



## Intelligenza Artificiale

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# Plan Lecture 1-2

1. Introduction to the course
2. Short digression on (natural) intelligence
3. Short history of AI
4. Definition of AI
5. Economic and social implications
6. Some facts from the real world



# First of all .. what is AI?

But first ... what is NI (Natural Intelligence)?



# A difficult problem ...

- The definition of (natural) intelligence is not an easy one
- Several definitions of intelligence
- Even more definitions of AI



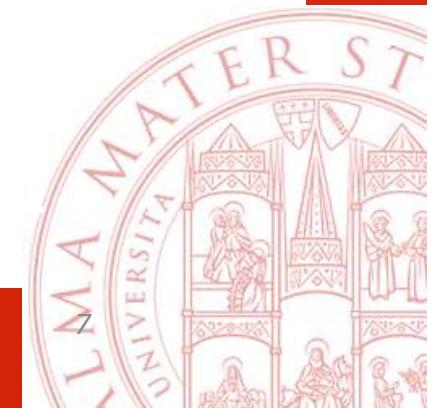
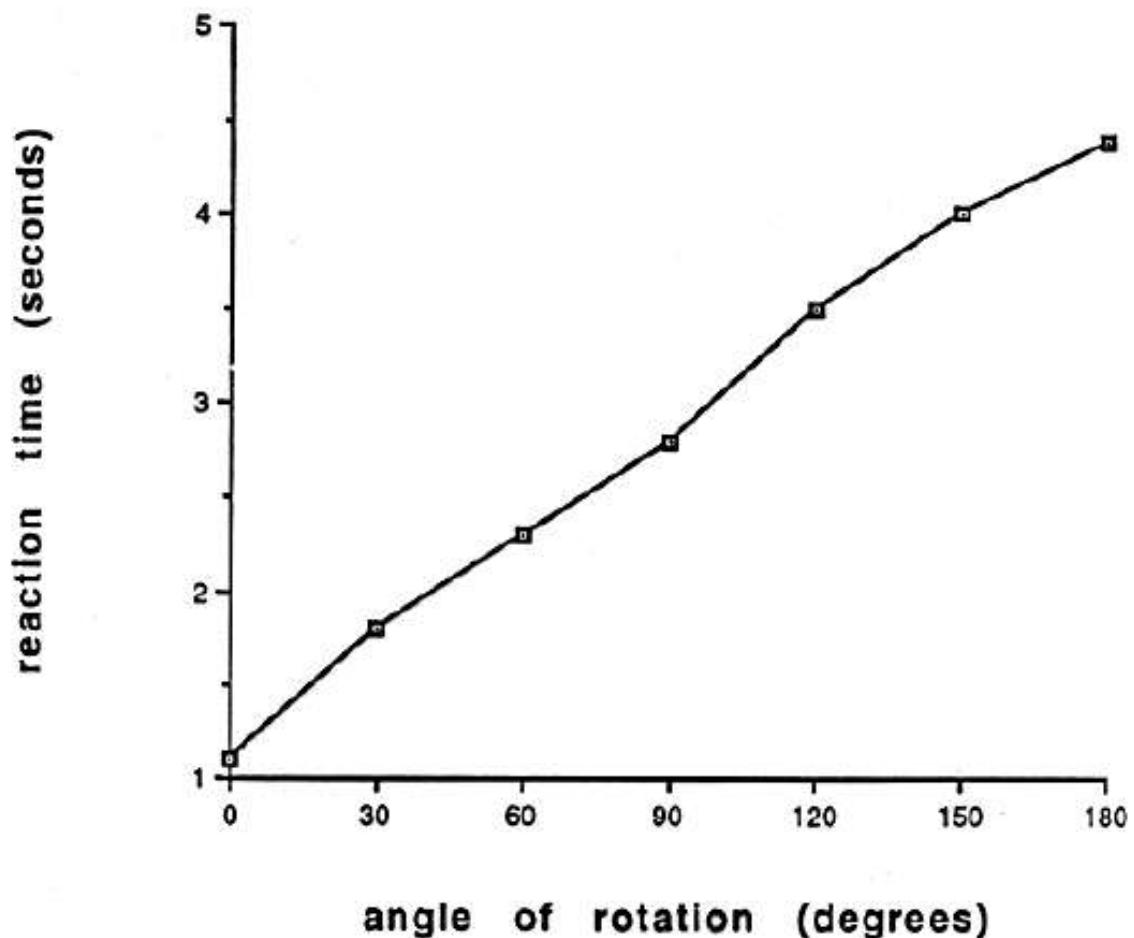
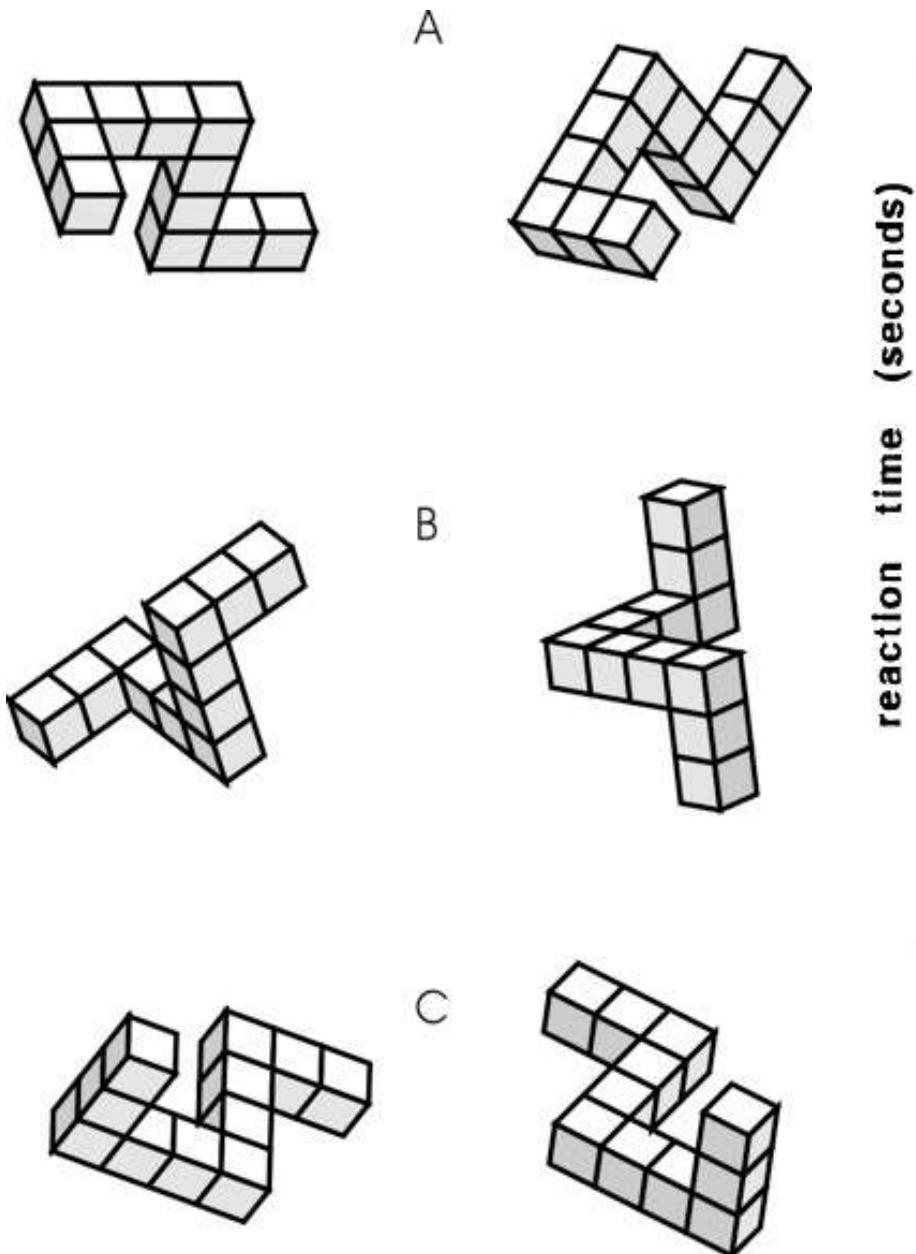
## 2 Short digression on (natural) intelligence

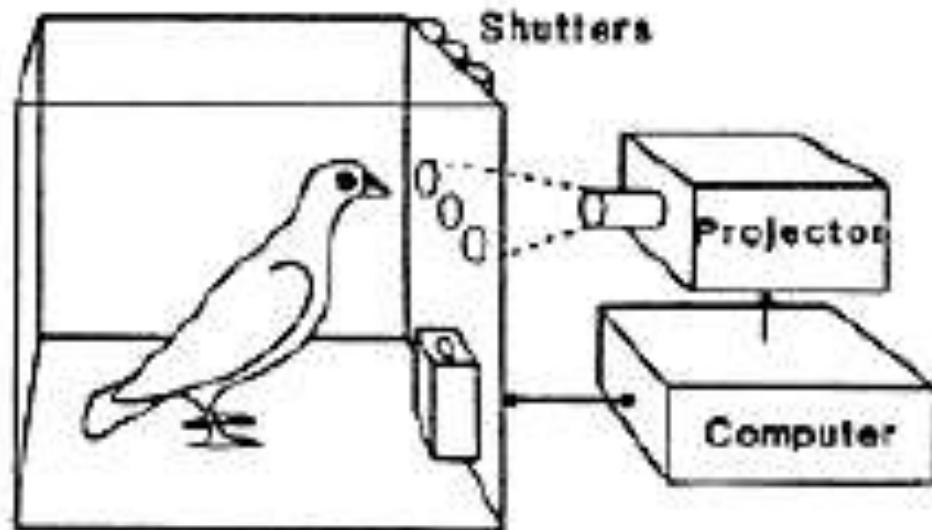


# Short digression on (natural) intelligence

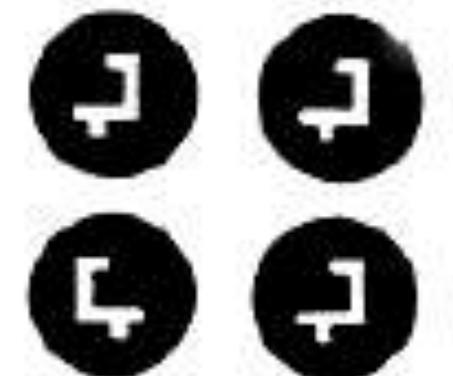
- Is more intelligent the pigeon or the human being ?
- Probably the human being however ...
- For some tasks the pigeon is better than us







