

Summer School in Artificial Intelligence

Introduction to Artificial Intelligence

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Let's start

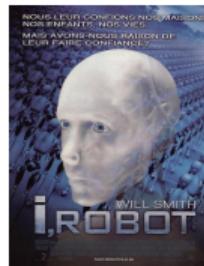
Small survey

What is Artificial Intelligence for you ?

Let's start

Small survey

What is Artificial Intelligence for you ?



Definition attempt

Artificial Intelligence is..

... a discipline of computer science whose purpose is to build **intelligent** programs or systems.

Definition attempt

Artificial Intelligence is..

... a discipline of computer science whose purpose is to build **intelligent** programs or systems.

- ▶ What is a system ?
- ▶ What is intelligence ?

Tasks that can be accomplished with intelligence

Example : Games

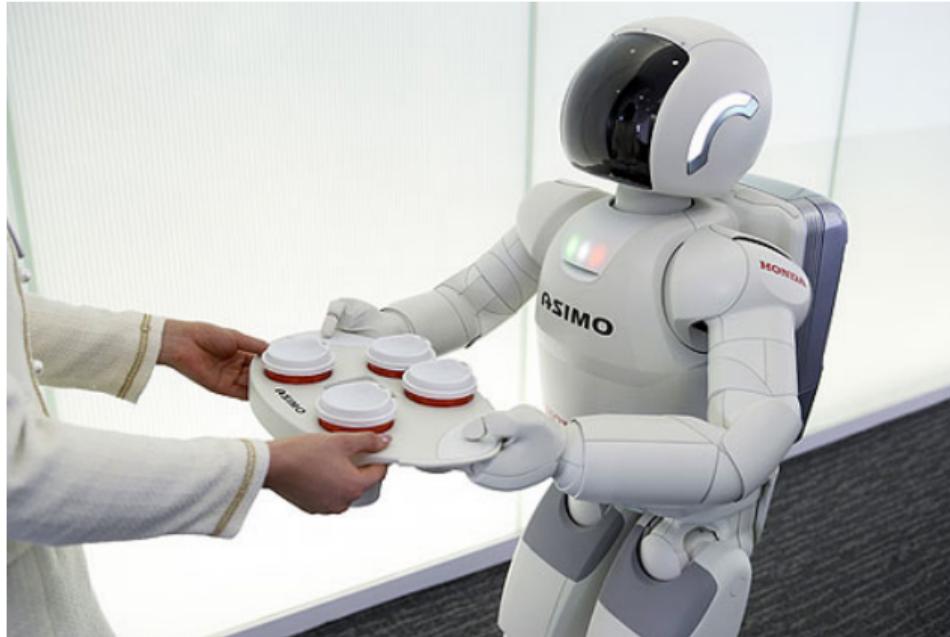
Decision making



Tasks that can be accomplished with intelligence

Example : Robotics

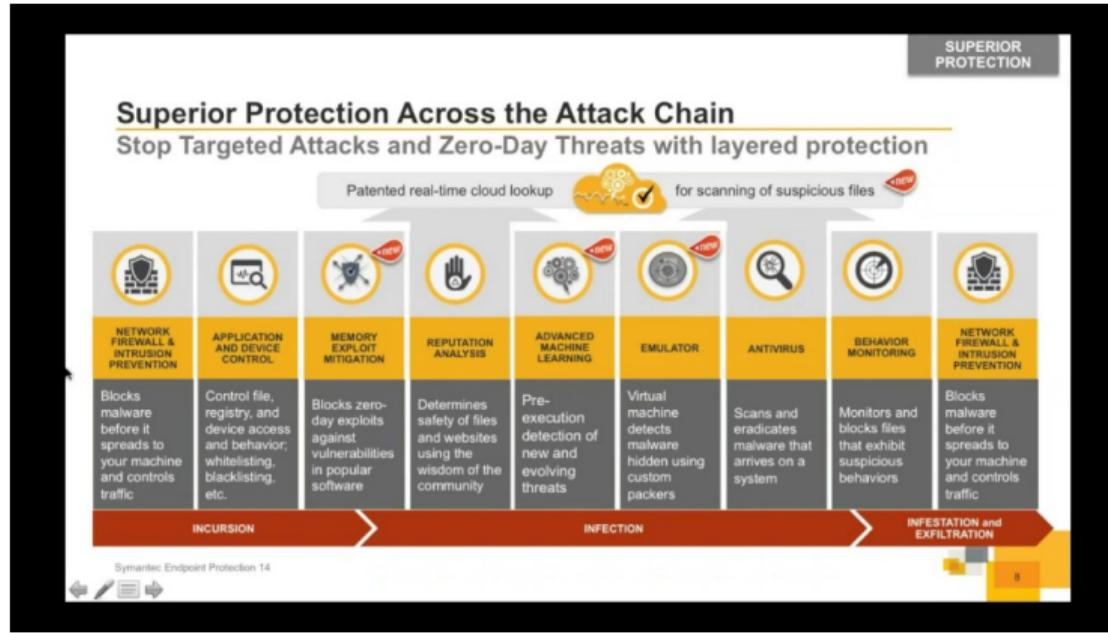
Perception, decision making, action, communication, learning



Tasks that can be accomplished with intelligence

Example : cybersecurity

Decision making, action, communication, learning



Artificial Intelligence : definition from a founding father

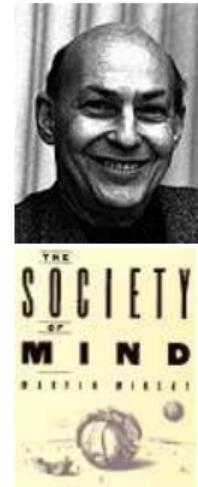
Marvin Minsky :

"the science of making machines do things that would require intelligence if done by men"

<http://web.media.mit.edu/~minsky/>

This definition is relative to what humans do.

