Source: MIT

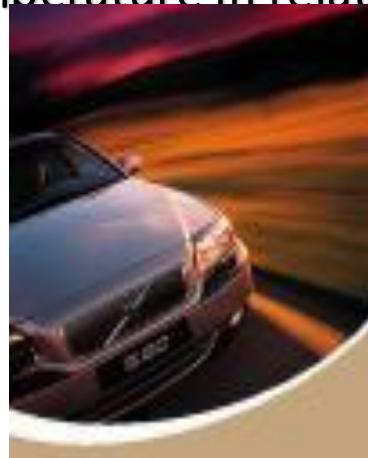


Intrusion Detection and Spam Filtering

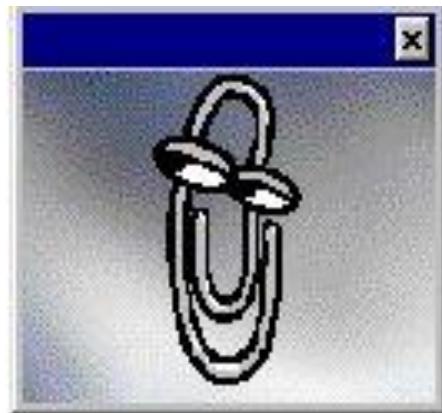
- How to tell if a message is junk or in fact matters?
- How to tell if user behavior is suspicious and how to deal with it?



- How to brake the car without the wheels sliding depending on speed, friction, etc.?
- How to focus the camera according to brightness, distance, etc.?
- How to adjust the temperature in relation to the amount of clothes, water flow, etc.?

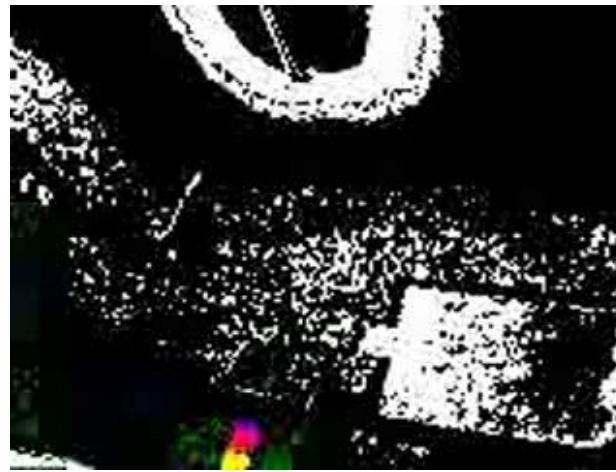


- How to provide the user with the help he needs?
- How to interact (and maybe surf the web)?



Computer Vision:

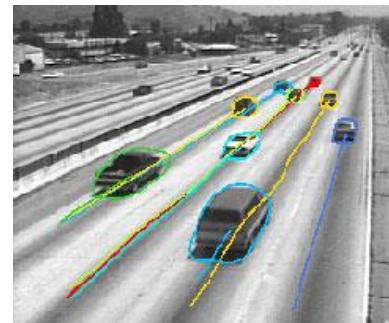
Vision as a sensor of the environment.



- Robots for playing soccer (RoboSoccer):



- Intelligent, real-time surveillance of urban traffic (cities and highways):



Google Self-Driving Car Project

- Car (Electric) self-developed by Google;
- Google Chauffeur Software;



- This project was previously led by Sebastian Thrun, former director of the Intelligence Laboratory of Stanford Artificial and Google Street View co-inventor.

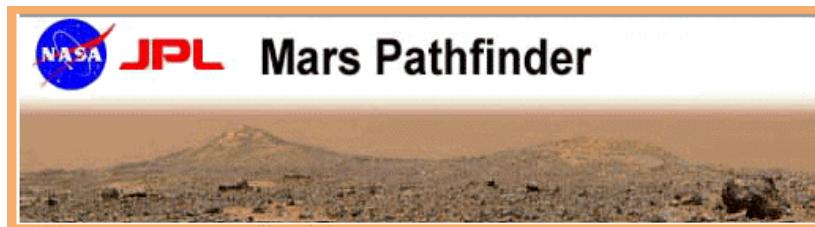


Google Self-Driving Car Project

Autonomous vehicles along 212 km of the Nevada desert: Stanley winner against CMU.



Sebastian Thrun of Stanford University beat the 3 teams from CMU, which had in turn beat MIT Rodney Brooks at the NASA Mars Mission Contest (STANLEY, 2005).





Stop Searching. Start Sourcing.

SITE MAP

Welcome Back manuela cunha

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Total Value Of Open RFQs

In Millions (USD)



Date	Total Value (USD Millions)
Jul-29	~65
Aug-04	~35
Last 14 Days	~15
Aug-11	~18

Buyers with Open RFQs

Designs, Inc. BioTrove AU

Value of Open RFQs

Today's Total \$ 24,442,388

Machining \$ 12,521,559

Casting \$ 1,848,339

Cold Forming \$ 1,828,300

Stamping \$ 1,674,270

Molding \$ 1,615,372

Gears \$ 1,114,264

Extrusions \$ 863,688

Powdered Metal \$ 819,701

Fabrication \$ 782,653

Assembly \$ 523,777

Die Making \$ 383,700

Coating \$ 220,786

Gaskets/Rings/ \$ 61,061

Forging \$ 58,173

Tubing \$ 25,000

Bearings \$ 22,500

Material, Raw \$ 18,000

Woodworking \$ 13,773

Mold Making \$ 13,475

Rapid Prototyp \$ 11,416

Engraving / Ma \$ 10,547

If Lockheed Martin Trusts
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Enough For Your Business.



You're Cleared For Takeoff.

Sourcing Professionals & Engineers



Find the right suppliers to complete your project on time and within budget. MfgQuote is the single fastest way to go from RFQ to finished part. More...

[Start Sourcing Online Now](#)



Suppliers & Job Shops

Find new Customers now. MfgQuote gives you access to over 40,000 registered buyers and engineers. Its the most powerful new business tool ever created. More...

[Take a Test Drive Now](#)

Below is a Sample of RFQs for Quoting Right Now!

Machining



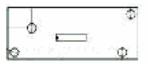
RFQ Qty: 8 ; 80

Annual Usage: 80

Material: steel

Place: SARASOTA FL

Machining



RFQ Qty: 1 ; 10

Annual Usage: 10

Material: Steel

Place: SARASOTA FL

Machining



RFQ Qty: 1

Annual Usage: 1

Material: HRS

Place: TROY MT

MfgQuote In The News

50,000th RFQ Posted...

MfgQuote Named To Sup & Demand Chain Execut Top 100...