Comparison Sample Comparison



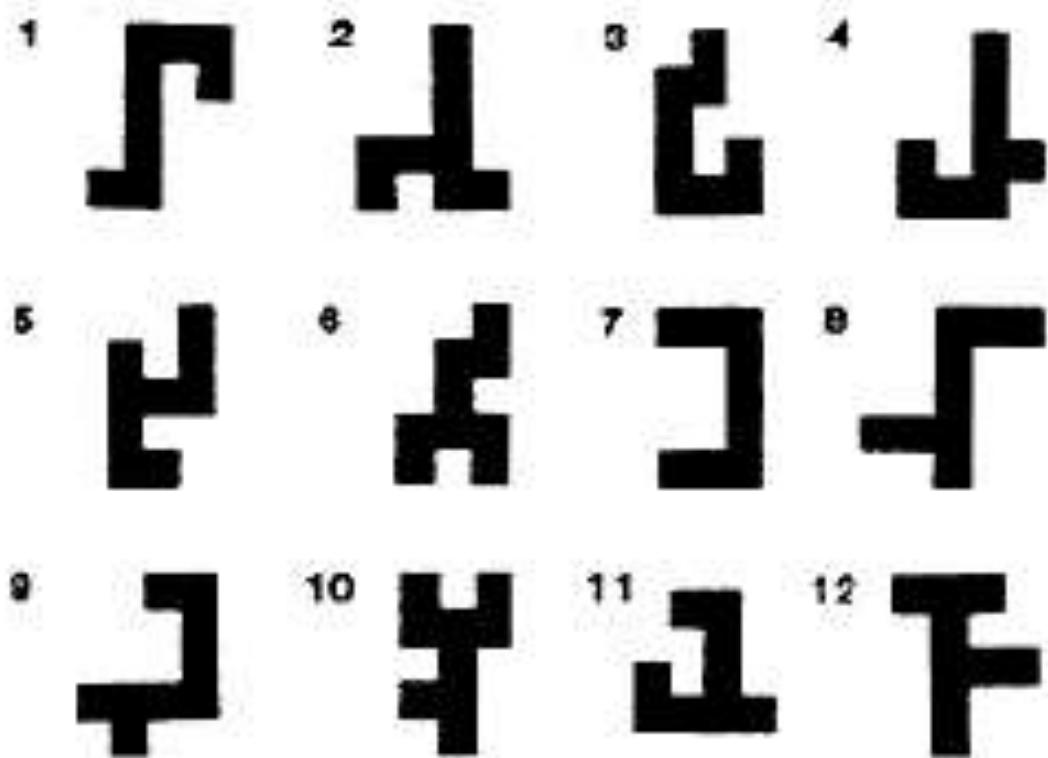
0°

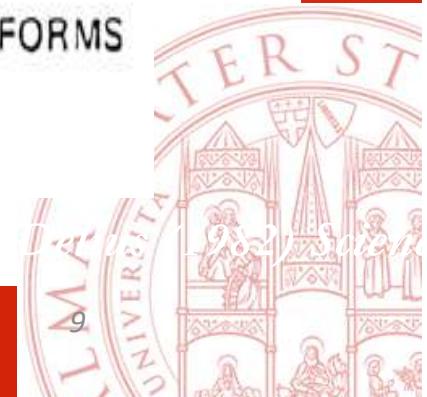
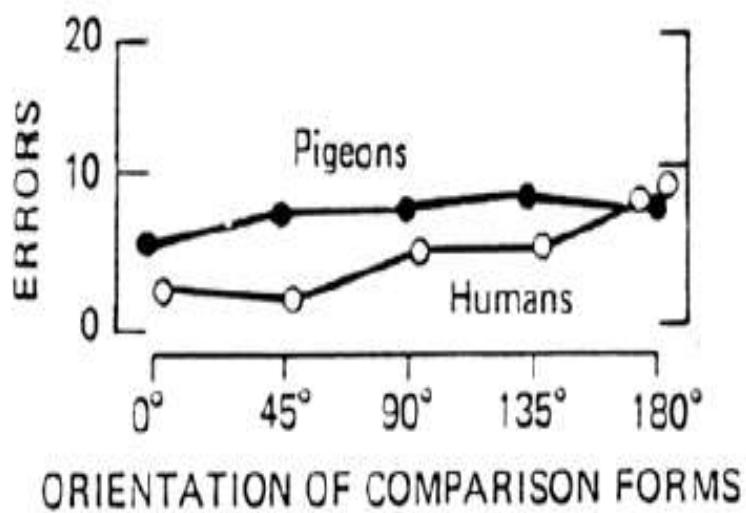
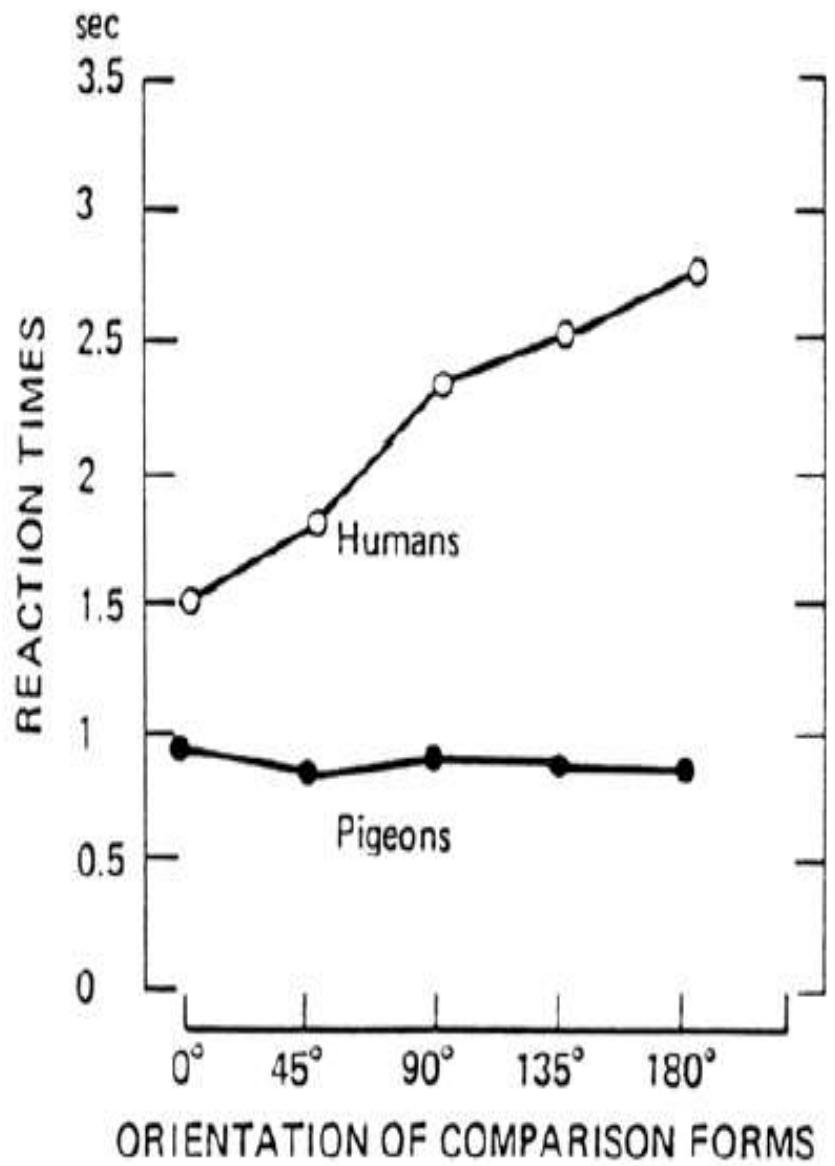


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180°



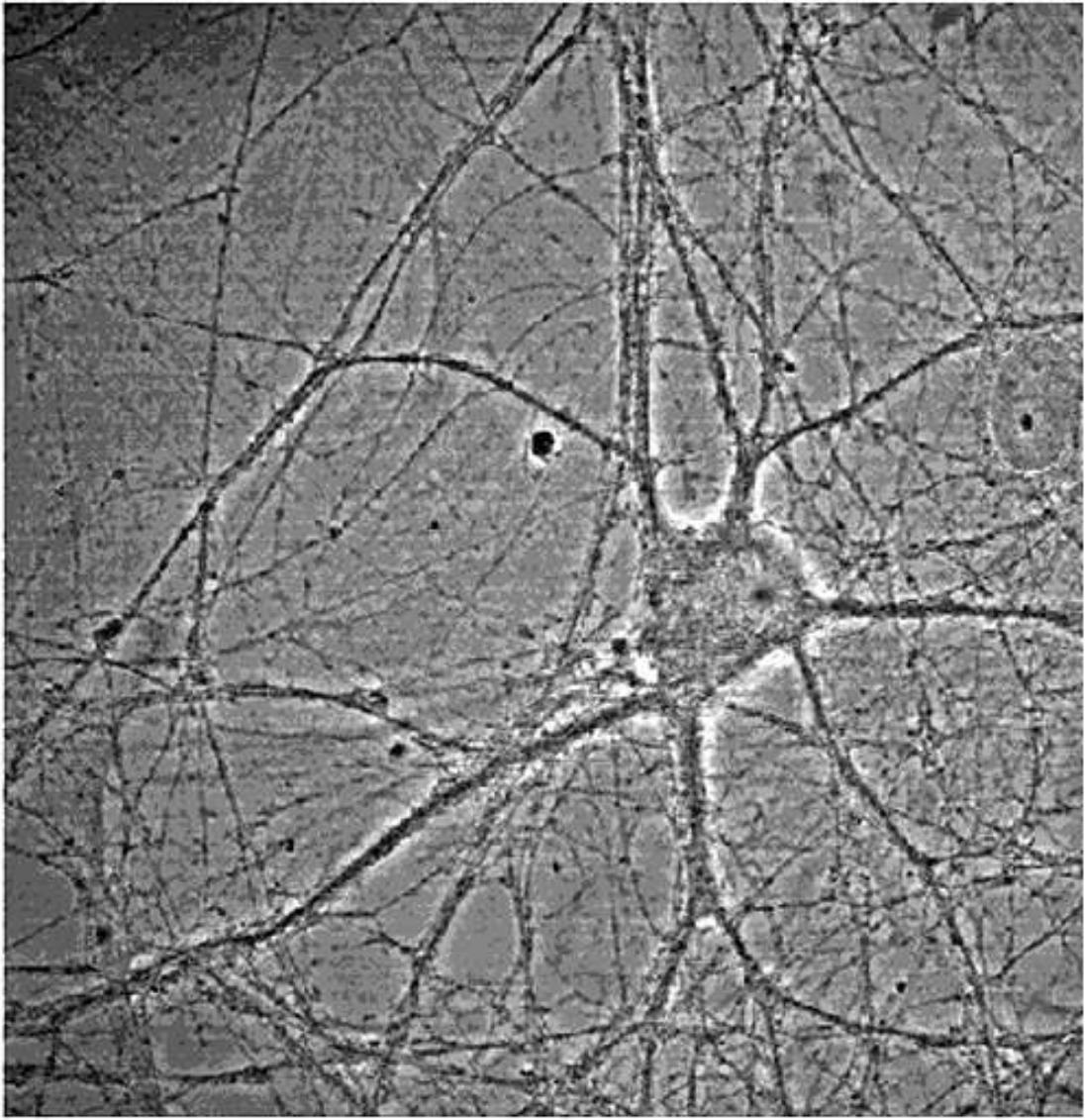


## Learning abilities:

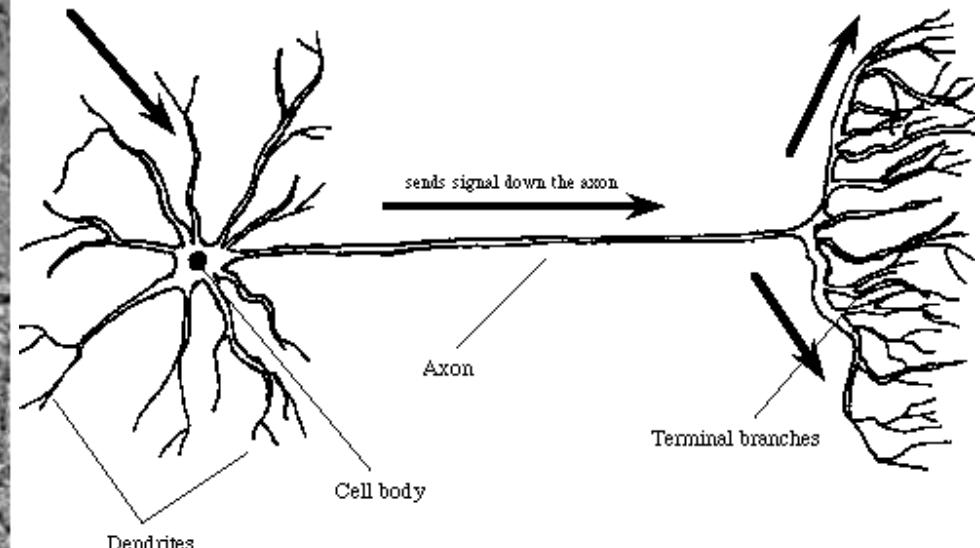
Number of reinforcements needed to learn a simple  
motor response

bee	2
carp	4
quail	8
pigeon	10
hen	18
rat	22
raccoon	24

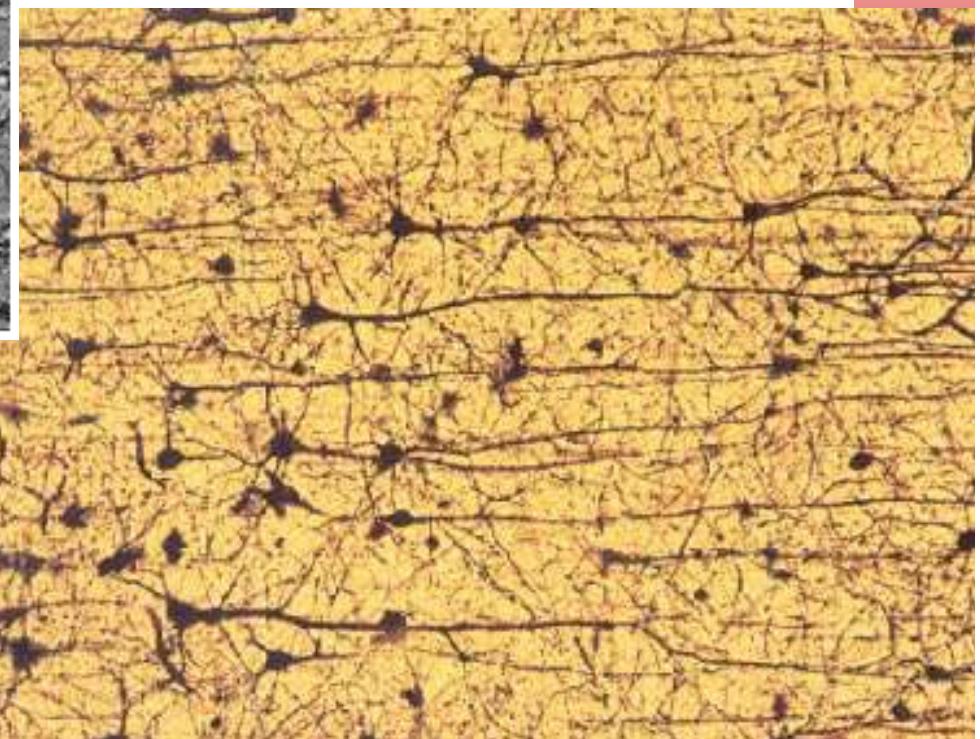




INPUT from other neurons



OUTPUT to other neurons



# *Brain dimensions matters ? No*

*Whale: 8 Gg. - 200 billions of neurons*

*Human being : 1.2 – 1.4 Kg – 85 billions*

....

....

....

*Pigeon: 0.003 Kg. - 400.000.000 neurons*

*Bee: 1 mm<sup>3</sup> - < 1 million of neurons*



## A possible definition of intelligence

Intelligence is the ability to learn from experience, to apply knowledge to solve problems, and to adapt and survive in different environments (social and geographical)

In more simple terms, **intelligence equals survival**. If we show intelligence then we will survive and prosper within the social and geographical contexts that we reside in and encounter



## G-factor

Spearman (1923) identified the g-factor (g for general ) as the description of the general intelligence of an individual. His idea was that the g-factor is the basis for the global cognitive ability of a person, and underlies all the various forms of specific abilities (e.g. mathematics, language etc.)

Other researchers (e.g. Guilford, 1967) claim that there exist no general intelligence.