- ▶ "Require intelligence" ?
- ▶ "Making [...] do" ?



"The simplest things to do by a human (e.g. adapting his gesture when grabbing an object) have proved extremely difficult to reproduce on a machine, while things difficult for a human (like solving a problem of failure) proved to be very simple"

What is *intelligence* ?

Different answers :

- To Turing

What makes it difficult to distinguish between a task performed by a human or a machine



What is *intelligence* ?

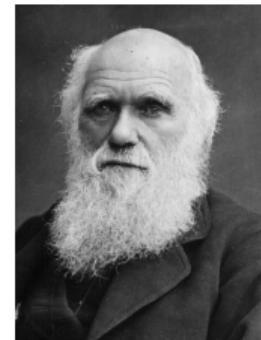
Different answers :

- ▶ To Turing

What makes it difficult to distinguish between a task performed by a human or a machine

- ▶ To Darwin

What allows the survival of the most suitable individual



What is *intelligence* ?

Different answers :

- ▶ To Turing

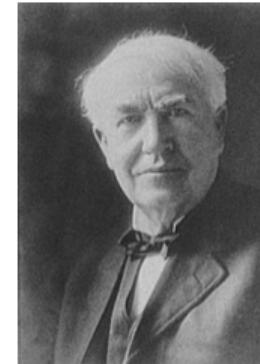
What makes it difficult to distinguish between a task performed by a human or a machine

- ▶ To Darwin

What allows the survival of the most suitable individual

- ▶ To Edison

What makes it work



What is *intelligence* ?

Different answers :

- ▶ To **Turing**

What makes it difficult to distinguish between a task performed by a human or a machine

- ▶ To **Darwin**

What allows the survival of the most suitable individual

- ▶ To **Edison**

What makes it work

- ▶ To **Lorentz**

It is collective and it emerges from collective behavior



Artificial Intelligence definitions organized in 4 categories

Think like humans	Think rationally
<p><i>The exciting new effort to make computers think... machine with minds, in the full and literal sense.(Haugeland,1985)</i></p> <p><i>The automation of activities that we associate with human thinking, activities such as decision-making, problem solving, learning.(Bellman, 1978)</i></p>	<p><i>The study of mental faculties through the use of computational models (Charniak and Mc Dermott, 1985)</i></p> <p><i>The study of the computation that make it possible to perceive, reason and act(Winston, 1992)</i></p>
Act like humans	Act rationally
<p><i>The art of creating machines that perform functions that require intelligence when performed by humans (Kurzweil, 1990)</i></p> <p><i>The study of how to make computers do things at which, at the moment, people are better(Rich and Knight, 1991)</i></p>	<p><i>Computational intelligence is the study of the design of intelligent agents(Poole et al, 1998)</i></p> <p><i>AI... is concerned with intelligence behavior in artifacts(Nilsson, 1998)</i></p>

Think like humans : the cognitive modeling approach

- ▶ How does our brain work ?
- ▶ Need of scientific theories about the internal functioning of the brain.
- ▶ Implementing those theories and compare to humans.
- ▶ Validation :
 - ▶ Study and analysis of human behavior (top-down approach : **cognitive sciences**).
 - ▶ Deduction from neurophysiological evidences (bottom-up approach : **cognitive neurosciences**).

Example

General Problem Solver (Newell and Simon, 1967) : modeling of the human ability to process information.

Act like humans : the Turing test approach(1950)

Idea

Do not define AI, but test it.

Protocol

The AI passes the test if a human interrogator, after asking some written questions, cannot tell whether the written responses come from a person or not.

Required skills

Natural language processing, knowledge representation, reasoning, learning, ...



The turing test

- ▶ An annual competition since 1991 : “the loebner prize”
- ▶ Other competitions :
 - ▶ Chatbot challenges
 - ▶ Already in use in commercial services



Eliza, the psychologist chatbot (Joseph Weizenbaum, 1966)

<http://www.manifestation.com/neurotoys/eliza.php3>

Example of conversation

Men are all alike.

IN WHAT WAY ?

They're always bugging us about something or other.

CAN YOU THINK OF A SPECIFIC EXAMPLE ?

Well, my boyfriend made me come here.

YOUR BOYFRIEND MADE YOU COME HERE

He says I'm depressed much of the time.

I AM SORRY TO HEAR YOU ARE DEPRESSED

It's true. I am unhappy

DO YOU THINK COMING HERE WILL HELP YOU NOT TO BE UNHAPPY

I need some help, that much seems certain.

WHAT WOULD IT MEAN TO YOU IF YOU GOT SOME HELP

Perhaps I could learn to get along with my mother.

...

Reviews of the Turing test

The Chinese room argument [Searl,80]

- ▶ A human is in a closed room, with a Chinese book with all the questions that can be asked, and the associated answers
 - ▶ Does the human speak Chinese ?
-
- ▶ Seale pointed out that the chatbots do not literally understand the conversations. He opposed weak AI and strong AI.