MfgQuote Adds Todd Cr as Director of Marketing

Fabricating & Metalwork Manufacturing's Matchm

Production Machining Make It To The Top Of Search Engines' Lists

[more news](#)

Buyers | Suppliers

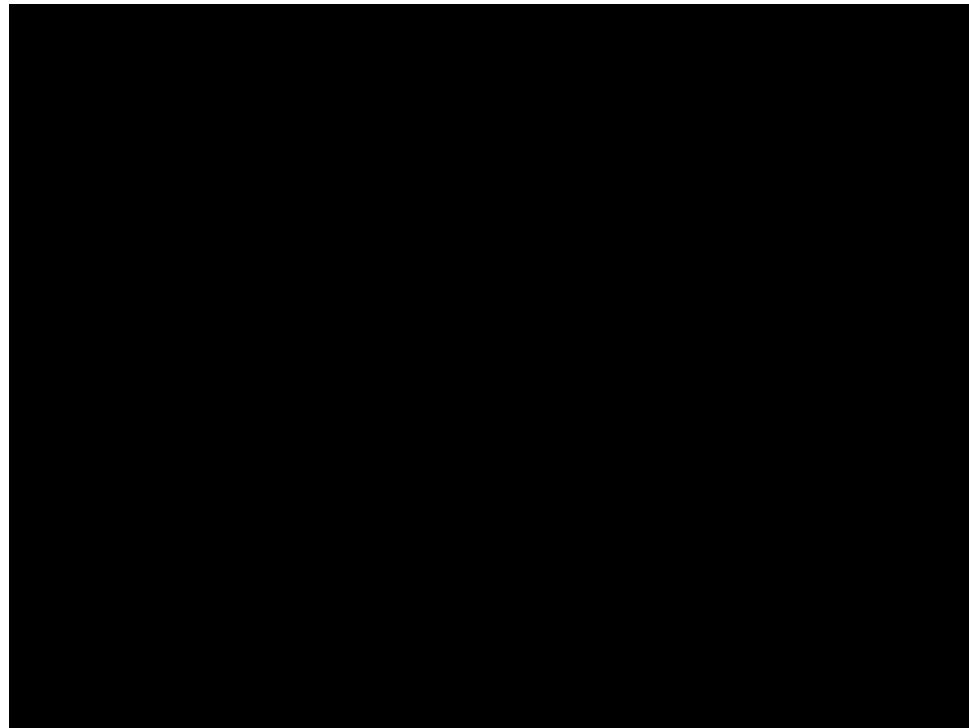
Video Message to Buyer

[Buyer Brochure](#)

[Supplier Brochure](#)

[CS Brochure](#)

Microsoft Home TV Commercial



At Home

- EMBASSI: Context Awareness



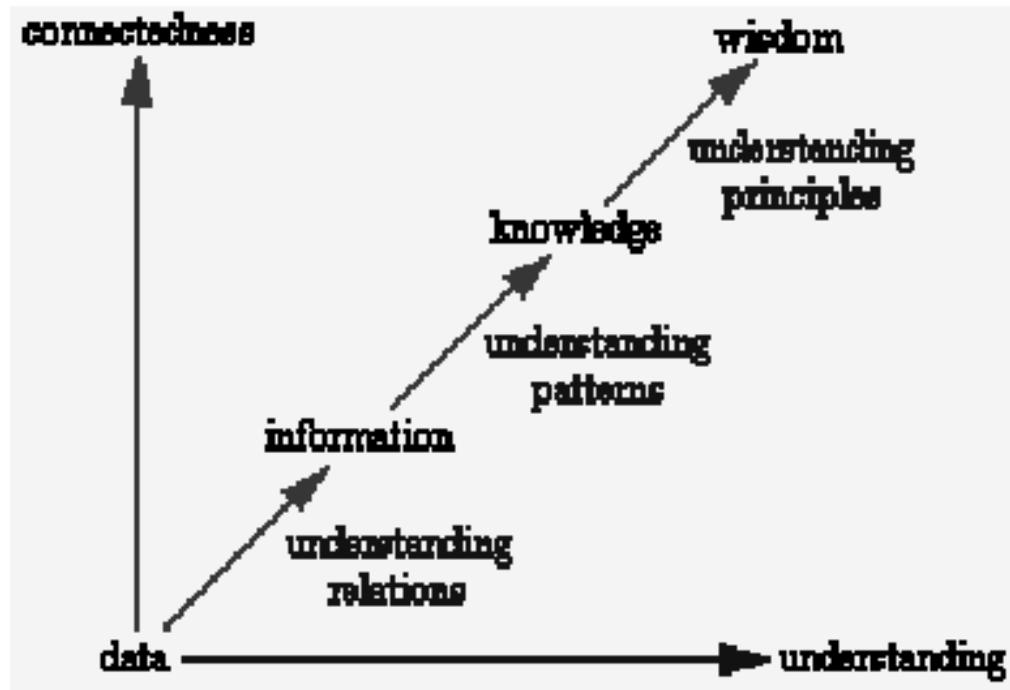
- Philips HomeLab, entertainment at WC mirror

Tourism and Culture



What do these problems have in common?

- Great complexity (number, variety and nature of tasks);
- There is no “algorithmic solution”, but there is knowledge;
- Intelligent behavior modeling (knowledge, learning, initiative, etc.).



Kulsch, 2001

- (Feigenbaum and Feldman, 1963) Computers and Thought
- (Minsky, 1968) Semantic Information Processing
- (Michie, 1968) Machine Intelligence 3
- (Banerji, 1969) Theory of Problem Solving
- (Simon, 1969) The Sciences of the Artificial
- (Minsky and Papert, 1969) Perceptrons
- (Nilsson, 1971) Problem-Solving Methods in AI
- (Winograd, 1972) Understanding NL
- (Minsky, 1972) Computation, Finite and Infinite Machines
- (Newell and Simon, 1972) Human Problem Solving
- (Michie, 1974) On Machine Intelligence