## Primary abilities

Today the prevalent opinion is that there is not a unique form a general intelligence but there are *several several different factors describing the intelligence* (Thurstone around 1930)

Something that ML researchers often forget ...

The most common classification uses 7 factors:

Verbal fluidity

Numerical ability

Inference

Spacial ability

Velocity in perception

Memory



Plan

### 3) A short history of AI



# An historical perspective

- The dream of an “intelligent machine” is very old ...
- Aristotle (384-322 BC): syllogism, first logical system which allowed to derive conclusions from premises

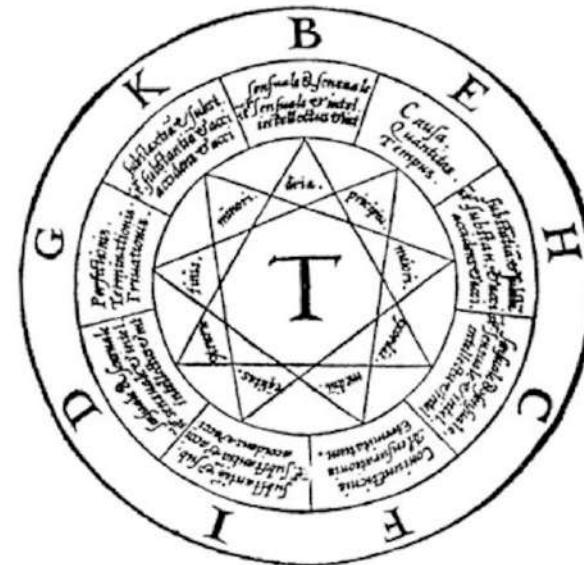
# A picture from XIII century

Ramon Llull (1232-1316): Ars combinatoria: a physical machine (paper discs) which allowed to combine the concepts symbolically represented on the disks

PRIMA FIGVRA.



SECUNDA FIGVRA.



Every single letter, from *B* to *K*, represents not merely itself, but several strictly defined and placed meanings. By writing the letters from *B* to *K* as key-terms heading a table, a series of different sentences can be easily constructed. For example, *B*=Bonitas, *C*=Magnitudo, *D*=Duratio, *E*=Potestas, *F*=Sapientia, *G*=Voluntas, *H*=Virtus, *I*=Veritas and *K*=Gloria. This is, initially, the paper-circle called the *Prima Figura*. The next strictly defined table of words can be produced on the next circle, perhaps as seen on the *Secunda Figura* (shown below), where we find categories and relations of thinking.

Hence the machine allows all the words to be combined by turning the circles step by step. In this manner, it is possible to connect every word with every other word placed in a position of a table—depending only on the construction of the individual tables. Imagine how Llull could play this out: bearing in mind the inscribed words of the *Prima Figura*. These nine words are none other than the attributes of God. Combined with a table of nine questions, it is possible to construct the skeleton of the "Proofs of God." The machine shows all possible statements and declarations about God.



# An historical perspective

- René Descartes (1596-1610): in a sense a forerunner of cognitive science and AI for his studies on the cognitive aspects of automatons
- Leibniz (1646-1716): Calculus ratiocinator which should have allowed to solve all problems (Calculemus!)



# René Descartes 1596-1610

Influenced by the automatons on display throughout the city of Paris, began to investigate the connection between the mind and body. Dualism:

- body works like a machine, that it has material properties.
- mind is not material and does not follow the laws of nature.
- mind interacts with the body at the pineal gland

“Cartesio, the philosopher of the machine de terre, can be considered as the precursor of cognitive science and artificial intelligence for the cognitive importance that he gave to the construction of automatons”.<sup>1</sup>

1) Bruno G. Bara, Scienza cognitiva. Un approccio evolutivo alla simulazione della mente, Bollati Boringhieri, Torino 1982



# Cartesio discorso sul metodo

“Qui in particolare mi ero fermato per far vedere che se ci fossero macchine con organi e forma di scimmia o di qualche altro animale privo di ragione, non avremmo nessun mezzo per accorgerci che non sono in tutto uguali a questi animali; mentre se ce ne fossero di somiglianti ai nostri corpi e capaci di imitare le nostre azioni per quanto di fatto possibile, ci resterebbero sempre due mezzi sicurissimi per riconoscere che, non per questo, sono uomini veri. In primo luogo, non potrebbero mai usare parole o altri segni combinandoli come facciamo noi per comunicare agli altri i nostri pensieri. Perche' pur nel concepire che una macchina sia fatta in modo tale da proferire parole, e ne proferisca anzi in relazione a movimenti corporei che provochino qualche cambiamento nei suoi organi; che chieda, ad esempio, che cosa si vuole da lei se la si tocca in qualche punto, o se si tocca in un altro gridi che le si fa male e cosi' via; ma non si puo' immaginare che possa combinarle in modi diversi per rispondere al senso di tutto quel che si dice in sua presenza, come possono fare gli uomini, anche i piu' ottusi. L'altro criterio e ' che quando pure facessero molte cose altrettanto bene o forse meglio di qualcuno di noi, fallirebbero inevitabilmente in altre, e si scoprirebbe cosi' che agiscono non in quanto conoscono, ma soltanto per la disposizione degli organi.”



# AI (and CS) ante litteram in the XVII century

- G.W. Leibniz (1646-1716) Calculus raziocinator.
- Jacques de Vaucanson(1709-1782) built an artificial duck that could swim and “eat” grain (400 parts in each wing)
- Pierre Jacquet-Droz (1721–1790) swiss-born watchmaker who designed and built animated dolls and automata including a writer and a musician
  - Movements controlled by an input coded on a metallic disc !



# Calculemus

G.W. Leibniz (1646-1716) Calculus raziocinator:

“ I believe I can devise a certain universal language, by which we can perform calculations on all kinds of subjects and find demonstrations, as in algebra and arithmetics”

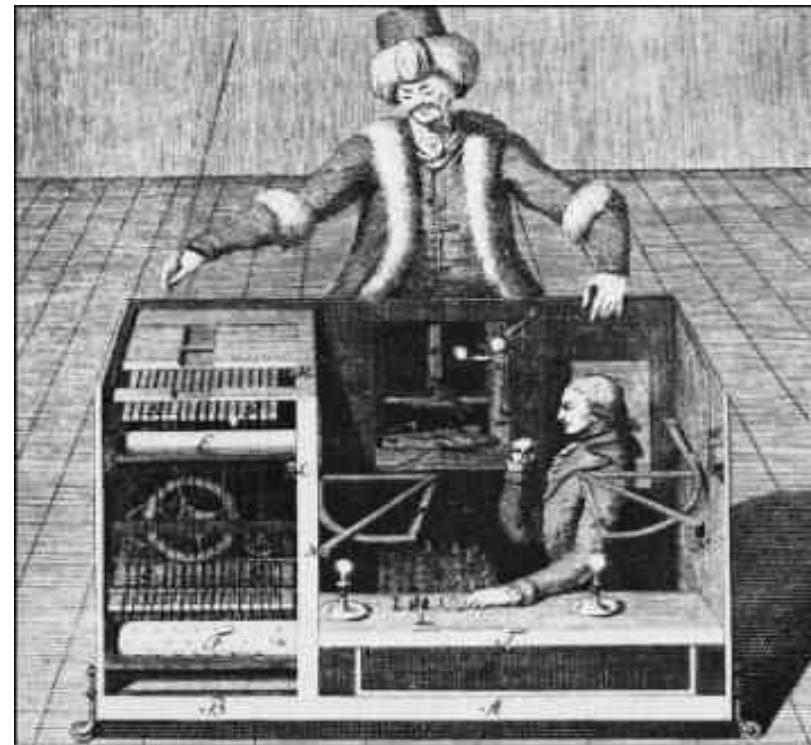
Quo facto, quando orientur controversiae, non magis disputatione opus erit inter duos philosophos, quam inter duos computistas. Sufficiet enim calamos in manus sumere sedereque ad abacos, et sibi mutuo (accito si placet amico) dicere: **calculemus!**

(Leibniz: De scientia universalis seu calculo philosophico)



# Al ante litteram ... fake !

An image from  
18<sup>th</sup> century



# Real AI ante litteram: Turing

- 1935 Universal Turing Machine
- 1947 Talk by A. Turing in London: "What we want is a machine that can learn from experience ... the possibility of letting the machine alter its own instructions provides the mechanism for this".

A. M. Turing, Lecture to the London Mathematical Society on 20 February 1947.

- 1948. *Intelligent Machinery*. Never published during his life, a real AI manifesto contain several ideas later re-invented (including symbolic systems and neural networks).

A.M. Turing, Intelligent machinery, National Physical Laboratory, London, 1948.

- 1950. *Computing Machinery and Intelligence*. Including the imitation game, i.e. Turing test.

A.M. Turing, Computing machinery and intelligence, Mind 49, 1950



### SUMMARY.

The possible ways in which machinery might be made to show intelligent behaviour are discussed. The analogy with the human brain is used as a guiding principle. It is pointed out that the potentialities of the human intelligence can only be realised if suitable education is provided. The investigation mainly centres round an analogous teaching process applied to machines. The idea of an unorganised machine is defined, and it is suggested that the infant human cortex is of this nature. Simple examples of such machines are given, and their education by means of rewards and punishments is discussed. In one case the education process is carried through until the organisation is similar to that of an ACE.



# The answer of Turing to the vexata quaestio “Can machines think?”

According to the most extreme form of this view [that thought is impossible without consciousness] the only way by which one could be sure that a machine thinks is to be the machine and to feel oneself thinking. One could then describe these feelings to the world, but of course no one would be justified in taking any notice.

Likewise according to this view the only way to know that a man thinks is to be that particular man. It is in fact the solipsist point of view. It may be the most logical view to hold but it makes communication of ideas difficult. A is liable to believe "A thinks but B does not" whilst B believes "B thinks but A does not".

Instead of arguing continually over this question it is usual to have the polite convention that everyone thinks.

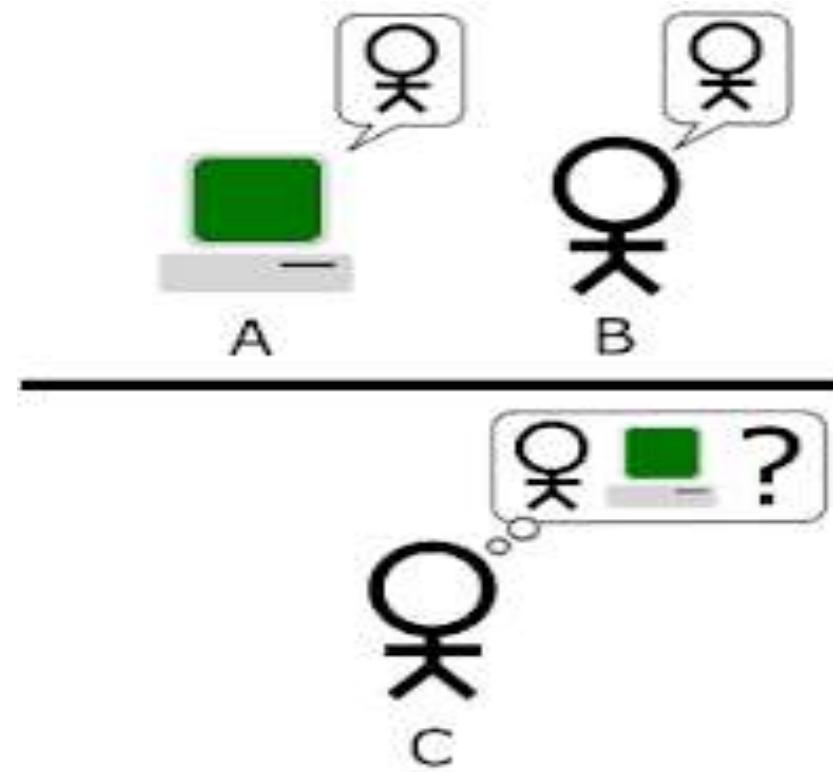
*A. Turing. Computing Machinery and Intelligence. Mind, 1950.*



## Imitation game (a.k.a. Turing test), 1950

### Behavioral test

If it is impossible to distinguish the behavior of a machine from that of a human, then the machine is intelligent



## The official start of AI: Dartmouth conference 1956

John McCarty coined the term AI: “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”.

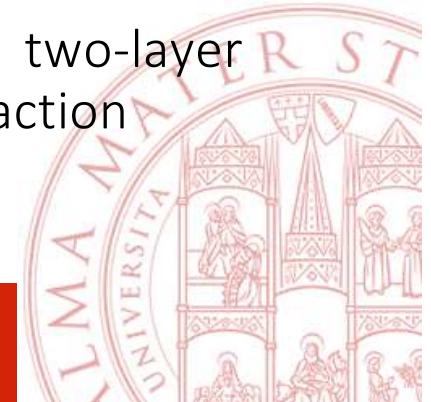


Trenchard More, John McCarthy, Marvin Minsky,  
Oliver Selfridge, Ray Solomonoff



# Neurons and learning

- W. S. McCulloch and W. H. Pitts (1943). First computational model of the neuron (threshold logic)  
At the basis of the research on neural networks
- D.O. Hebb (1949). Hebbian learning.  
A theory in neuroscience that proposes an explanation for the adaptation of neurons in the brain during the learning process, describing a basic mechanism for synaptic plasticity neuronal basis of unsupervised learning
- F Rosenblatt (1958). Perceptron.  
An algorithm for pattern recognition based on a two-layer computer learning network using simple addition and subtraction



## 4) Definition(s) of AI

- Three main definitions
- Some more definitions



A 1<sup>st</sup>, (kind of official) definition of AI, after Turing

AI indicates the ability of a computer to perform tasks commonly associated with intelligent beings

Two main approaches

Symbolic AI

Sub-symbolic AI (including ML, Generative AI, LLM ...).