Think rationally : the “laws of thought” approach

- ▶ Aristotle and the “right thinking” : logic.
 - ▶ ex : *Socrates is a man. All men are mortal. Socrates is mortal.* (syllogisms)
- ▶ 19th century : the field of logic becomes part of mathematics.
 - ▶ Development of precise notations for statements about all kind of things in the world and about their relations.
- ▶ Main obstacles :
 - ▶ It is not easy to take informal knowledge and state it in formal terms (**uncertainty**).
 - ▶ There's a big difference between solving a problem *in principle* and in practice (**complexity**).

Think rationally : the rational agent approach

- ▶ Rational behavior :
 - ▶ always choose the right action : the one which maximizes the outcome regarding the available information.
- ▶ Do not necessarily involve reasoning (ex : blinking).

Rational agent

Definition

An agent is an entity which **perceives** and **acts** in its environment to accomplish goals regarding its skills or its beliefs (or knowledge).

- ▶ For each environment or task, one looks for the agent (or the group of agents) which has the best performance.
- ▶ Computing limitations make perfect rationality impossible.
 - ▶ Make the best program regarding the available resources.

Humans vs Machines

Some tasks difficult for humans are really easy for machines

- ▶ Checkers, Othello
- ▶ Logistics planning
- ▶ Planning for airlines
- ▶ Fraud detection
- ▶ Mail sorting
- ▶ Proof of theorems
- ▶ ...

Humans vs Machines

Some tasks are difficult for machines but really easy for humans

- ▶ Speech recognition
- ▶ Objects recognition
- ▶ Musical creativity
- ▶ Gestures
- ▶ Common sens reasoning
- ▶ ...

Foundations : disciplines that contributed to AI

Philosophy (428 B.C. – present)

- ▶ Logic, reasoning
- ▶ How does the mental mind arise from a physical brain ?
- ▶ Theory of learning, language, rationality

Mathematics (800 – present)

- ▶ Formal notations, proof
- ▶ Algorithms
- ▶ Computation, (in)decidability, (in)solvability
- ▶ Probability

Foundations : disciplines that contributed to AI

Economics (1776 – present)

- ▶ Formal theory of rational decision making

Neuroscience (1861 – present)

- ▶ Study of mental activity

Psychology (1879 – present)

- ▶ Adaptation
- ▶ Behaviours
- ▶ Experimental techniques

Foundations : disciplines that contributed to AI

Computer engineering (1940 – present)

- ▶ Computer : artifact that we can make intelligent (?)

Control theory and cybernetics (1948 – present)

- ▶ How can artifacts operate under their own control ?

Linguistics (1957 – present)

- ▶ Knowledge representation
- ▶ Natural language generation

The founding fathers

Turing (1912 – 1954)

- ▶ Computer scientist, mathematician, physicist, philosopher
- ▶ Turing machine



The founding fathers



The founding fathers



The founding fathers



*Dip the apple in the
brew/Let the sleeping death
seep through*

The founding fathers

Alan Turing granted Royal pardon by the Queen

NOW KNOW YE that We, in consideration of circumstances humbly represented unto Us, are Graciously pleased to extend Our Grace and Mercy unto the said Alan Mathison Turing and to grant him Our Free Pardon posthumously in respect of the said convictions;

AND to pardon and remit unto him the sentence imposed upon him as aforesaid;

AND for so doing this shall be a sufficient Warrant.

GIVEN at Our Court at *Saint James's*
the 24th day of December 2013;
In the sixty-second Year of Our Reign.

By Her Majesty's Command.



The founding fathers

1956 Dartmouth Conference: The Founding Fathers of AI



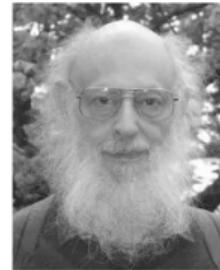
John MacCarthy



Marvin Minsky



Claude Shannon



Ray Solomonoff



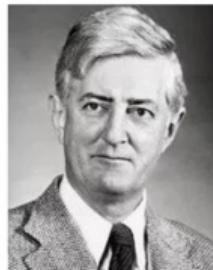
Alan Newell



Herbert Simon



Arthur Samuel



Oliver Selfridge



Nathaniel Rochester



Trenchard More

The founding fathers

Shannon (1916 – 2001)

- ▶ Information theory
- ▶ Pioneer in AI : wrote the first AI that can play chess game
(Programming computer for playing chess)



The founding fathers

Newell (1927 – 1992) and Simon (1917 – 2001)

- ▶ Authors of *Logic Theorist* (in which linked lists are first described)
- ▶ Chess game programming
- ▶ Decision process (Simon is the Nobel Prize of Economy, 1977)



The founding fathers

John MacCarthy (1927 – 2011)

- ▶ Has invented the term “Artificial Intelligence”
- ▶ Has invented LISP (LISt Processing)
- ▶ Stanford : <http://www-formal.stanford.edu/jmc/>



Development of AI

- ▶ 1943 – 1955 : the gestation of AI
 - ▶ Artificial neurons [McCulloch and Pitts, 1943] : first formal model of a neuron
 - ▶ Turing : *Computing Machinery and Intelligence* : computable functions on machines
 - ▶ Von Neumann : computer architecture
- ▶ 1956 : the birth of AI : Darmouth summer meeting
 - ▶ Two-month workshop at Darmouth College
 - ▶ Symbolic reasoning (Logic Theorist) [McCulloch and Pitts]
 - ▶ The term “Artificial Intelligence” is suggested [McCarthy]