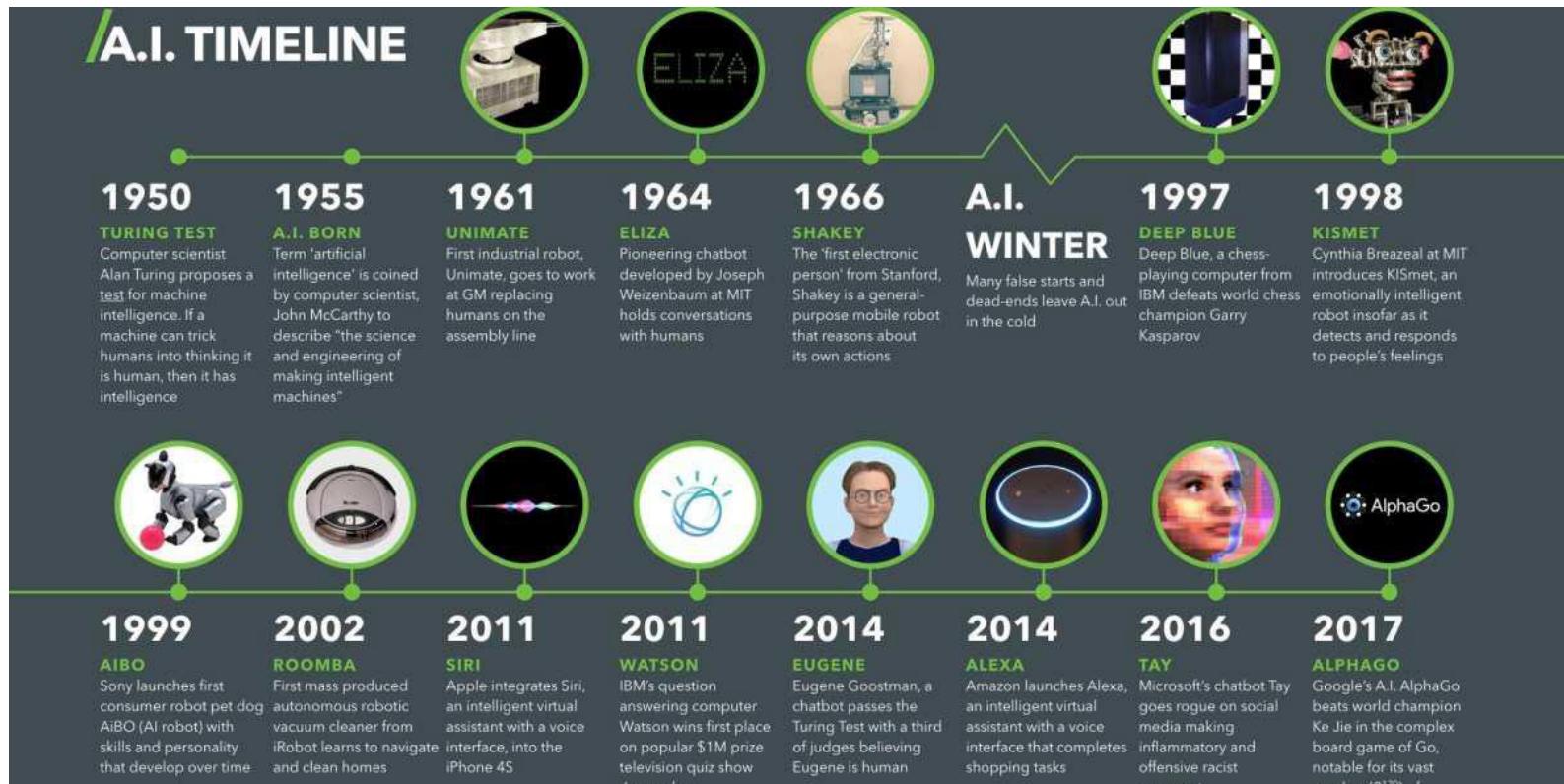
- (Coelho, Moniz Pereira and Cotta, 1979) "How to solve it with PROLOG".
- (Nilsson, 1980) Principles of AI
- (Winston, 1984) Artificial Intelligence
- (Minsky, 1986) The Society of Mind
- (Genesereth and Nilsson, 1987) Logical Foundations of AI
- (Coelho and Cotta, 1988) Prolog by Example, How to Learn, Teach and Use it
- (Newell, 1990) Unified Theories of Cognition
- (Rich e Knight, 1991) Artificial Intelligence
- (Ginsberg, 1993) Essentials of AI

- (Russell and Norvig, 1995) AI A Modern Approach
- (Dean, Allen and Aloimonos, 1995) AI Theory and Practice
- (McCarthy, 1996) Defending AI Research
- (Mitchell, 1997) Machine Intelligence
- (Nilsson, 1998) AI: A New Synthesis
- (McDermott, 2001) Mind and Mechanism
- (Baum, 2004) What is Thought?
- (Pedro Domingos, 2015) The Master Algorithm
- (Nick Bostrom, 2017) Superintelligence: Paths, Dangers, Strategies
- (Arlindo Oliveira, 2018) The Digital Mind: How Science Is Redefining Humanity
- (Max Tegmark, 2018) Life 3.0: Being Human in the Age of Artificial Intelligence
- (Stuart Russel, 2019) Human Compatible : AI and the Problem of Control
- (Marcus and Davis, 2019) Rebooting AI: Building Artificial Intelligence We Can Trust

- AI (improves / improves) as people use it.
- It is us?
- When we look at AI we see not a single program, but an aggregation of several software and multiple agents.

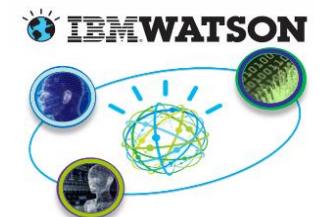
Goal:

- Helping humans to think and act smarter.



Source: Paul Marsden
<https://digitalwellbeing.org/artificial-intelligence-timeline-infographic-from-eliza-to-tay-and-beyond/>

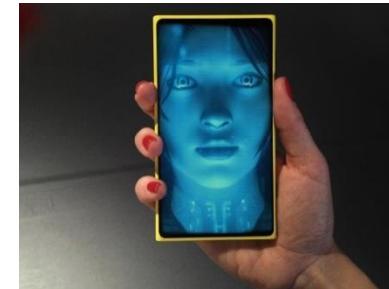
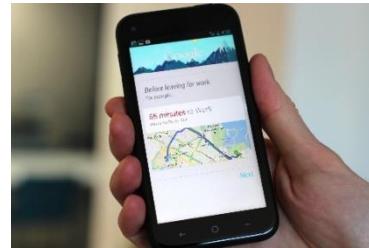
- In February 2011, Watson beat the two best players in the USA program TV Jeopardy (Brad Rutter and Ken Jennings);
- Watson represents an important step in the development of cognitive systems.
- It uses Natural language processing, generation and evaluation of hypotheses and learning.
- Deep QA



- The AI returned for good (at least until further disappointment...)
- AlphaGo (Google) Wins Go World Champion, Not using brute force (Impossible) but using Strategy/Complexity Reduction
- Algorithm paints a Rembrandt
- WaveNet (Google) able to create speech with different accents and music
- Facebook, Amazon, Google, IBM and Microsoft Create AI Partnership
- Drone captures other drones autonomously
- Google's translation tool "accidentally" invents a language of its own in Korean <-> Japanese translation
- OpenAI (Elon Musk) makes Universe available
- ...



- Siri (Apple iPhone);
- Messenger (Facebook);
- Google Now (Google);
- Cortana (Windows Phone, Microsoft).



- Personal photo archivist;
- Self driving car (Toyota brevemente);
- Universal translator (Skype);
- Body tracker (Microsoft Xbox Kinect tv);
- Smarter news feed (voice and image recognition software).

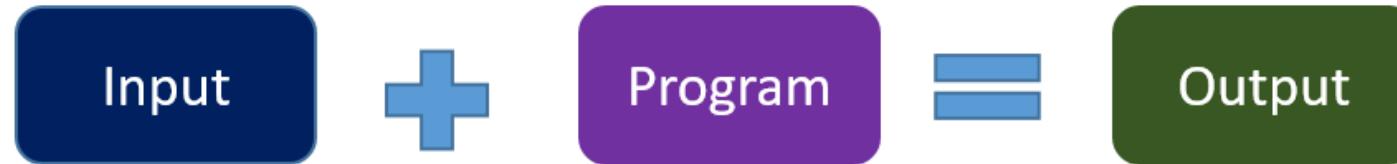
“In the years ahead, further exciting innovations will unify the software, hardware and services in people’s lives, offering them even richer, more engaging and deeply connected experiences.”