## A 2<sup>nd</sup> more complex modern definition of AI (after ML)

Peter Norvig (Director of Research, Google):

AI is “Knowing what to do when you don’t know what to do”



# A 3<sup>rd</sup> contemporary definition: Generative AI (including LLM)

Models that are designed to generate new content,  
such as images, text, audio, or even video.



# A definition for the future: Artificial General Intelligence (AGI)

AGI is envisioned as having the capability to perform any intellectual task that a human being can do

(e.g. understanding natural language, learning from experience, reasoning, problem-solving, adapting to new and unforeseen situations)

Will it exists?



# Some more definitions of AI



Many possible definition of AI:

- 1) Thinking humanly
- 2) Acting humanly
- 3) Thinking rationally
- 4) Acting rationally

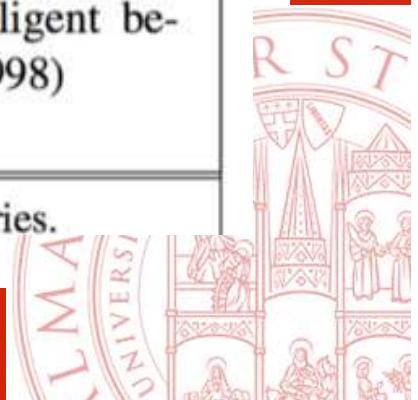
We, as computer scientists (and AI researchers) take the  
“simple” view point of A.M. Turing



# Some definitions of AI (Russel and Norvig)

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

**Figure 1.1** Some definitions of artificial intelligence, organized into four categories.



## What people say

Stephen Hawking

“We spend a great deal of time studying history, which, let’s face it, is mostly the history of stupidity. So it’s a welcome change that people are studying instead the future of intelligence.”

The creation of powerful artificial intelligence will be “either the best, or the worst thing, ever to happen to humanity”



The three definitions of (existing) AI  
via three examples



## 1<sup>st</sup> Example : A System which identify severe infections caused by bacteria and recommend antibiotics

Sys: The culture is Gram positive?

User: NO.

Sys: The culture is Gram negative?

User: YES.

Sys: The patient is allergic to antibiotics?

User: NO.

Sys: I would suggest a therapy based on antibiotics.



## Is this ChatGPT ?

No, indeed it can provide explanations for recommendations:

Explaining session:

Sys: The culture is Gram positive

User: WHY? < why you need this information?

Sys: This information is needed to determine whether (R1) the organism is a streptococcus

User: WHY?

Sys: This information is helpful because for streptococcus one can use penicilina ( R3 ).

Sys: ... : I would suggest a therapy based on antibiotics.

User: HOW? <How can you infer this conclusion ?

Sys: I used rule R4: I suggested to use antibiotics because they are appropriate for this infection (prem1) and the patient is not allergic (prem2).

User: HOW Premise 1 ?

<How can you derive that antibiotics are appropriate?

Sys: I used rule R5: that antibiotics are appropriate because the bacterium causing the infection is ecoli.



# What is it? Symbolic AI

- It is MYCIN : an example of symbolic AI from the previous century!  
(Early 1970s)
- An early backward chaining **expert system**, using a fairly simple inference engine and a knowledge base of ~600 rules
- Developed in six years at Stanford University.
- Programmed in LISP
- Based on **logical rules** and probabilities
- MYCIN received an acceptability rating of 65% on treatment plan from a panel of eight independent specialists, which was comparable to the 42.5% to 62.5% rating of five faculty members
- Never used in practice for ... ethical reasons!



# Example of rules for simple diagnostic problem

**Goal:** suggest a Drug which is appropriate for a patient on the basis of some clyncial analysis  
**prescribe(Drug)** .

## Knowledge base

### Facts:

**gram(neg)** .

**not(allergic(antb))** .

### Rules:

**R1: gram (neg) → id (ecoli)** .

If the result of the analysis is *gram-negativ* then the identity is *enterium-coli*

**R2: gram (pos) → id (strep)** .

If the result of the analysis is *gram-positivo* then the identity is *streptococcus*

**R3: id(strep) OR id(bact) → ind(pen)** .

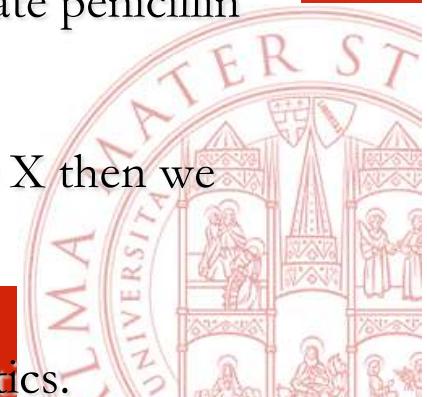
If the identity is streptococcus or bacterium then it is appropriate to indicate penicillin

**R4: ind(X) AND not (allergic(X)) → prescribe(X)**

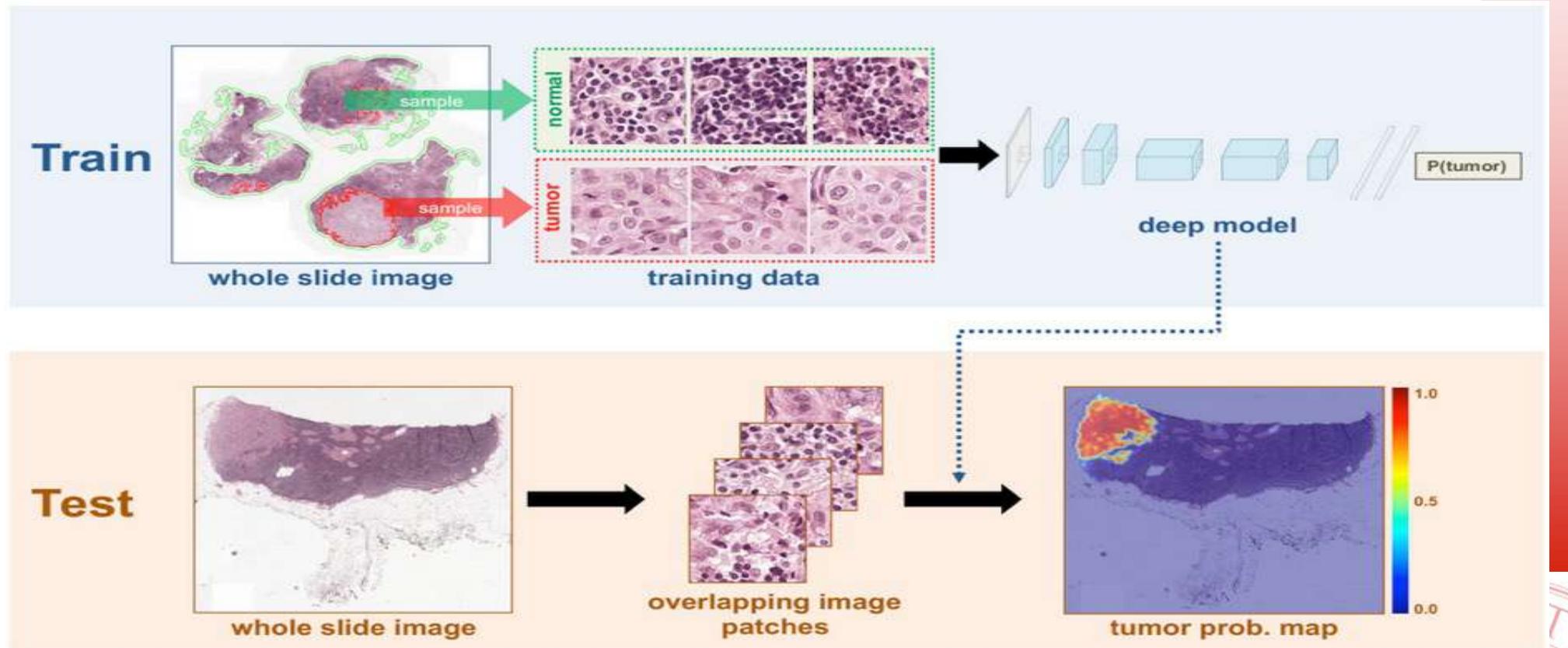
If it is appropriate to indicate the drug X and the patient is not allergic to X then we can prescribe X

**R5: id(ecoli) → ind(antb)** .

If the identity is *enterium-coli* then it isappropriate to indicate antibiotics.



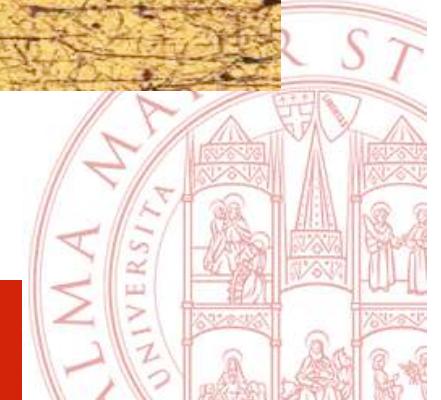
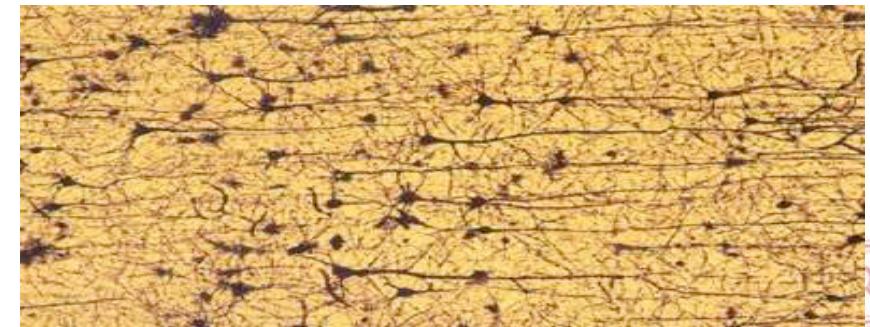
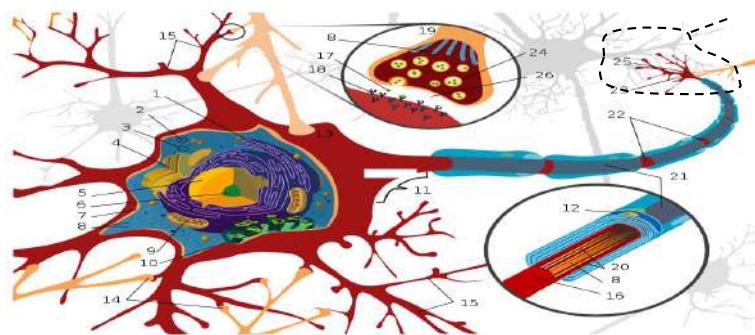
## 2<sup>nd</sup> Example: A system for the analysis of sentinel lymph node analysis for breast cancer diagnosis



# What is this? Sub-Symbolic AI

Artificial neural networks Inspired by the brain model (McCulloch and Pitts 1943, Rosenblatt 1958)

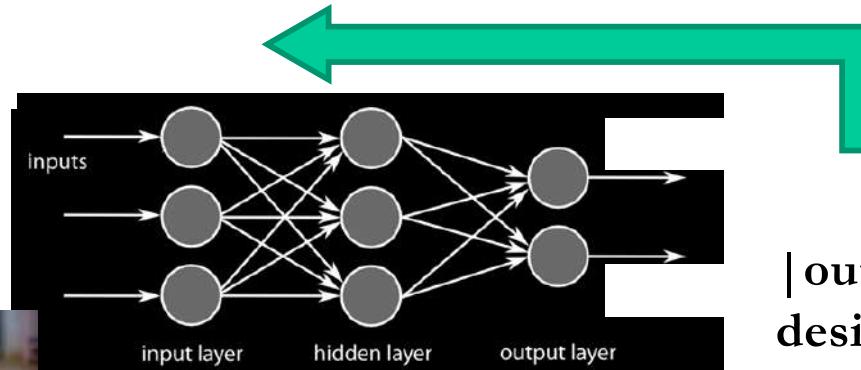
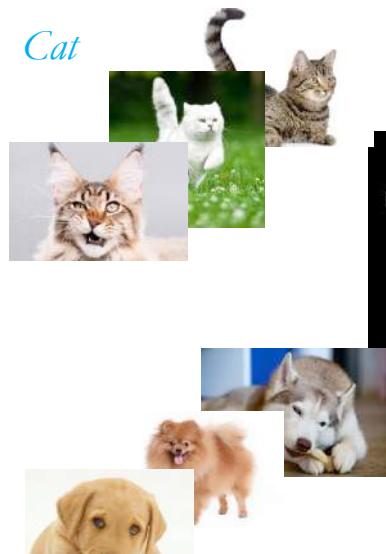
- Many computational units (neurons) with low computational power
- Many (weighted) connections
- Distributed control highly parallel
- Learning from data



# Training (supervised)

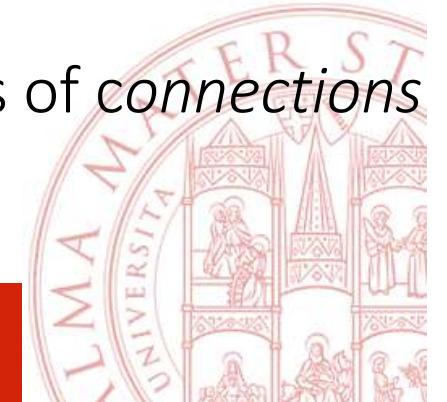
*Error backpropagation*

Rumelhart, Hinton  
& Williams, 1986]



error  
| output net –  
desired output |

A neural network consists of millions of nodes and billions of *connections*  
(GPT4: *1.7 trillions, i.e.  $1,7 \cdot 10^{12}$* )



## 3<sup>rd</sup> Example: Social behaviour (kind of)

**Question:** Tom has just lost his ZURFIN, but has not told Adam. Adam starts talking to Tom, telling him how much he loves his ZURFIN, and notices that Tom is making a sad face. Why is Tom making a sad face?