Development of AI

A Proposal for the

DARTMOUTH SUMMER RESEARCH PROJECT ON ARTIFICIAL INTELLIGENCE

June 17 - Aug. 16

We propose that a 2 month, 10 man study of artificial intelligence be carried out during the summer of 1956 at Dartmouth College in Hanover, New Hampshire. The study is to proceed on the basis of the conjecture that every aspect of learning or any other feature of intelligence can in principle be so precisely described that a machine can be made to simulate it. An attempt will be made to find how to make machines use language, form abstractions and concepts,

Development of AI

1956 – 1969 : the euphoric period

- ▶ GPS (General Problem Solver) [Newell and Simon]
- ▶ LISP : high level programming language [McCarthy]
- ▶ Adaline [Widrow], Perceptron [Rosenblath]
- ▶ Program that plays to checkers game (Samuel)
- ▶ Symbolic (Logic Theorist) [McCulloch and Pitts] (automatic proof of theorem)

History of AI

1969 – 1979 : emergence of knowledge-based systems

- ▶ Perceptrons, the book by Minsky closed the chapter “neural networks” and machine learning
- ▶ J.A. Robinson : logic programming, PROLOG
- ▶ Expert systems : inferences, explanation
- ▶ Knowledge representation paradigms
- ▶ First crisis : AI splits into several fields : natural language processing, proof of theorem, games, knwoledge representation, perception, machine learning, ...

History of AI

1980 – 1989 : AI becomes an industry

- ▶ Success of symbolic methods (expert systems, decision trees)
- ▶ Expert systems are sold and allow companies to save several millions of dollars per year
- ▶ Applications of multi-layers neural network
- ▶ Second crisis : AI winter

Why AI winter ?

- ▶ Specialized hardware market collapsed, leading to the vanishing of LISP
- ▶ Less investment
- ▶ Promises are not kept

History of AI

1990 – 2000 : progress and well-advertized demonstrations

- ▶ Deep blue defeats Kasparov at chess game in 1997
- ▶ Speech recognition
- ▶ Real time expert systems
- ▶ Support Vector Machines
- ▶ Numerical methods : Hidden Markov Models, probabilistic reasoning

History of AI

2000 – 2010 : web

- ▶ More data (web) bring new challenges : indexing/classification, information retrieval, knowledge discovery,
...
- ▶ We speak about massive data

2010 – present : big data and deep learning

- ▶ Big data revive Artificial Intelligence : the quantity of data cannot be processed by humans
- ▶ Deep learning overshadows the other fields of Artificial Intelligence
- ▶ Revival of machine learning, but too much
- ▶ 2016 : the need for XAI (eXplainable Artificial Intelligence)

History of AI

The 50th anniversary of Dartmouth College Meeting



History of AI - AI Celebrities



Predictions vs Reality

Statement

We have made tremendous progress in all areas, but we are still so far from our initial goals
(IJCAI 05)

Predictions vs Reality

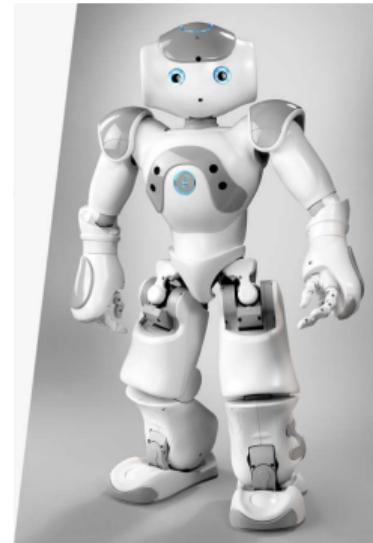
- ▶ At the present time there are still no vision systems capable of understanding a complex scene as does the human being [ECVision]
- ▶ **But**, intelligent systems for :
 - ▶ monitoring
 - ▶ biometry
 - ▶ medical image understanding
 - ▶ ...

Predictions vs Reality

- ▶ In 1958, Simon predicted in ten years, a computer would be a champion of chess game.
- ▶ Deep blue in 1998
- ▶ Machines are champions of chess, checkers and Othello games.
- ▶ Until 2016, bad level at GO, but now international champions !

Predictions vs Reality

- ▶ In 1970, prediction of robots everywhere...
- ▶ Domestic robots are still not current
- ▶ **But**, robots in industry, Mars exploration, surgical operations, humanoids..