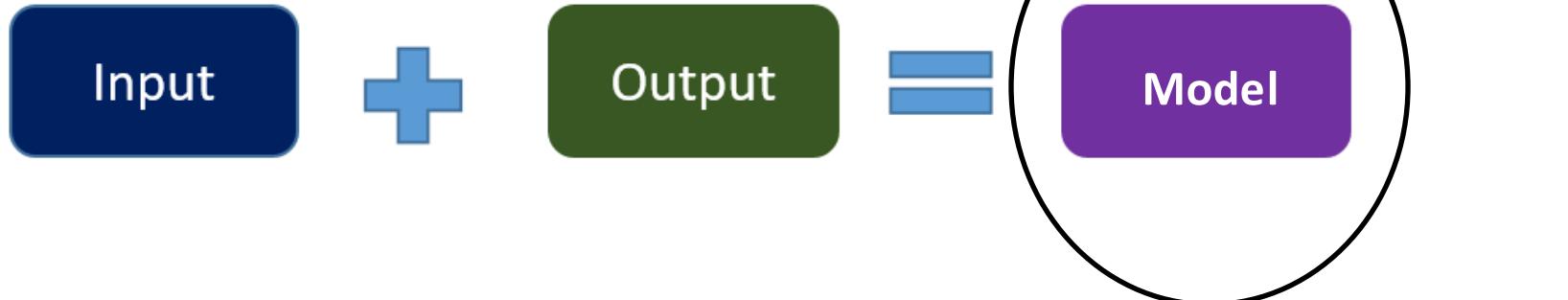
Bill Gates, Outlines Vision for the Digital Lifestyle (2006)

- From intelligence to instinct and intuition;
- Citizen empowerment (como mecanismo de inclusão);
- Contactless services;
- Smart mobility;
- Smart cities and transports;
- Cyber security and identity.

Programming



Machine Learning



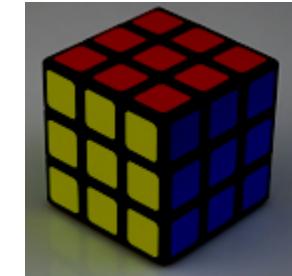
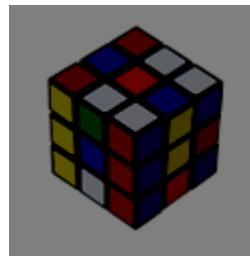
Deduction		Induction	
All humans are mortal.	(Axiom)	Socrates is human.	
Socrates is human.	(Fact)	Socrates is mortal.	
<i>Conclusion:</i>		<i>Generalization:</i>	
Socrates is mortal.		All humans are mortal.	

Deduction: from general to specific \Rightarrow **proven** correctness

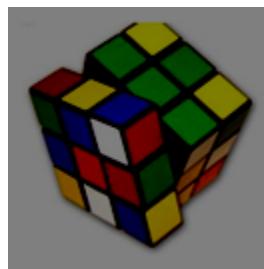
Induction: from specific to general \Rightarrow (**unproven**) knowledge gain

**Induction generates hypotheses
not knowledge!**

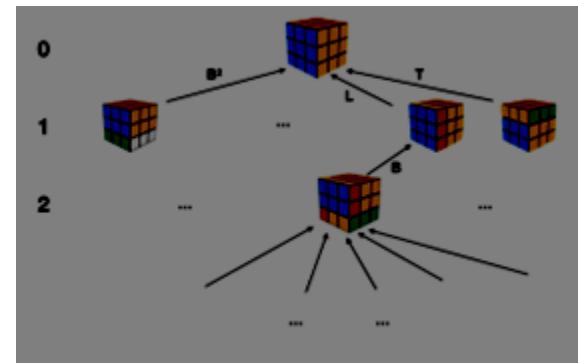
- Initial state
- goal (Final state)