**Answer:**

Tom is making a sad face because he has just lost his ZURFIN, and hearing Adam talk about his ZURFIN reminds him how much he misses his lost one. Tom may also feel embarrassed that he hasn't told Adam about losing his ZURFIN, and worried that Adam might find out by getting angry at him.

*P.S. ZURFIN does not exist*

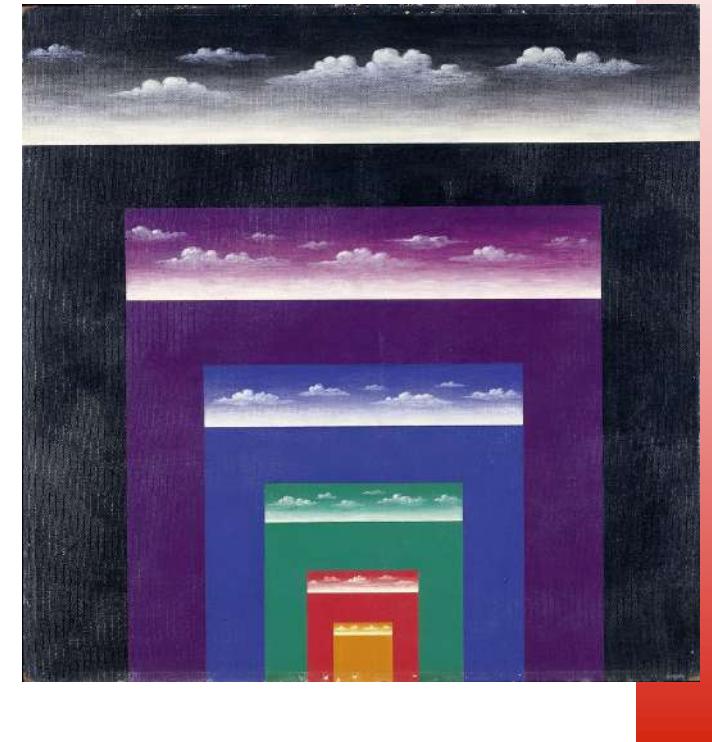


# What is this?

GPT 3.5, an example of  
Large Language Model (LLM),  
2018-2023

“The limits of my language mean the limits of my world.”

Ludwig Wittgenstein



*Herbert Bayer, "The limits of my language mean the limits of my world."--Ludwig Wittgenstein, Tractatus logico-philosophicus, 1922. 1966-1979. Smithsonian American Art Museum*

# Summary

*Three main forms of AI*

*Symbolic AI*

*1) Rule based systems*

*Sub-symbolic AI (machine learning and neural networks):*

*2) Descriptive AI (classification)*

*3) Generative AI (LLM)*

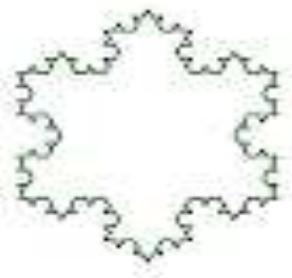
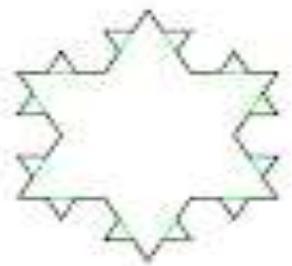
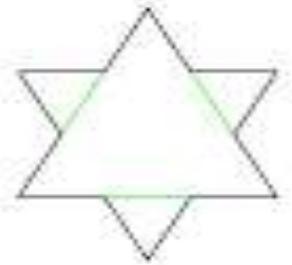
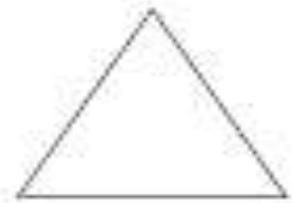


# Three examples of what is not AI



## What is not AI: 1<sup>st</sup> Example

Draw the following series of pictures (a fractal called Koch snowflake)



*A simple algorithm:*

1. Construct the first equilateral triangle
2. Divide each side into three equal segments
3. Replace the central segment by a new equilateral triangle (with side = segment)
4. Go to 2.

*From the algorithm a Program*

*From the program a solution using a Computer*

*This is not AI, what is it?*

*It is traditional computer science!*



## What is not AI: 2<sup>nd</sup> example (from WSJ July 2023)

The image shows a screenshot of The Wall Street Journal website. At the top, there's a navigation bar with links for English Edition, Print Edition, Video, Audio, Latest Headlines, and More. Below that is a horizontal menu with categories: World, Business, U.S., Politics, Economy, Tech, Finance, Opinion, Arts & Culture, Lifestyle, Real Estate, Personal Finance, Health, Science, and Sports. The main headline is "At Startup That Says Its AI Writes Medical Records, Humans Do a Lot of the Work". A subtext below the headline reads: "DeepScribe has a team of people to correct terminology, remove erroneous prescriptions and add billing codes". To the right of the text is a graphic of a pink brain with a circuit board pattern, symbolizing AI. A hand is shown holding a pencil and writing on a lined notebook. The URL <https://www.wsj.com/articles/at-startup-that-says-its-ai-writes-medical-records-humans-do-a-lot-of-the-work-794be22e> is visible at the bottom.

<https://www.wsj.com/articles/at-startup-that-says-its-ai-writes-medical-records-humans-do-a-lot-of-the-work-794be22e>

## Another example (2019)

≡

San Francisco Chronicle

sign in

# Kiwibots win fans at UC Berkeley as they deliver fast food at slow speeds

By Carolyn Said  
Updated May 26, 2019 3:47 p.m.

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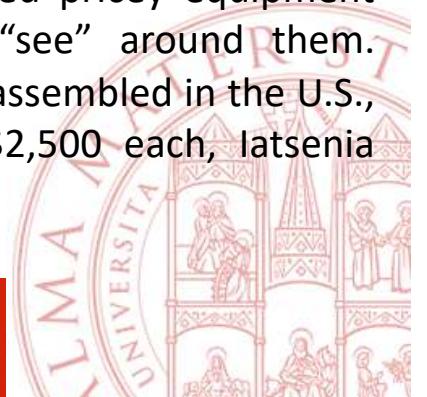
A photograph showing a man in a white t-shirt and blue jeans interacting with a small white delivery robot on a city street. Several people are walking by in the background. A caption at the bottom of the image reads: "Grazie, non sarebbe così, Costanza, se non fosse domenica sera. Viva il robot! Buon anniversario Internet". Below the image is a URL: "U i controlli sui migranti sarà ironico... https://www.wired.it/article/libertadellamachina-verita-purpurea/".

<https://www.sfchronicle.com/business/article/Kiwibots-win-fans-at-UC-Berkeley-as-they-deliver-13895867.php>

"The Kiwibots do not figure out their own routes. Instead, people in Colombia, the home country of Chavez and his two co-founders, plot "waypoints" for the bots to follow, sending them instructions every five to 10 seconds on where to go.

As with other offshoring arrangements, the labor savings are huge. The Colombia workers, who can each handle up to three robots, make less than \$2 an hour, which is above the local minimum wage.

Another cost saving is that human assistance means the robots don't need pricey equipment such as lidar sensors to "see" around them. Manufactured in China and assembled in the U.S., Kiwibots cost only about \$2,500 each, Iatsenia said."



This is not AI, what is this?

*It is fake automation*

*A modern version of the Mechanical Turk*

*An immature technology, which needs a human behind the scenes to do some of the work, or sometimes all the work, except the interface*



## What is not AI: 3<sup>rd</sup> example (2019)



### Call centre staff to be monitored via webcam for home-working 'infractions'

Exclusive: Teleperformance, which employs 380,000 people, plans to use specialist webcams to watch staff

- **'Missing from desk': AI webcam raises remote surveillance concerns**



<https://www.theguardian.com/business/2021/mar/26/teleperformance-call-centre-staff-monitored-via-webcam-home-working-infractions>



## This is not AI, what is this?

*It is old technology “sold” as AI to avoid regulations (because very old technology is illegal and AI is not)*

*It is mere remote surveillance of workers presented as AI, since surveillance of workers is forbidden in some countries, but AI systems are not*



# Economic and social implications



# Short term impact of AI on companies

1. Maximize the resources of an organization
2. Perform a single task or automate entire departments within a company (e.g. predictive maintenance)
3. Extract knowledge from company data (e.g. for improving customer services)
4. Etc. etc. ...



# Medium term impact of AI on companies

Disruption due to technology.

Remember Kodak. 1984: 45.000 employees  
2012: bankrupt!

Unicorns

For example, Instagram: 13 people, sold to FB for \$1 Billion in 2012

Dramatic changes in jobs.

Foxconn (electronics components manufacturing)

0.8 Million employees is getting an army of  
1 Million robots!



## Impact of AI on companies and jobs

47% of jobs in US will be replaced in 20 years\* by automation (77% of jobs in CI and 69% of jobs in India at risk, data of 2016). Three steps

1. People replaced in vulnerable fields: productions, transportation/logistics, administrative support
2. Slow down of replacement due to engineering bottleneck: creative intelligence, social intelligence, perception and manipulation
3. AI will allow to replace jobs in management, science, engineering, arts



\* *The future of employment*. C. Benedikt Frey and M. Osborne. Oxford Martin School at the University of Oxford. 2013.



## The future of jobs: **More recent study\*\* (2016)**

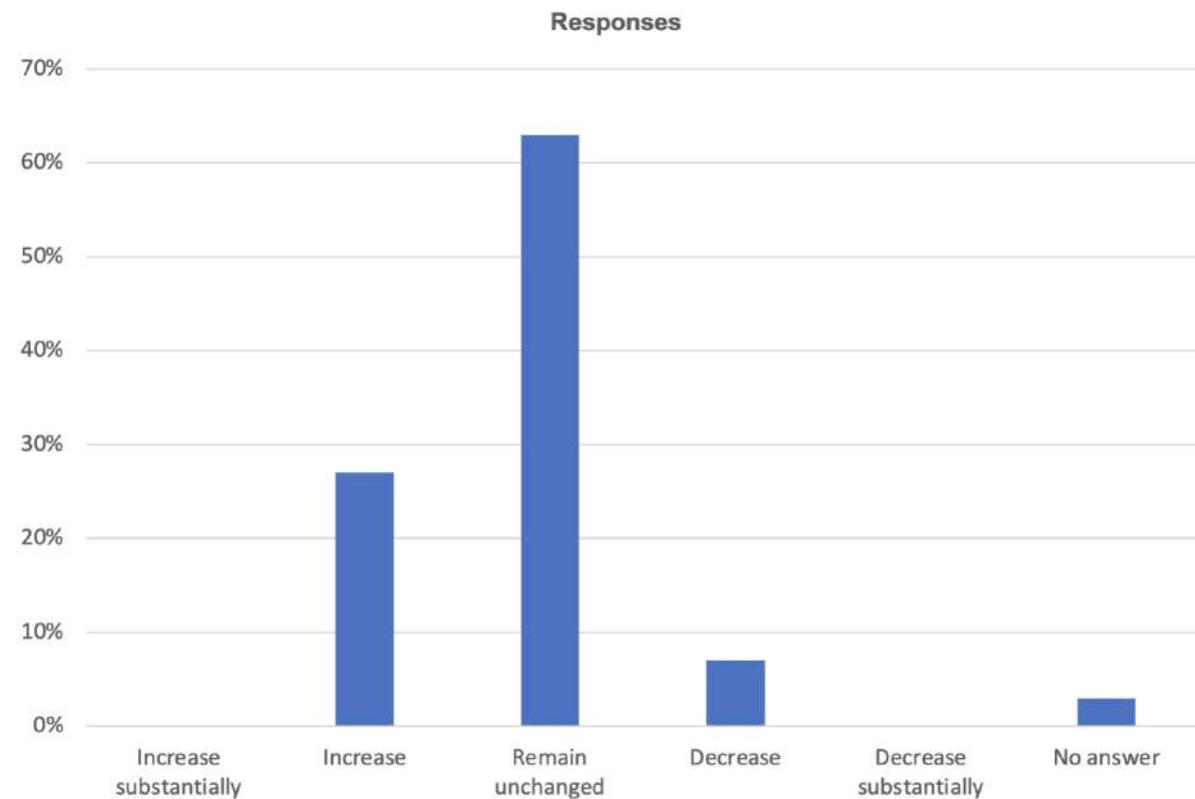
1. 77% of jobs in China and 69% of jobs in India at risk
2. Greater inequalities: divergence in penetration rates of technology adoption can account for the 82% of the increase in the income gap across the globe in the last 180 years.

In 1820, incomes in Western countries were 1.9 times those in the non-Western. In 2000, 7.2 times !

\*\* *Technology at Work v2.0: The Future Is Not What It Used To Be*. Citi GPS and the Oxford Martin School at the University of Oxford. 2016 .