The fight between connexionism and symbolism

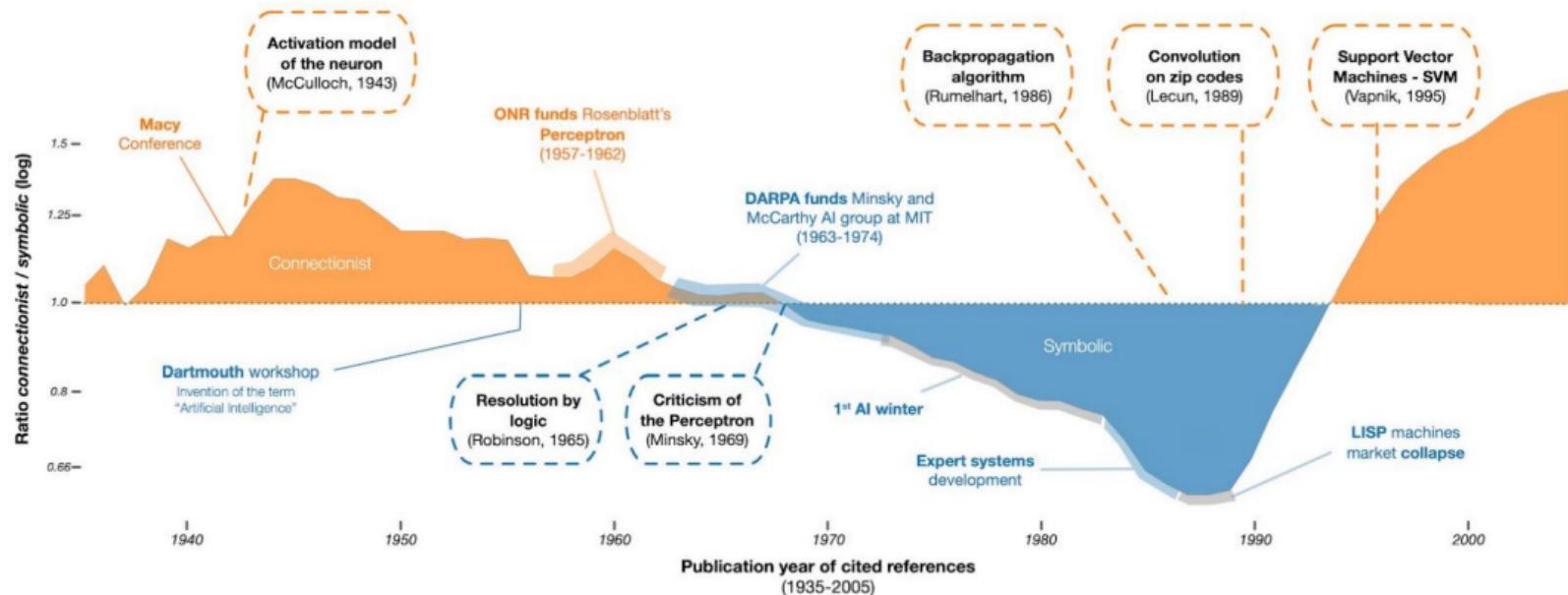
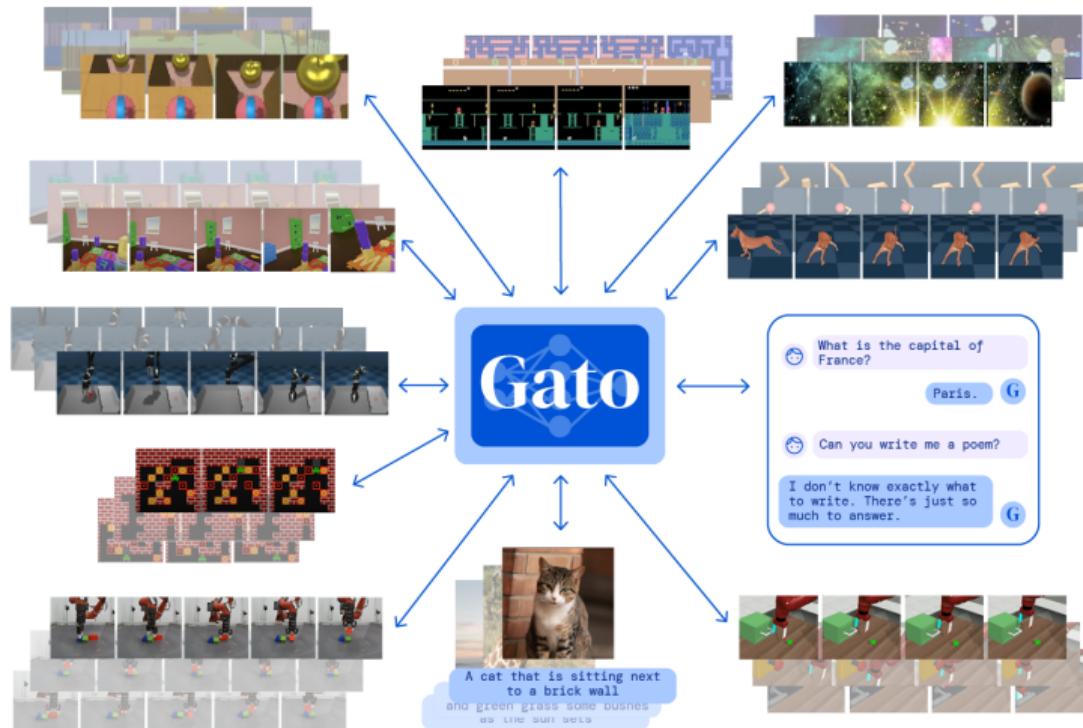