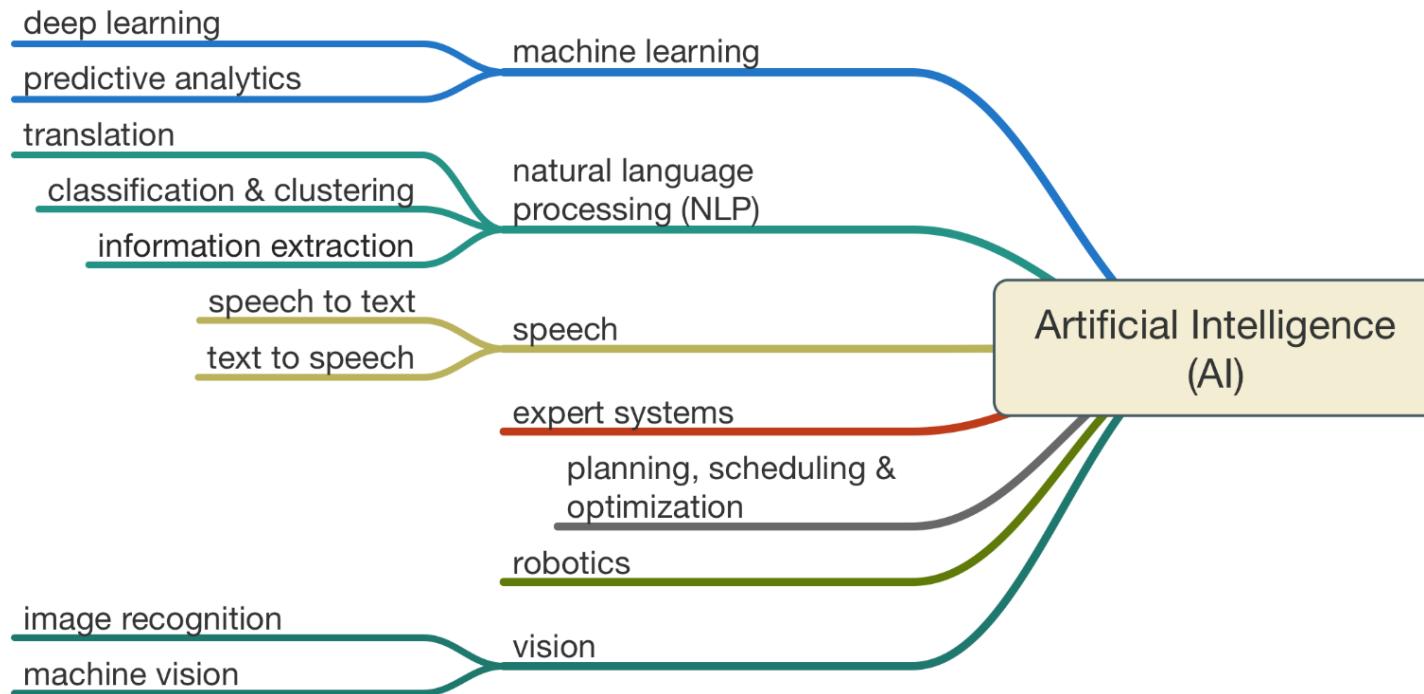


- change state with an action

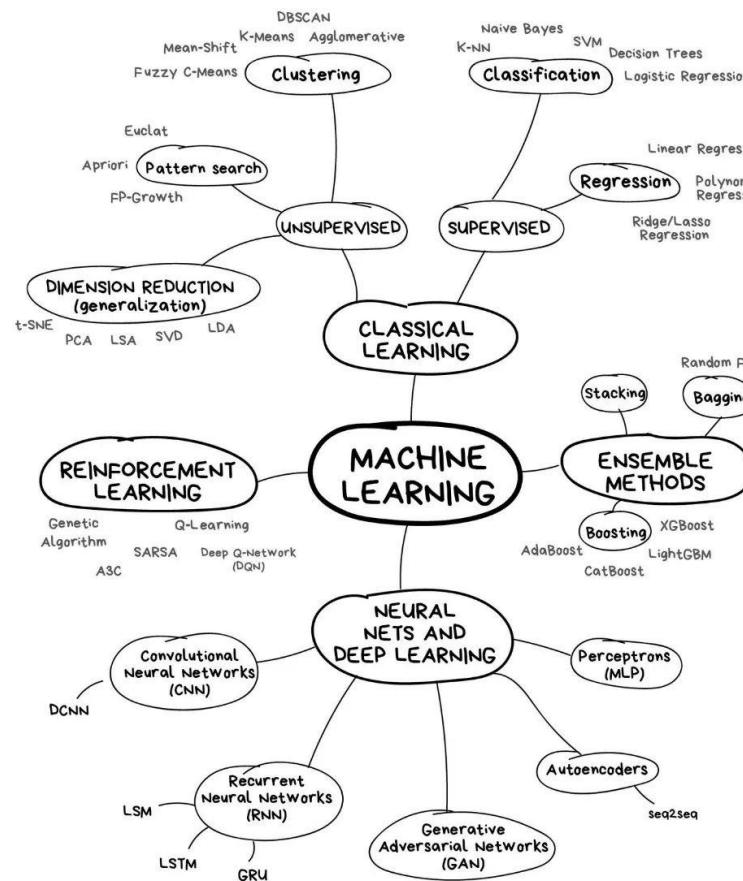


- state space

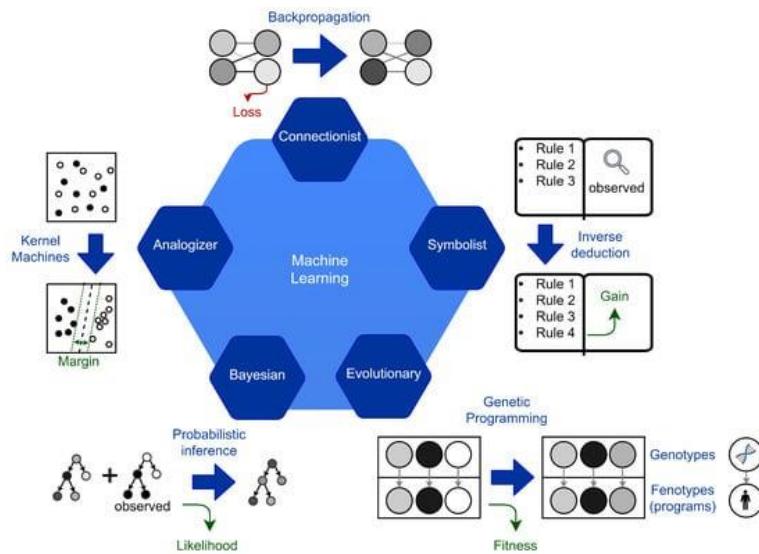




Source: Fields of artificial intelligence
Mills, M. "ARTIFICIAL INTELLIGENCE IN LAW: THE STATE OF PLAY"
<http://bloghs.neotalogic.com/state-of-play>.



Source: The map of the machine learning world
Vasily Zubarev (vas3k.com)



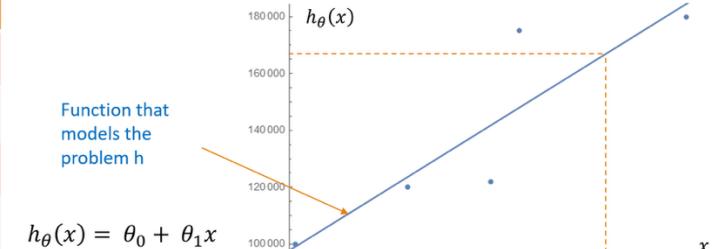
Source: Vaccaro, L.; Sansonetti, G.; Micarelli, A. An Empirical Review of Automated Machine Learning. Computers 2021, 10, 11. <https://doi.org/10.3390/computers10010011>



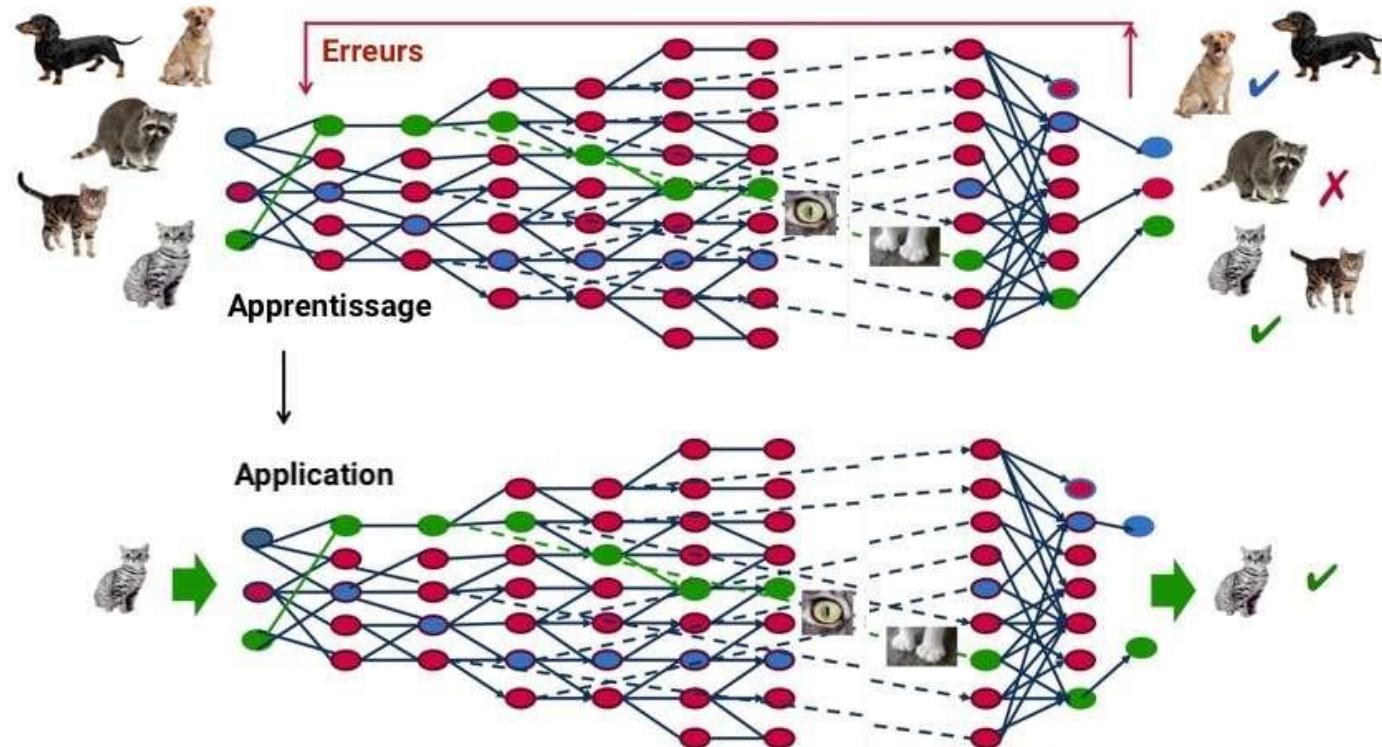
Pedro Domingos
The 5 Tribes of the Machine Learning