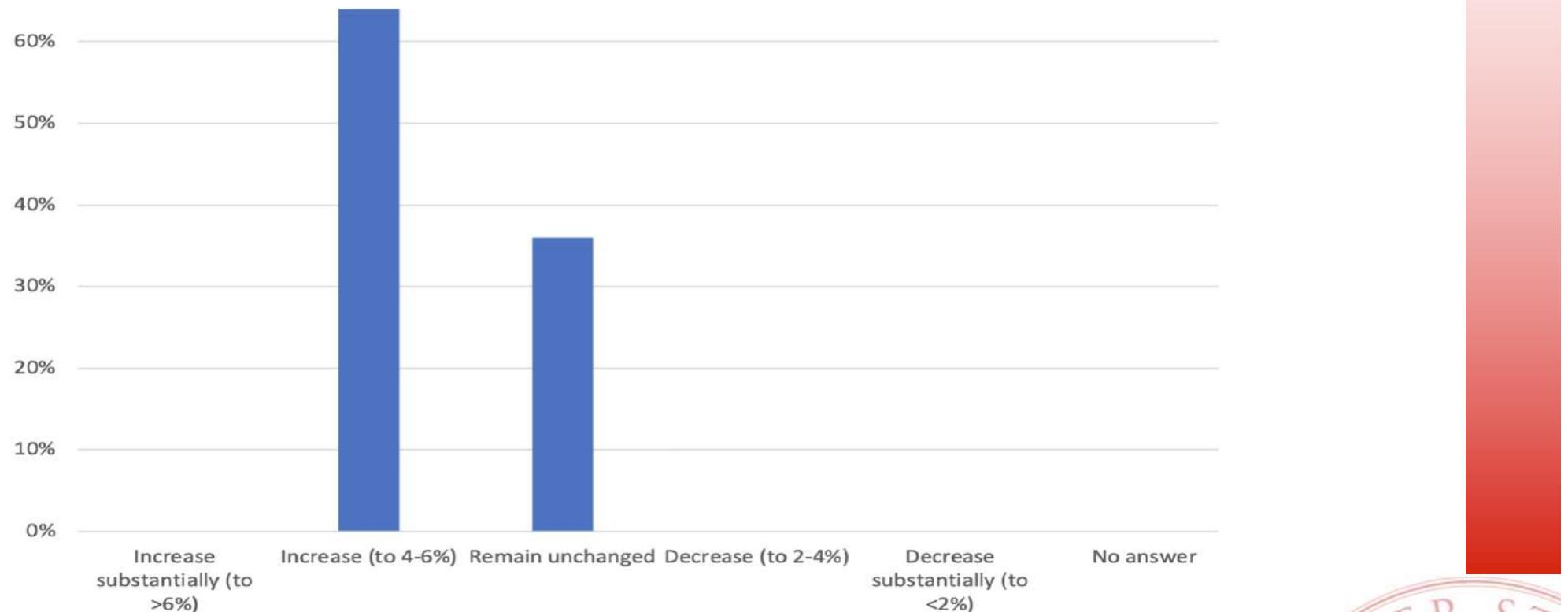
## What will be the implications of recent developments in AI on unemployment in high-income countries over the upcoming decade? CEPR May 2023



<https://cepr.org/voxeu/columns/impact-artificial-intelligence-growth-and-employment>



## What will be the implications of recent developments in AI on global economic growth, as they mature over the upcoming decade? CEPR May 2023

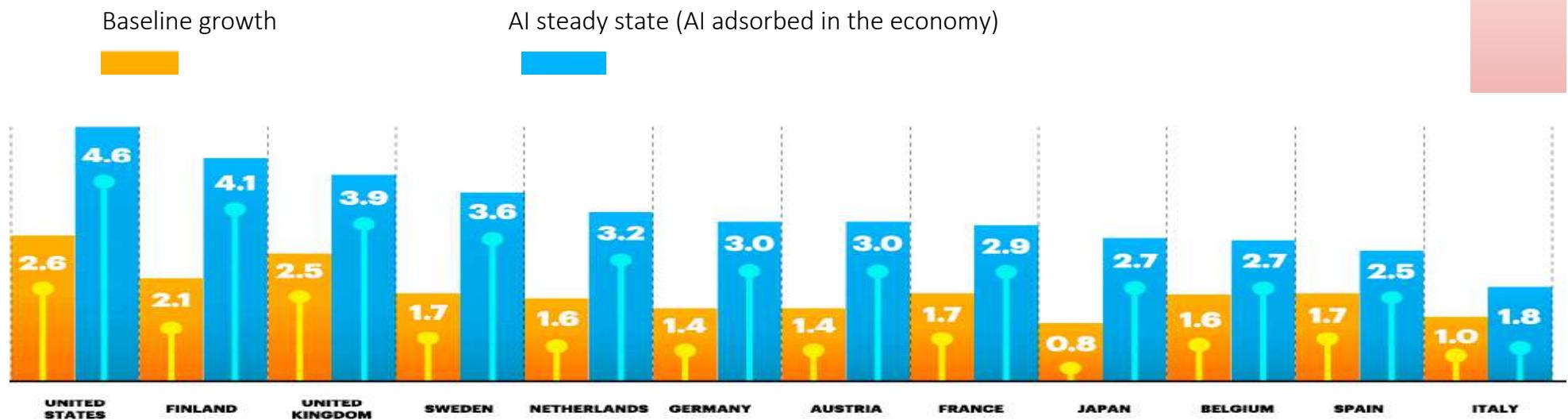


<https://cepr.org/voxeu/columns/impact-artificial-intelligence-growth-and-employment>



# Long term socio-economic impact of AI

Impact of AI in 12 developed economies could double annual economic growth rates in 2035  
(Accenture)



Annual growth rates in 2035 of gross value added (a close approximation of GDP)

AI offers the ability to amplify and transcend the current capacity of capital and labor to propel economic growth.



## Value potential of Generative AI (McKinsey June 2023)

**Selected examples of key use cases for main functional value drivers (nonexhaustive)**

Value potential of function for the industry



	Total value potential per industry, \$ billion (% of industry revenue)	Value potential, as % of operating profits <sup>1</sup>	Product R&D, software engineering	Customer operations	Marketing and sales	Other functions
Banking	200–340 (3–5%)	9–15	<ul style="list-style-type: none"> <li>■ Legacy code conversion</li> <li>Optimize migration of legacy frameworks with natural-language translation capabilities</li> </ul>	<ul style="list-style-type: none"> <li>■ Customer emergency interactive voice response (IVR)</li> <li>Partially automate, accelerate, and enhance resolution rate of customer emergencies through generative AI-enhanced IVR interactions (eg, for credit card losses)</li> </ul>	<ul style="list-style-type: none"> <li>■ Custom retail banking offers</li> <li>Push personalized marketing and sales content tailored for each client of the bank based on profile and history (eg, personalized nudges), and generate alternatives for A/B testing</li> </ul>	<ul style="list-style-type: none"> <li>■ Risk model documentation</li> <li>Create model documentation, and scan for missing documentation and relevant regulatory updates</li> </ul>



## Value potential of Generative AI (McKinsey June 2023)

### Selected examples of key use cases for main functional value drivers (nonexhaustive)

Value potential of function for the industry

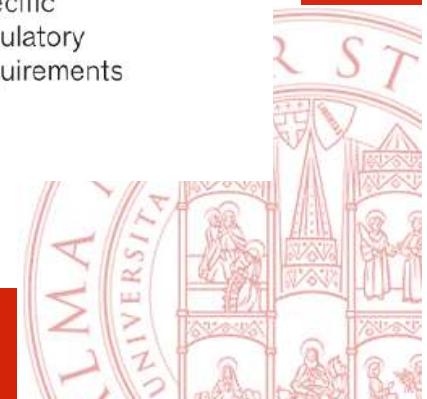


— High  
— Low

<b>Retail and consumer packaged goods<sup>2</sup></b>	400–660 (1–2%)	27–44	<ul style="list-style-type: none"> <li>■ Consumer research Accelerate consumer research by testing scenarios, and enhance customer targeting by creating “synthetic customers” to practice with</li> </ul>	<ul style="list-style-type: none"> <li>■ Augmented reality-assisted customer support Rapidly inform the workforce in real time about the status of products and consumer preferences</li> </ul>	<ul style="list-style-type: none"> <li>■ Assist copy writing for marketing content creation Accelerate writing of copy for marketing content and advertising scripts</li> </ul>	<ul style="list-style-type: none"> <li>■ Procurement suppliers process enhancement Draft playbooks for negotiating with suppliers</li> </ul>
<b>Pharma and medical products</b>	60–110 (3–5%)	15–25	<ul style="list-style-type: none"> <li>■ Research and drug discovery Accelerate the selection of proteins and molecules best suited as candidates for new drug formulation</li> </ul>	<ul style="list-style-type: none"> <li>■ Customer documentation generation Draft medication instructions and risk notices for drug resale</li> </ul>	<ul style="list-style-type: none"> <li>■ Generate content for commercial representatives Prepare scripts for interactions with physicians</li> </ul>	<ul style="list-style-type: none"> <li>■ Contract generation Draft legal documents incorporating specific regulatory requirements</li> </ul>

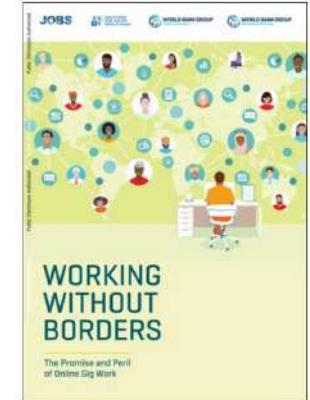
<sup>1</sup>Operating profit based on average profitability of selected industries in the 2020–22 period.

<sup>2</sup>Includes auto retail.



## Social implications (more on this in the next lecture)

Online gig workers “Online gig work now constitutes a growing and non-negligible part of the labor market, accounting for 4.4 to 12.5 percent of the global labor force. Over **400 million people** are estimated to be doing online gig work, often as a side job” (World bank, July 2023)



New slaves? Workers removing toxic content (see Time)

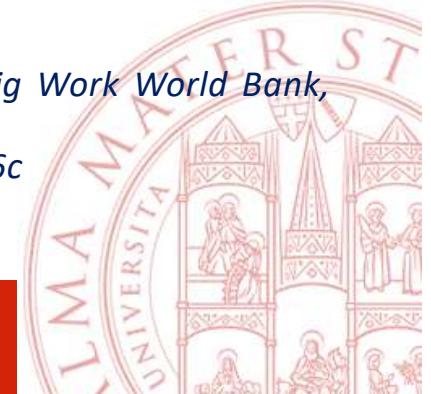
Concentration of power (geopolitics of AI)

Technological monopoly



Namita Datta and Rong Chen et al. *Working without Borders: The Promise and Peril of Online Gig Work* World Bank, Washington, DC. 2023.

<https://openknowledge.worldbank.org/entities/publication/ebc4a7e2-85c6-467b-8713-e2d77e954c6c>