FIGURE – Neurons spike back. D. Cardon, J.-P. Cointet, A. Mazieres

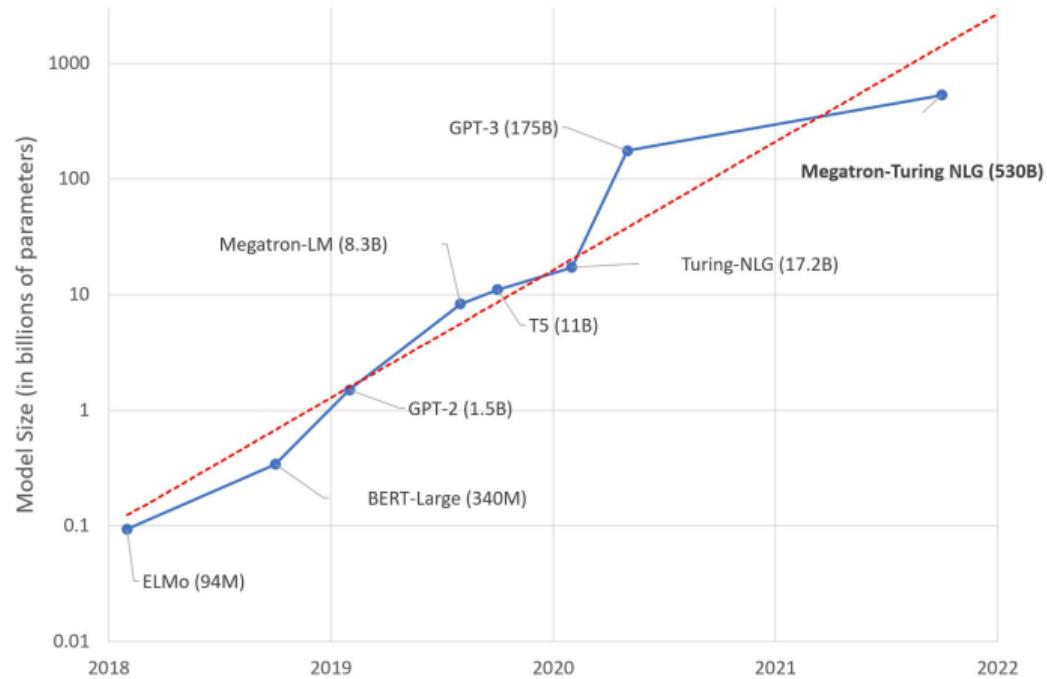
Deep Learning reaches unexpected results



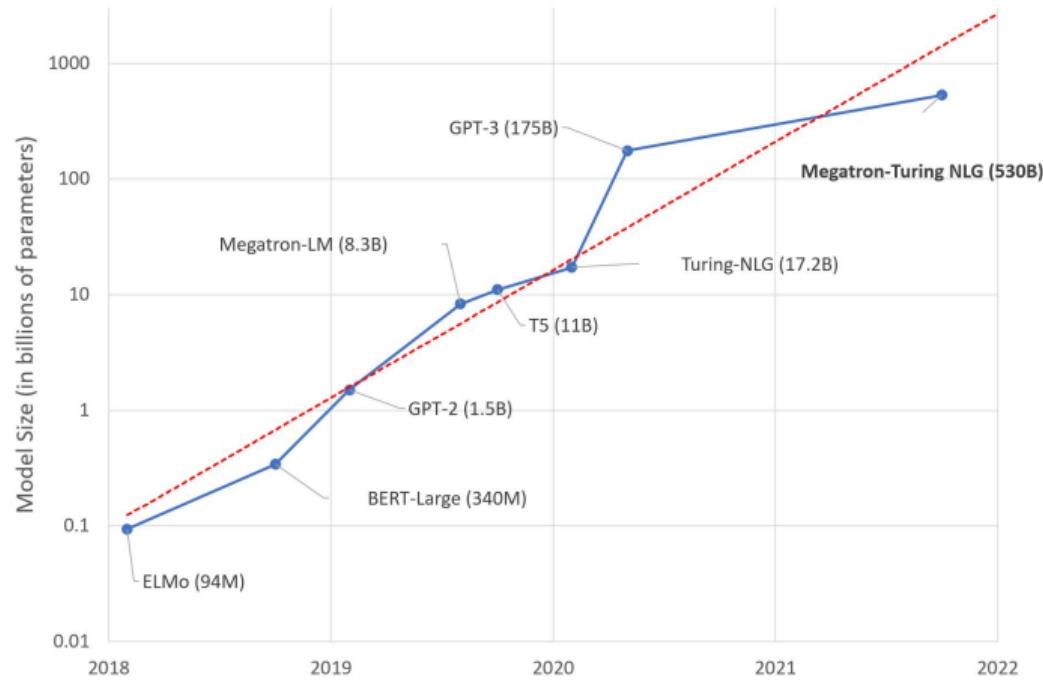
Deep Learning reaches unexpected results



The race for the number of parameters



The race for the number of parameters



100 billions of neurons in human brain !

Should an AI explain itself?



Yann LeCun @ylecun · Feb 5, 2020

We often hear that AI systems must provide explanations and establish causal relationships, particularly for life-critical applications.

Yes, that can be useful. Or at least reassuring....

1/n

45

372

988



...



Yann LeCun @ylecun · Feb 5, 2020

But sometimes people have accurate models of a phenomenon without any intuitive explanation or causation that provides an accurate picture of the situation. In many cases of physical phenomena, "explanations" contain causal loops where A causes B and B causes A.

2/n

5

14

144



...



Yann LeCun @ylecun · Feb 5, 2020

A good example is how a wing causes lift. The computational fluid dynamics model, based on Navier-Stokes equations, works just fine. But there is no completely-accurate intuitive "explanation" of why airplanes fly.