House prices by area

Area	Price
120	175000
150	180000
80	100000
100	120000
115	122000



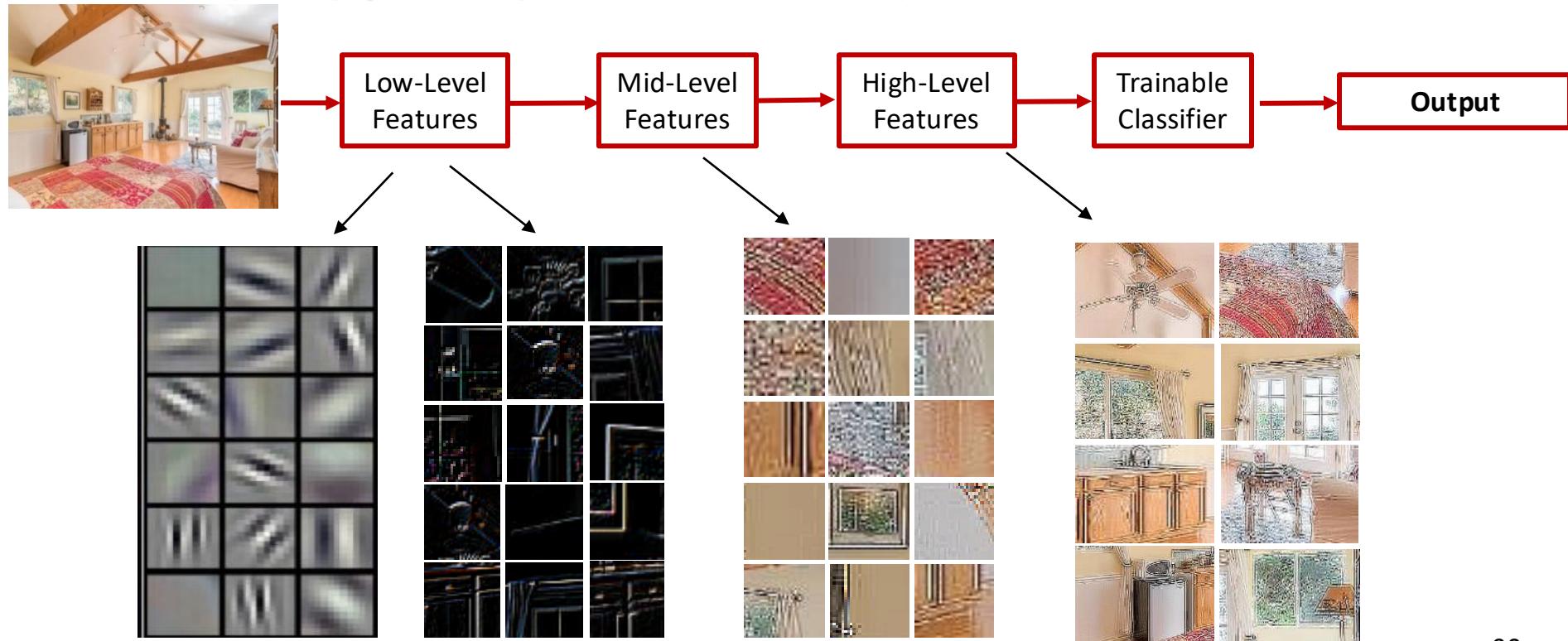
The issue of the moment: Deep(Dep(Dep)) Learning



Source:
<https://www.futura-sciences.com/tech/definitions/intelligence-artificielle-deep-learning-17262/>

DL applies a multi-layer process for learning rich hierarchical features (i.e., data representations)

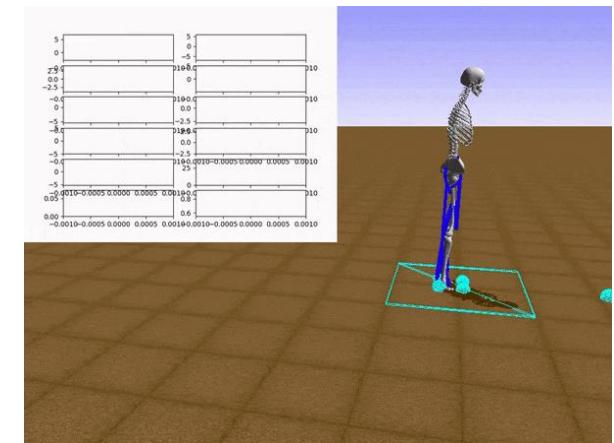
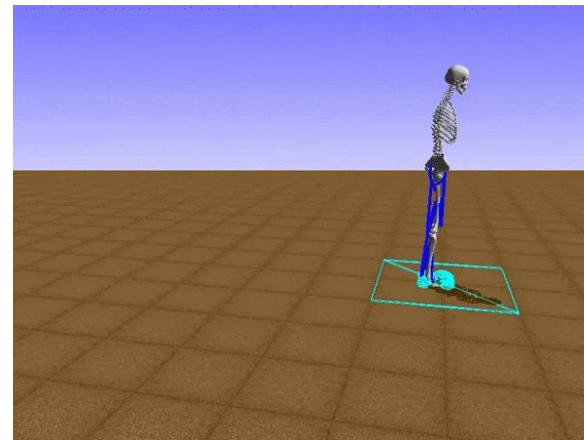
- Input image pixels → Edges → Textures → Parts → Objects





Reinforcement Learning

Source: Machine Learning for Everyone
https://vas3k.com/blog/machine_learning/



Source: Learning to run – an example of reinforcement learning
<https://deepsense.ai/learning-to-run-an-example-of-reinforcement-learning/>

- **General AI**

- A (intelligent) machine with the capacity to understand, learn and perform any human intellectual task;
- Intuition, instinct, consciousness, self-awareness, sentience, sapience, self-determination, etc.