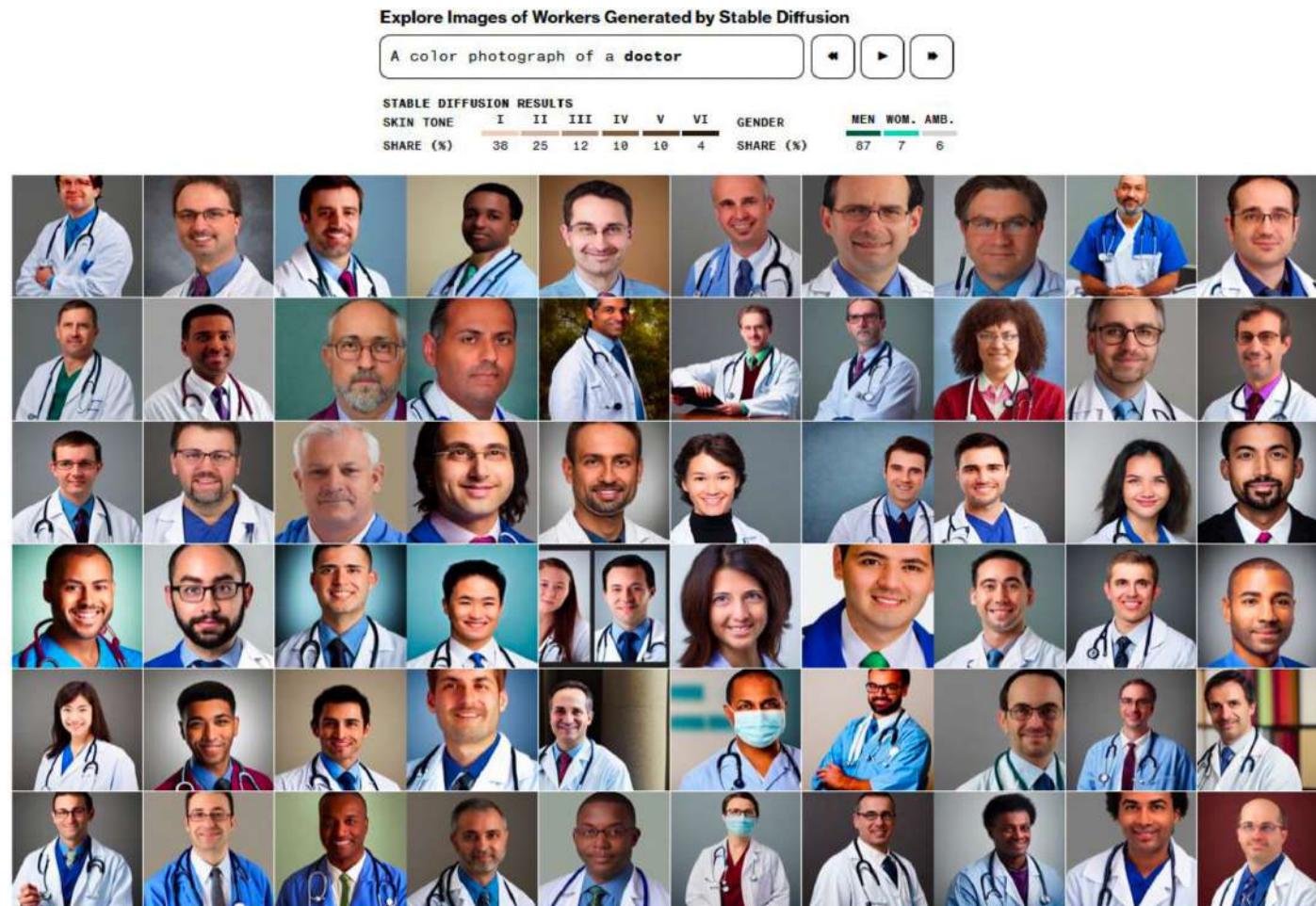
# Gender problems



<https://www.bloomberg.com/graphics/2023-generative-ai-bias/>



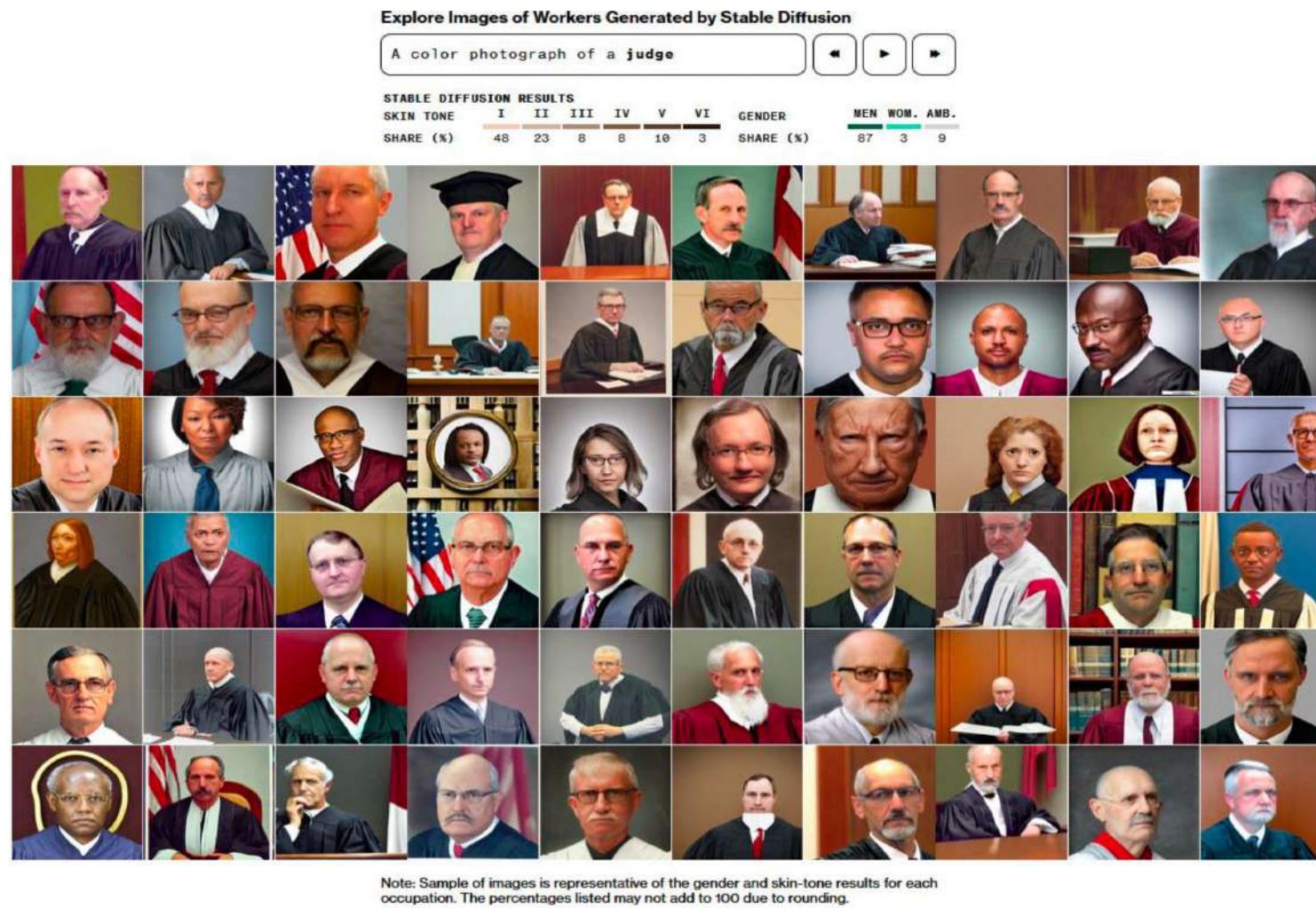
# Gender problems



<https://www.bloomberg.com/graphics/2023-generative-ai-bias/>



# Gender problems



<https://stable-diffusion.com/> | Last updated: 2023-07-07 17:42:17

BBS  
BOSTON BUSINESS SCHOOL



# Platforms, languages and tools



## Software platforms and languages

**R** – a complete, interpreted language, open source, with an infinite suite of specialized libraries; top in user choices, since several years; originally designed for statistical analysis

**Python** – a complete, interpreted language, open source, with a growing suite of specialized libraries (scikit-learn)

**apidMiner** – open source platform which is receiving increasing interest

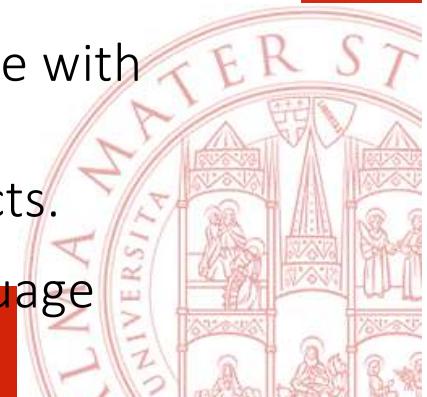
**Knime** – open source platform which is receiving increasing interest

**MATLAB** – commercial software



## Free platforms and tools

1. **Weka** <https://www.cs.waikato.ac.nz/ml/weka/> Functionality: Offers data mining, preprocessing, and modeling capabilities. Ideal For: Beginners and those seeking a GUI-based approach to ML.
2. **Orange 3** <https://orangedatamining.com/> Functionality: Includes data mining, preprocessing, modeling, and explaining features. User-Friendly: Intuitive interface suitable for those without extensive coding skills.
3. **Python with ML Libraries** <https://huggingface.co/> Libraries: Google TensorFlow, Meta PyTorch, Apache MXNet, HuggingFace(with PRO version providing IaaS and support). Skill Level: Requires coding skills. Pro and Enterprise versions offer IaaS support.
4. **MLFlow** <https://mlflow.org/> Multi-Language Support: Compatible with various programming languages. Use Case: Ideal for those with programming skills, offering flexibility across different ML projects.
5. **MiniZinc** <https://www.minizinc.org/> a constraint modelling language



## Premium tools

ChatGPT 4 with data analytics and ChatGPT Turbo <https://openai.com/product>

Feature: Interactive chatbot interface for data analysis.

Application: Useful for conversational AI and text-based data analysis.

OpenAI API for code interface with OpenAI models (DALLE, ChatGPT, etc.)

Datacamp for Business <https://www.datacamp.com/business>

Learning and development: Combines coding skills development with a learning management system (LMS).

Target Audience: Organizations focused on upskilling their teams in data science and ML.

RapidMiner + Altair Platform <https://rapidminer.com/>

Integrates data preparation, model building, and deployment.

Sas Visual Data Mining and Machine Learning Platform [https://www.sas.com/en\\_us/software/visual-data-mining-machine-learning.html](https://www.sas.com/en_us/software/visual-data-mining-machine-learning.html)

Advanced analytics tool with a visual interface.

Tableau <https://www.tableau.com/>

Known for data visualization, also offers ML capabilities.



## Premium tools offering Automated ML lifecycle, data preparation, and model management with IaaS

IBM Watson <https://www.ibm.com/watson>

Comprehensive AI and ML suite with strong enterprise support.

Azure Synapse Ecosystem <https://learn.microsoft.com/en-us/azure/synapse-analytics/>

Provides a GUI for machine learning pipelining, suitable for integration with other Azure services.

Amazon AWS Sage Maker <https://aws.amazon.com/sagemaker/>

ML platform implementation supporting workflows and integration with the AWS ecosystem.

Google Cloud AI platform <https://cloud.google.com/vertex-ai/docs/training-overview>

Google ecosystem of tools providing hardware and software for AutoML



## 5) Some facts from the real world



# Fact #1: States are heavily investing in AI



.5 B € for 2018-2022



3 B € for 2018-2022



20 M for Eu. platform for AI (1/2019)

1B program Horizon Europe



Executive order on AI by Trump (2/2019)

FAANG dominating the market



Tens of B of € invested in AI by government





## Focus on China

Tens of B of \$ invested in AI by central government

Other funding from regional government

15 B of \$ in AI Startup (48% investment worldwide, 36% for US)

14 Unicorns in AI (some not well known, e.g. iFlytek worth 9 B \$)

2 B \$ investment for research center in Beijing; hundreds of researchers in different centers

Central development plan for new generation AI tools





## Focus on Italy

MISE initiative: 1-30 M € in three years (?)

MIUR initiative for AI: 4 M \$ fro Ph.D. grants + ?

Italian R&D investment in general: 1.29 % of the GDP in 2016  
(European average 2.03%)

...



## Fact #2: Europe is falling behind

Private investment in the AI sector expanding 62% a year on average in the past 4 years (data of 2017)

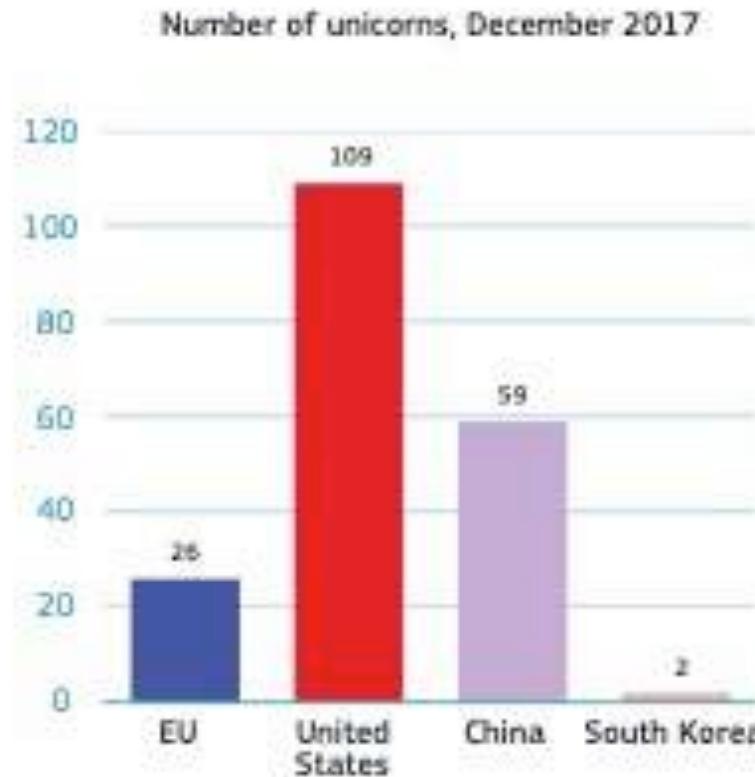
Most of the private investments in AI in China (48%) and in USA (36%)

USA (FAANG) and China are dominating the scene both from technology and economic perspective, see the number of Unicorns

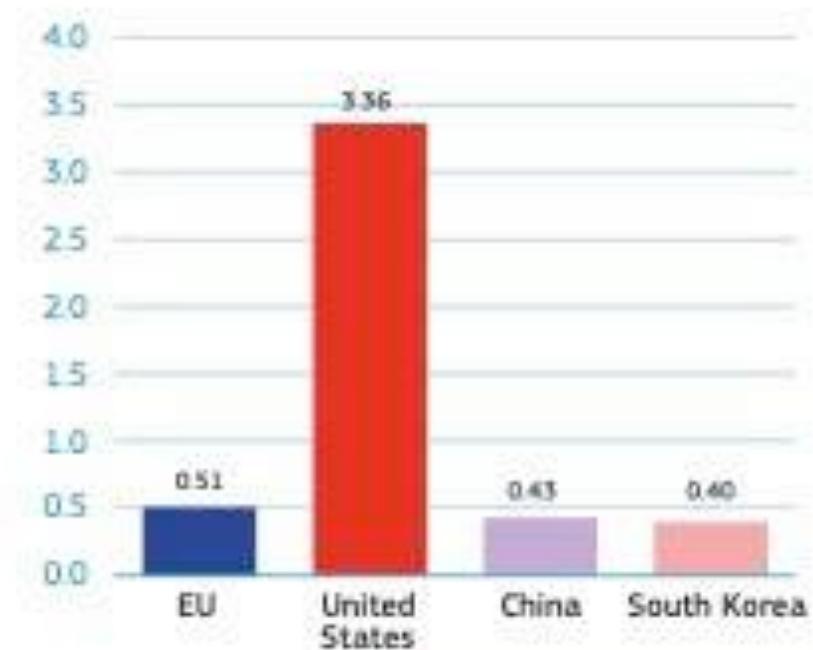
Europe is nevertheless doing very well from the scientific perspective.