3/n



Should an AI explain itself?

We should stop training radiologists now, it's just completely obvious within five years deep learning is going to do better than radiologists.

Geoffrey Hinton, 2016

Should an AI explain itself?



AI has a long way to go before doctors can trust it with your life

Research

Use of artificial intelligence for image analysis in breast cancer screening programmes: systematic review of test accuracy

BMJ 2021; 374 doi: <https://doi.org/10.1136/bmj.n1872> (Published 02 September 2021)
Cite this as: *BMJ* 2021;374:n1872

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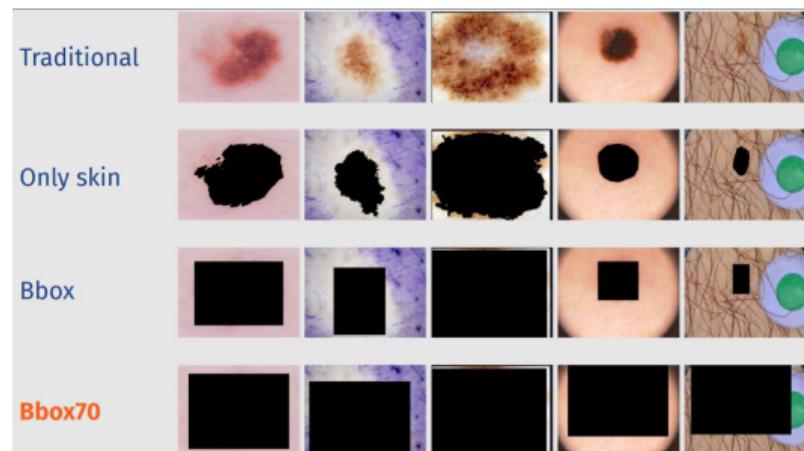
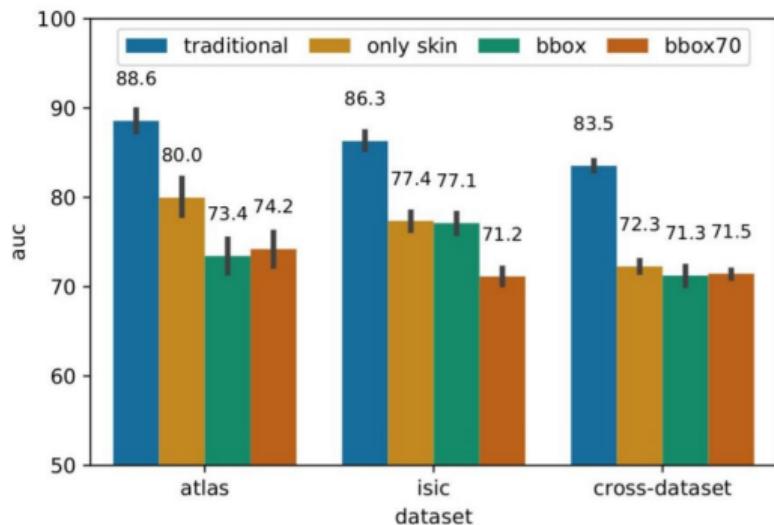
Karoline Freeman senior research fellow¹, Julie Geppert research fellow¹, Chris Stanton senior research fellow¹, Daniel Todkill clinical research fellow¹, Samantha Johnson academic support librarian¹, Aileen Clarke, professor of public health and health services research¹, Sian Taylor-Phillips, professor of population health¹

FIGURE — <https://doi.org/10.1136/bmj.n1872>

FIGURE — <https://qz.com/2016153/ai-promised-to-revolutionize-radiology-but-so-far-its-failing/>

Should an AI explain itself?

Black boxes raise an issue : biases in large datasets.



https://openaccess.thecvf.com/content_CVPRW_2019/papers/ISIC/Bissoto_DeConstructing_Bias_on_Skin_Lesion_Datasets_CVPRW_2019_paper.pdf

Should an AI explain itself?

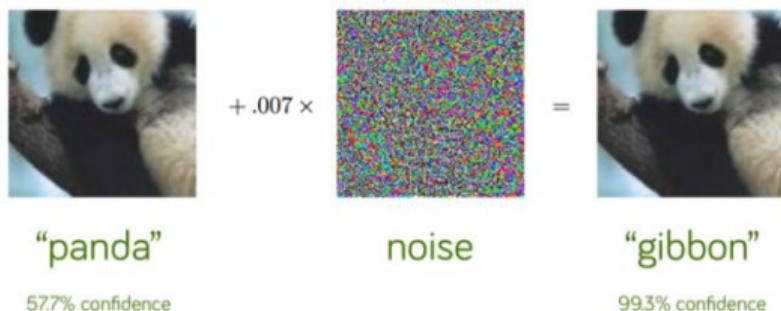


Image credits [Explaining and Harnessing Adversarial Examples](#)