- **Most of the existing AI tech work differently than human intelligence;**

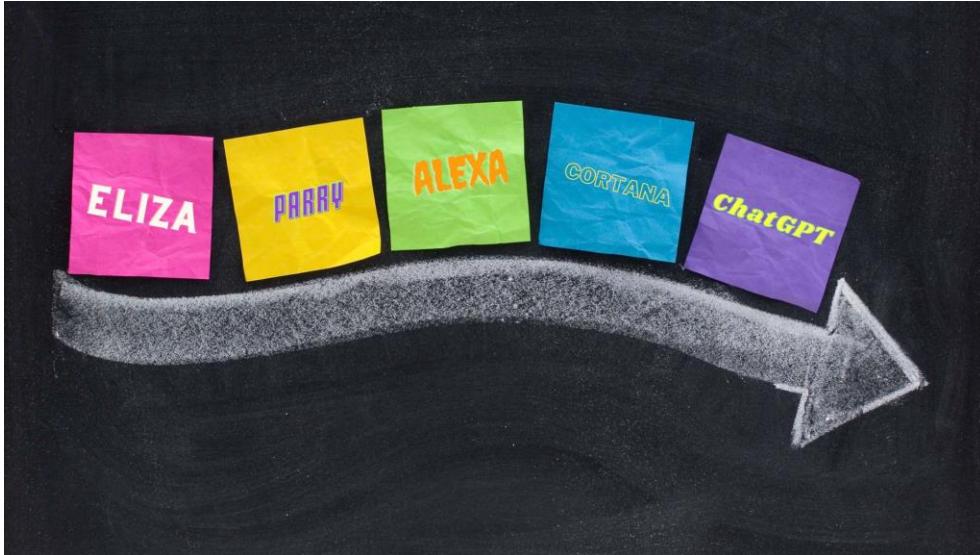
“the development of full artificial intelligence could spell the end of the human race”
Stephen Hawking

The creation of super intelligence as “summoning the demon”
Elon Musk



OpenAI (Microsoft and Elon Musks) receives 1\$ Billion USD funding to create AI that replicates the human brain (GAI), 2019.

Suddenly, the world has changed ChatGPT



Source: The History Of Chatbots – From ELIZA to ChatGPT
<https://onlim.com/en/the-history-of-chatbots/>

“ChatGPT is a large language model trained by OpenAI (OpenAI,2021). It is designed to assist users in generating human-like text based on given input. ChatGPT can be used for a variety of tasks, including conversation generation and language translation.

The model is trained on a massive amount of data, allowing it to generate text that is often difficult to distinguish from text written by a human. ChatGPT has been praised for its ability to generate natural-sounding text and its potential applications in a variety of fields.

By the way – this abstract was created by ChatGPT.”

- **Generative AI** is a type of AI technology that can produce various types of content, including text, images, audio and synthetic data;
- It does this by **learning patterns** from existing data, and then using this knowledge to generate new and unique outputs in response to prompts;
- Output: highly realistic and complex content that **mimics human creativity**;
- Using **Large language models (LLM)** are language models consisting of a very large neural network with billions of weights, trained on very large quantities of unlabelled text using self-supervised learning.

Generative AI's evolution

For an advanced technology that's considered relatively new, generative AI is deep-rooted in history and innovation.

1932	George Aranun invents a machine that reportedly called the "mechanical brain" to translate between languages on a mechanical computer that uses punch cards.
1966	MIT professor Joseph Weizenbaum creates ELIZA, the first multimodal AI that can manipulate and reason out a world of blocks according to instructions from a user.
1980	Michael Tog and Glenn Whitman develop the Unix-based game which uses procedural content generation to dynamically generate new game levels.
1986	Michael Jordan lays the foundation for the modern use of recurrent neural networks (RNNs) with his work on "Serial Order: a parallel distributed processing approach."
2000	University of Montreal researchers publish "A Neural Probabilistic Language Model," which suggests a method to model language using feed-forward neural networks.
2011	Apple releases Siri, a voice-powered personal assistant that can generate responses and take account of users' voice requests.
2013	Google researcher Tomas Mikolov and colleagues introduce word2vec to identify semantic relationships between words automatically.
2015	Stanford researchers publish a paper on diffusion models in the paper "Deep Unsupervised Learning using Nonequilibrium Thermodynamics." The researchers introduce the process of adding reverse-engineer noise to a final image.
2018	Google researchers introduce BERT, which is trained on more than 3.3 billion words and can make predictions based on the context between words in sentences, paragraphs and even books to predict the meaning of the entire document.
2021	Google DeepMind researchers develop Alphafold for predicting protein structures, laying the foundation for many other applications in medical research, drug development and chemistry.
2022	OpenAI releases GPT (Generative Pre-trained Transformer), which is trained on 40 gigabytes of data and consisting of 117 million parameters, or 17 times more than subsequent LLMs, and includes content generation, chatbots, and language translation.
2023	Researchers from Bloomberg Research, Stability AI and CompVis release Stable Diffusion as open source code that can automatically generate image content from text prompts.
2023	OpenAI releases ChatGPT in November to provide a chat-based interface to its GPT 3.5 LLM. It attracts over 100 million users within two months, representing the fastest user consumer adoption of a service.

Source: https://www.semanticscience.org/generative-ai.html

ChatGPT

 Examples	 Capabilities	 Limitations
"Explain quantum computing in simple terms" →	Remembers what user said earlier in the conversation	May occasionally generate incorrect information
"Got any creative ideas for a 10 year old's birthday?" →	Allows user to provide follow-up corrections	May occasionally produce harmful instructions or biased content
"How do I make an HTTP request in Javascript?" →	Trained to decline inappropriate requests	Limited knowledge of world and events after 2021

Source: <https://openai.com/blog/chatgpt>

	DALL-E 2	stable Diffusion	craiyon	lexica	MetStable
Text-to-Image (T2I)	Imagen	wombo	NightCafe	GauGAN2	DeepAI
	Wonder	pixray-text2image	neural love	Omnekky	alpaca
	image.space	KREA	Nyx + gallery	>ROSEBUDAI	PhotoRoom
Text-to-Video (T2V)	runway	Flik!	○-synthesis	○ MetaAI	Google AI
Text-to-Audio (T2A)	Play.ht	MURFA!	RESEMBLE.AI	WELLSAID	descript
	Simplified	Jasper	frase	eleutherAI	Regustry
	grammarly	COPY.ai	MarketMuse	AI21Labs	HubSpot
Text-to-Text (T2T)	InferKit	GooseAI	ResearchAI	Writsonic	cohere
	Ideas AI	copysmith	Flowrite	WICHNESS	sudo write
	ideasbyai	text.cortex	OpenAI GPT-3	Blog Idea Generator	Rytr
	HyperWise	Subtxt	WRITER	wordline	LATKA
	Moonbeam	BerthaAI	anyword	Hypotenuse AI	Peppertype.ai
Text-to-Motion (T2M)	TREE	MDM: Human Motion Diffusion Model			
Text-to-Code (T2C)	replit	Ghostwriter	Github Copilot	MUTABLE AI	tobin9ne
	Amazon CodeWhisperer				
Text-to-NFT (T2N)	LensAI				
Text-to-3D (T2D)	DreamFusion	CLIP-Mesh	GET3D		
Audio-to-Text (A2T)	descript	AssemblyAI	Whisper		
Audio-to-Audio (A2A)	AudioLM	NN-VOICEMOD			
Brain-to-Text (B2T)	speech from brain	non-invasive brain recordings			
Image-to-Text (A2I)	neural love	GPT-3 x Image Captions			

GPT-4 CONTEXT WINDOW (MAX IN/OUT LENGTH)



GPT-1



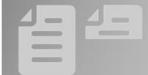
GPT-3



GPT-3.5



GPT-2



768w
1½ pages



GPT-3



1,536w
3 pages



GPT-3.5



3,000w
6 pages

GPT-4 (8k/32k)