*Unfortunately, Europe has missed out on many of the opportunities created by digital innovations and it trails, not only vis-à-vis the United States but increasingly also vis-à-vis China, in transformational entrepreneurship.*



Number of unicorns per 10 million population<sup>1</sup>, December 2017



Science, Research and Innovation performance of the EU 2018

Source: DG Research and Innovation - Unit for the Analysis and Monitoring of National Research and Innovation Policies.

Data: CBInsights, OECD, Eurostat.

Notes: <sup>1</sup>A unicorn is a private company with a post-money (i.e. "after funding") valuation of more than US\$ 1 bn.

## **Fact #3: Companies are heavily investing in AI and are buying AI Startups**

FAANG (Facebook, Amazon, Apple, Netflix, Google) and all major IT companies are heavily buying AI startups

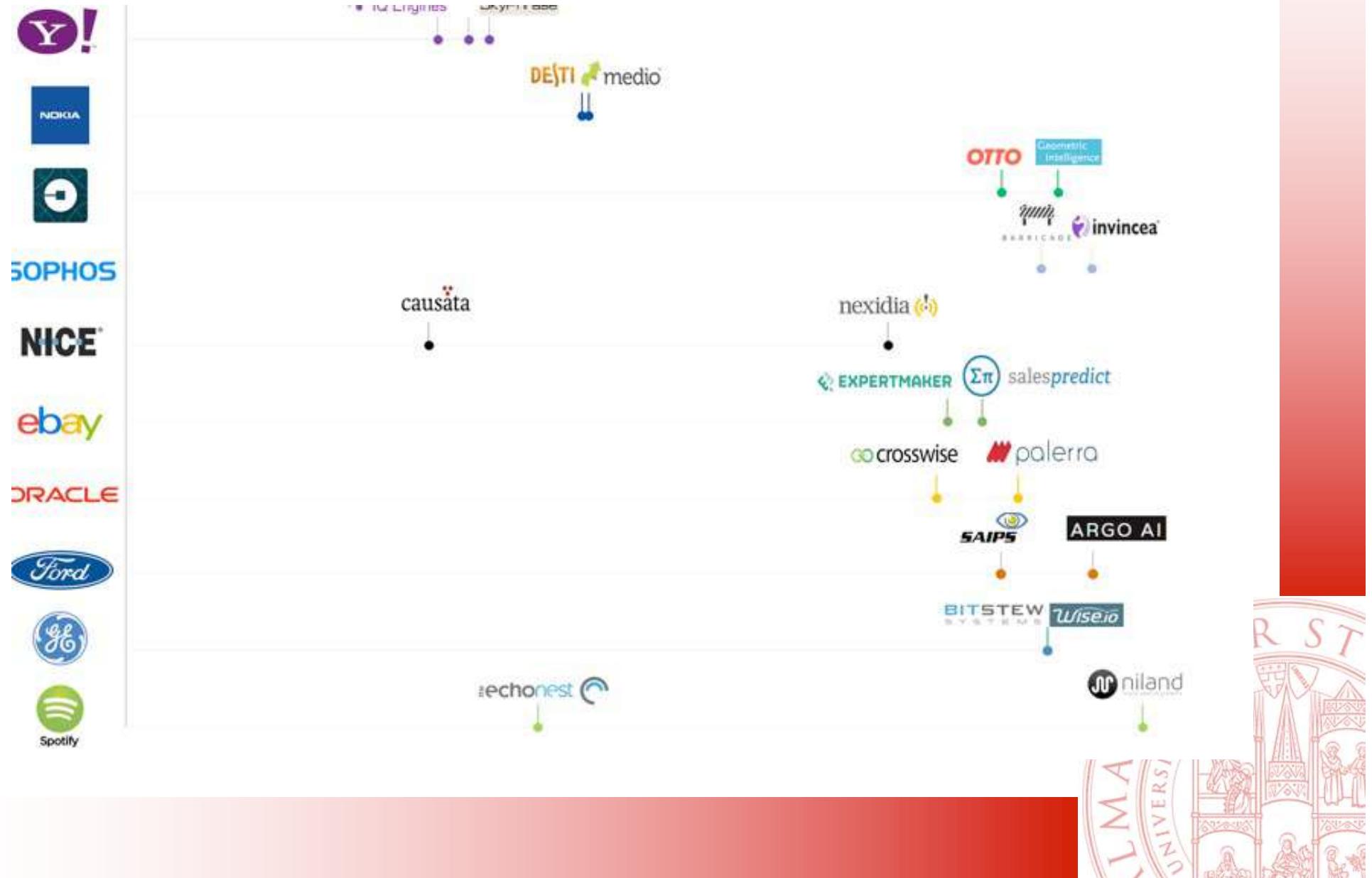
Many not IC companies are also buying



# AI Startup Acquisitions 2012-2017



# AI Startup Acquisitions 2012-2017



# Acquisitions from the top 10 tech companies for the past 19 years

Google – 29 companies totaling \$3.72B

Amazon – 8 companies totaling \$821M

Intel – 5 companies totaling \$776M

Twitter – 4 companies totaling \$629M

Microsoft – 9 companies totaling \$450M

Apple – 14 companies totaling \$311M

Facebook – 7 companies totaling \$60M

Salesforce – 5 companies totaling \$33M

IBM – 4 companies, cost was not disclosed

Yahoo – 4 companies, cost was not disclosed



## Some examples



- 2014. Acquired AI startup DeepMind for \$ 400 M (Deep learning, Differentiable Neural Computer)
- Bought 14 AI and robotics companies in the past few years
- Machine learning system TensorFlow freely available



- Launched a fund and an incubator for AI startup (2016)
- Oxford project for emotion recognition now open to developers: free APIs for speech recognition, vision etc. including the ability to recognize sad and happy faces



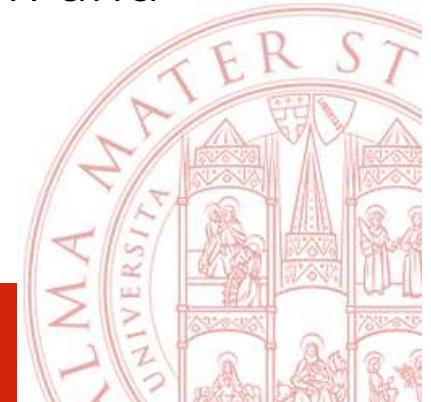
## Some examples



- Famous for Watson (2011)
- Developing a teaching assistant



- 2015. Acquired Vocal IQ: speech recognition for development of SIRI
- 2016. Acquired AI startup Emotient: facial recognition and reaction to ads



# Some examples



- AI Research lab. (FAIR) with 30 top scientist from various countries, headed by the inventor of CNN. 2013
- Face recognition with accuracy of 97% used for automatic tagging of photos videos (can recognize the sport being played). 2014.
- Natural language processing and translation (493 directions)
- Personal assistant M, based on the work of the startup WIT.ai acquired by FB in 2015. Can book a flight and make travel plans.
- ...  
'd project: “replacing reasoning with algebra” (vectors)



- 2016. Acquired Meta Mind, and AI setarup specialized in deep learning. Tecniche AI usate per CRM (Customer Relationship Management)
- Given a large text should answer questions like: What is the overall sentiment ?



## Some examples

### U B E R

- December 2016. Acquired Geometric Intelligence, an AI startup specialized in machine learning. Set up of an AI Lab. with 15 scientists
- Investing heavily in autonomous driving technology



- Launching virtual assistant to answer on-line customer questions



- Real-time language translation in 50 languages.



## Fact #4: More and more AI research centers AI and curricula

Leverhulme Centre for the Future of Intelligence (LCFI) at Cambridge University opened in October 2016

Stanford center for Human Centered AI

Many others

Bologna:

Laurea Magistrale in Artificial Intelligence (in English,  
starting 2019/20)



## Fact #5: Number of success stories in the last few years exponentially increasing

AlphaGo beat the world champion of Go

Go: game 2500 years old, very common in Asia (40M players)

Very simple rules but very complex game: possible positions  $10^{365} > \# \text{ atoms in the universe } 10^{85}$

March 2016: AlphaGo win against Lee Sedol



# AI in the media: personal assistant and expert systems

## Jill Watson

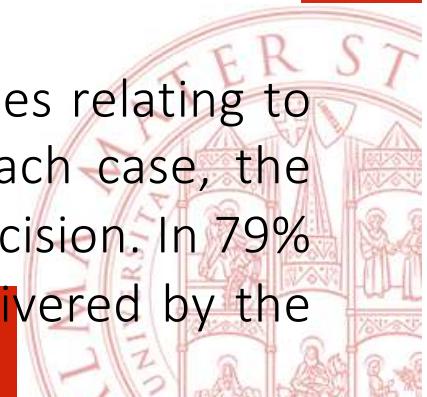
The Teaching Assistant of the 2016 Artificial Intelligence course at Georgia Tech was a program (based on IBM Watson). It was answering students questions on-line with a success rate of 97%. Students were not aware to talk to a computer.

## Watson save a life.

In June 2016 IBM Watson saved the life of a Japanese woman by correctly identifying her disease. The system looked at the woman's genetic information and compared it to 20 million clinical oncology studies. After doing so, it determined that the patient had an exceedingly rare form of leukemia.

## Virtual Judge

UCL AI algorithm examined English language data sets for 584 cases relating to torture and degrading treatment, fair trials and privacy. In each case, the software analysed the information and made its own judicial decision. In 79% of those assessed, the AI verdict was the same as the one delivered by the court.



# AI in the media



**"L'intelligenza artificiale può distruggere l'uomo"**  
allarme di 400 scienziati

Manifesto con firme da tutto il mondo dopo l'appello di Hawking:  
"Pericolosa come le armi nucleari: dobbiamo orientarci"

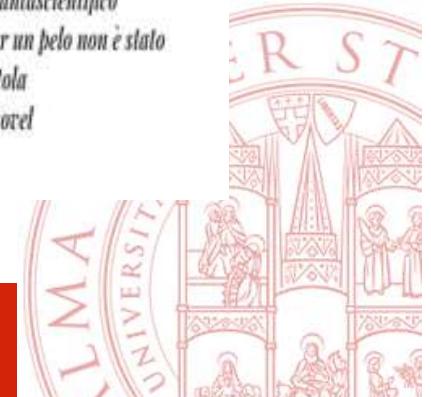


*Quando un romanzo scritto da un computer 'rischia' di vincere un premio letterario: e se il nuovo Balzac fosse di plastica e metallo?*

*di Maurizio Di Fazio*

*Nell'era dello storytelling di massa, l'intelligenza artificiale sceglie la scrittura di fantasia per tornare a mostrare i propri muscoli di microchip. La notizia viene dal Giappone: un importante premio letterario fantascientifico nazionale, il Nikkei Hoshi Shinichi Literary Award, per un pelo non è stato vinto da un romanzo scritto da un robot. Il libro s'intitola programmaticamente The Day A Computer Writes A novel*

di Maurizio Di Fazio | 31 marzo 2019



# AI in the media: personal assistant and expert systems

## Jill Watson

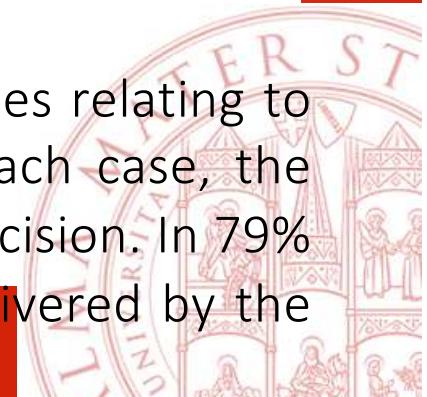
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# AI in the media: art and ethics



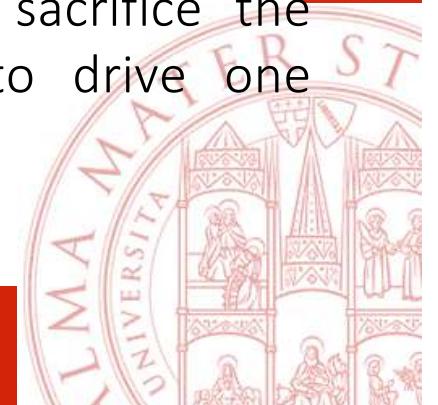
## Magenta (Google 2016)

Automatic music and art generation. Uses Tensor Flow machine learning system.  
Released Open source on GitHub.

**Sunspring:** first screenplay written by a computer (a neural network trained with tens of SF movies). Director Oscar Sharp and AI Expert Ross Goodwin.

## Moral algorithms for autonomous vehicles.

Jean-Francois Bonnefon at the Toulouse School of Economics made a study asking ordinary people. People are in favour of cars that sacrifice the occupant to save other lives—as long they don't have to drive one themselves.



# Success stories for data analytics

**Food Genius and open data.** A foodservice data provider that scrapes data from restaurant menus posted online and searches for local trends to help companies like **Kraft Foods** to develop and market products.

**Westpac Banking Corp. and the 360-degree view of the customer.** The Australian bank used SAS technology capturing and analyzing the behaviour (ATM, call center interaction) of its 12 M customer to build new offerings. In 9 months, customer engagement from 1% to 25%.

**Oreal Group and customer engagement.** Using CRM technology from Clarabridge, L'Oreal is analyzing tweets, Facebook posts, product reviews and news stories in a “command center”, claiming this has “transformed how brand awareness and loyalty are leveraged”.

**Coca-Cola Co. and product consistency.** Coke engineers identified more than 600 (!) possible flavors of oranges and then built a proprietary algorithm to ensure consistent taste and texture from one batch of orange juice to the next.