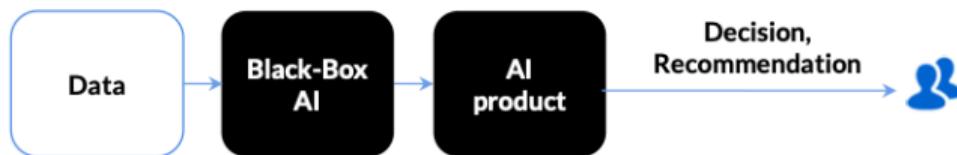
FIGURE – Attacking neural network



FIGURE – Recidivism score

Explainable Artificial Intelligence

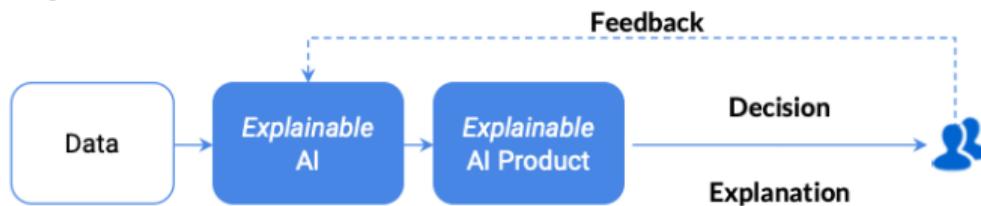
Black Box AI



Confusion with Today's AI Black Box

- Why did you do that?
- Why did you not do that?
- When do you succeed or fail?
- How do I correct an error?

Explainable AI



Clear & Transparent Predictions

- I understand why
- I understand why not
- I know why you succeed or fail
- I understand, so I trust you

FIGURE – Source : DARPA

Trustful Artificial Intelligence

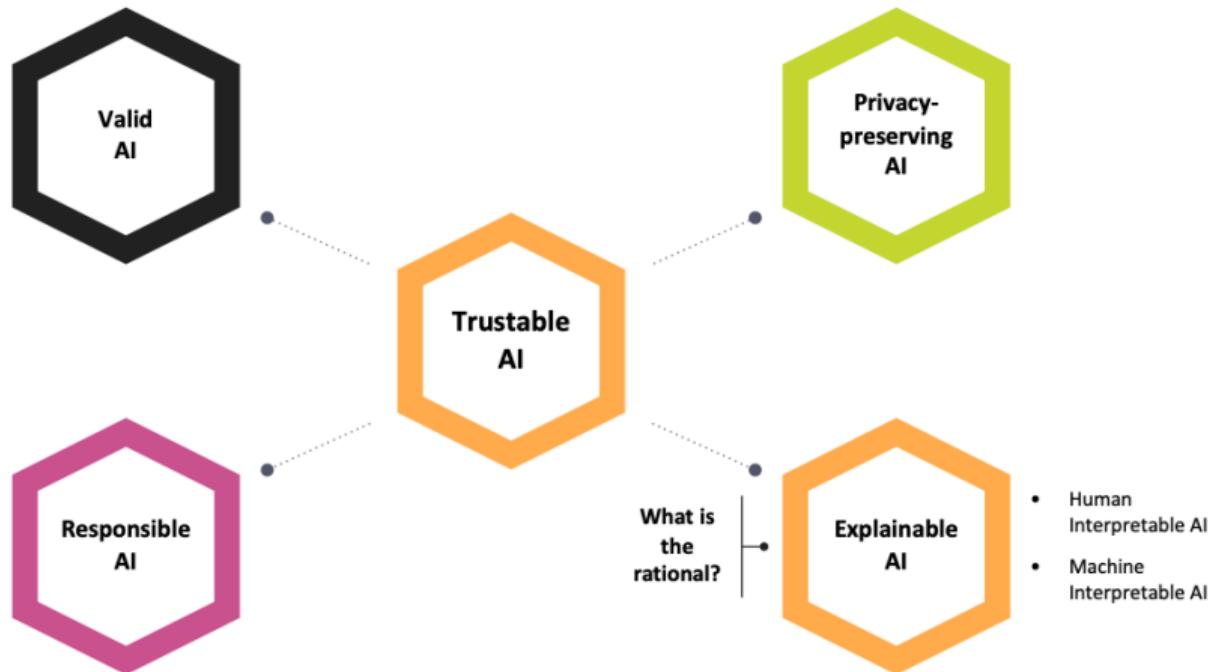


FIGURE – Source : Freddy Lecué

AI is overhyped

Press about AI for health (2018)

- ▶ Le Figaro, January : Artificial intelligence stumbles on medicine
- ▶ Le Parisien, May : Artificial intelligence at the bedside of medicine
- ▶ Forbes, July : Artificial Intelligence : More Reliable than Doctors ?
- ▶ Huffington post, September : Health plan : how France can become “a champion of artificial intelligence in medicine” (and why it’s important)
- ▶ Les échos, October : Artificial intelligence revolutionizes health

AI is overhyped

Bad press

- ▶ The guardian : A beauty contest was judged by AI and the robots didn't like dark skin
- ▶ Wired : Photo Algorithms ID white men fine – black women, not so much
- ▶ Reuters : Amazon scraps secret AI recruiting tool that showed bias against women

AI is overhyped

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Cons

Lots of famous people raise against AI :

- ▶ Stephen Hawkins, "I'm not afraid of black holes. AI is another story."
- ▶ Bill Gates, "First, you'll lose your job, then it gets scary."
- ▶ Elon Musk, "we [...] need to colonize Mars-so that we'll have a bolt-hole if A.I. goes rogue and turns on humanity"
- ▶ ...

In conclusion : AI is everywhere !!!

- ▶ In the industry : control, diagnostic, automation
- ▶ At home : domotic
- ▶ In your pocket : smartphones
- ▶ ...

- ▶ What about singularity ?
- ▶ What about ethics ?