24,000 words
48 pages

Not to scale. Using rounded figures of 1 token = 0.75 words (e.g. 32,000 tokens = 24,000 words), 500 words = 1 page. Paper icons created by Angara – FlatIcon. Alan D. Thompson, March 2023. <https://lifearchitect.ai/gpt-4/>



LifeArchitect.ai/gpt-4

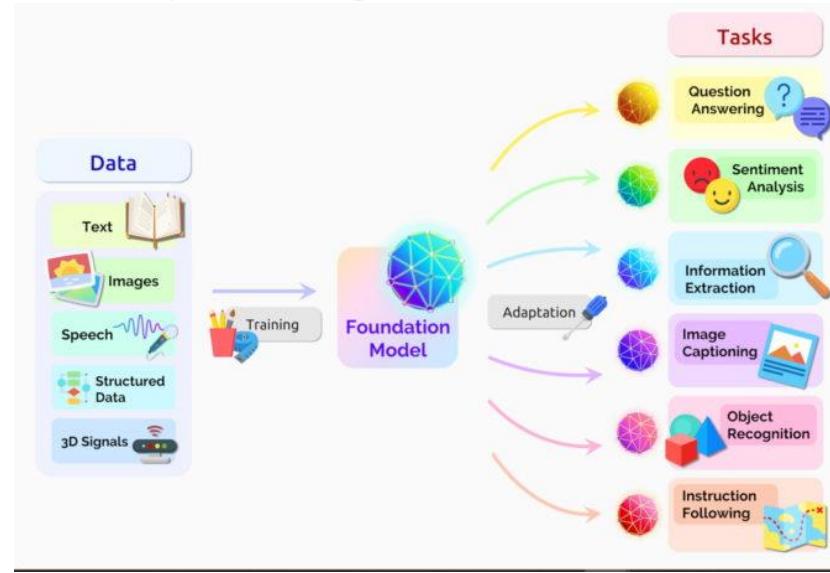
GPT-4 VS HUMAN TESTS (APR/2023)



Selected highlights only. Percentiles; 50 refers to the 50th percentile as average, and may not be the testing average for some tests. Alan D. Thompson. April 2023. <https://lifearchitect.ai/iq-testing-ai/>



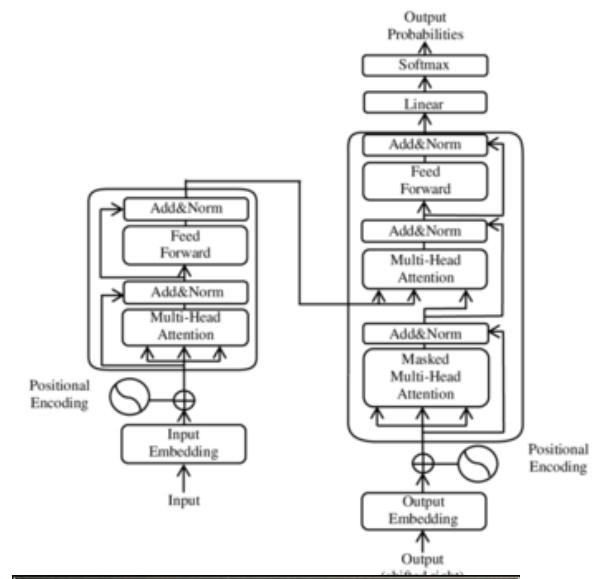
[LifeArchitect.ai/iq-testing-ai](https://lifearchitect.ai/iq-testing-ai/)



Source: <https://blog.nvidia.com.br/2022/04/19/o-que-e-um-modelo-transformer/>

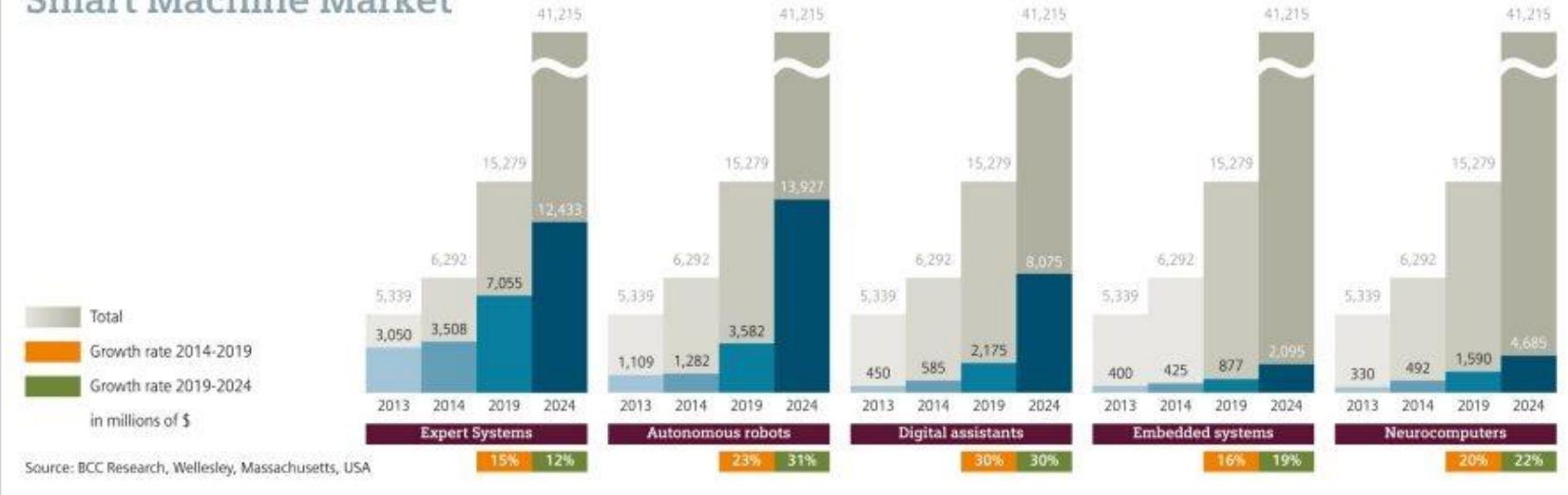
"Attention is all we need":
<https://arxiv.org/abs/1706.03762>

Transformer!



- Emotions;
- Non-determinism;
- Intelligent agents;
- Environment Intelligence;
- Increased intelligence.
- ...
- Entities with “Free Will”.

Autonomous Robots to Surpass Expert Systems: Forecast Share of the Smart Machine Market



Source: BCC Research

“AI will help us solve big problems in genomics, energy, and climate science.” Eric Schmidt, Google Chairman, Sept 14, 2015.

“Google wants to be the best in search. To reach that goal Google wants to have the world’s top AI research laboratory.” Larry Page, Google, 2006

“Siri and virtual assistants like her will soon change everything. I. Mean. Everything.” Mike Elgan, in Computerworld, Sep 21, 2015

**“Our Intelligence is what makes us human, and
AI is an extension of that quality.”**

Yann LeCun (A.M. Turing Award 2018)

Artificial Intelligence: Past, Present and Future

LICENCIATURA EM ENGENHARIA INFORMÁTICA
MESTRADO integrado EM ENGENHARIA INFORMÁTICA
Inteligência Artificial
2025/26