



UNIVERSITÀ
DEGLI STUDI
DI PADOVA

Machine Learning 2024/2025



Lecture #01 Organization & Intro

Gian Antonio Susto



Let's start with some questions...

1. What is ~~Machine Learning~~ Artificial Intelligence (AI)?

Let's ask an Artificial Intelligence!



ChatGPT 4o ▾

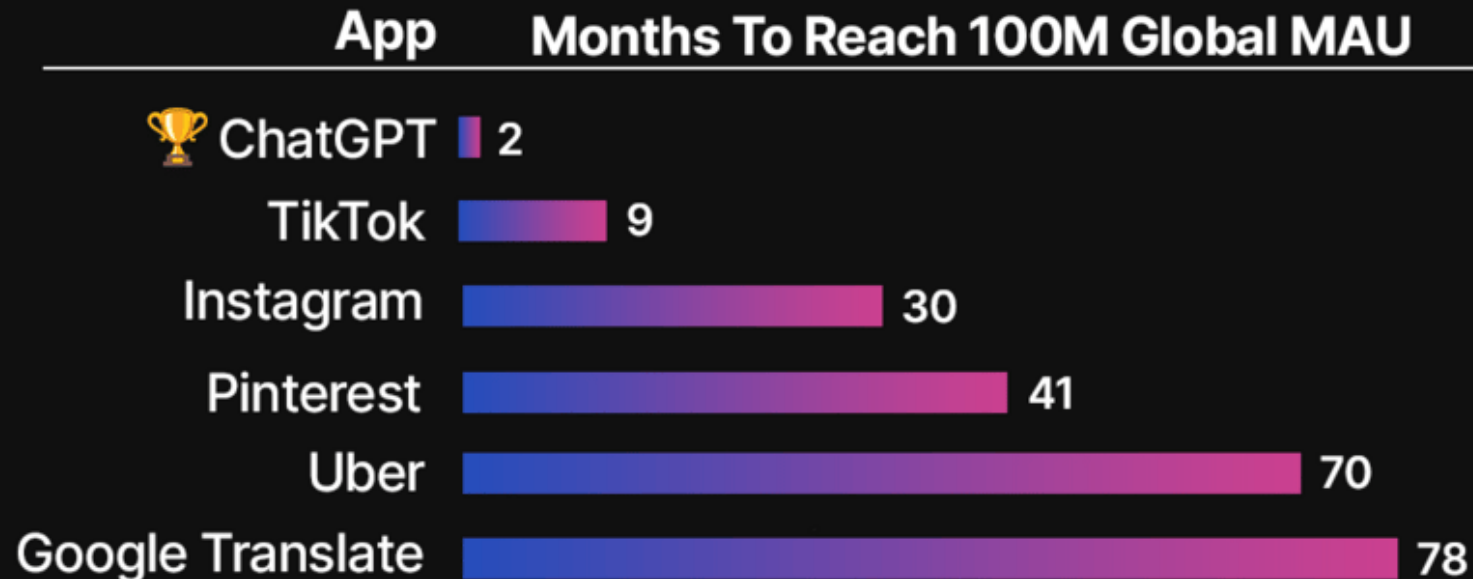
↑ Condi

a definition of artificial intelligence

Artificial Intelligence (AI) is the field of computer science that focuses on creating systems capable of performing tasks that typically require human intelligence. These tasks include learning from experience, reasoning, problem-solving, understanding natural language, recognizing patterns, and making decisions. AI encompasses a variety of techniques, such as machine learning, deep learning, and natural language processing, enabling machines to adapt and improve their performance over time.

The fastest-growing software in history!

Time it took to reach **100 million** monthly users:



Source: UBS



What an AI can do: write emails!



ChatGPT 4o ▾

↑ Condividi

ST

can you write an email to a student who is asking me why he should study machine learning?

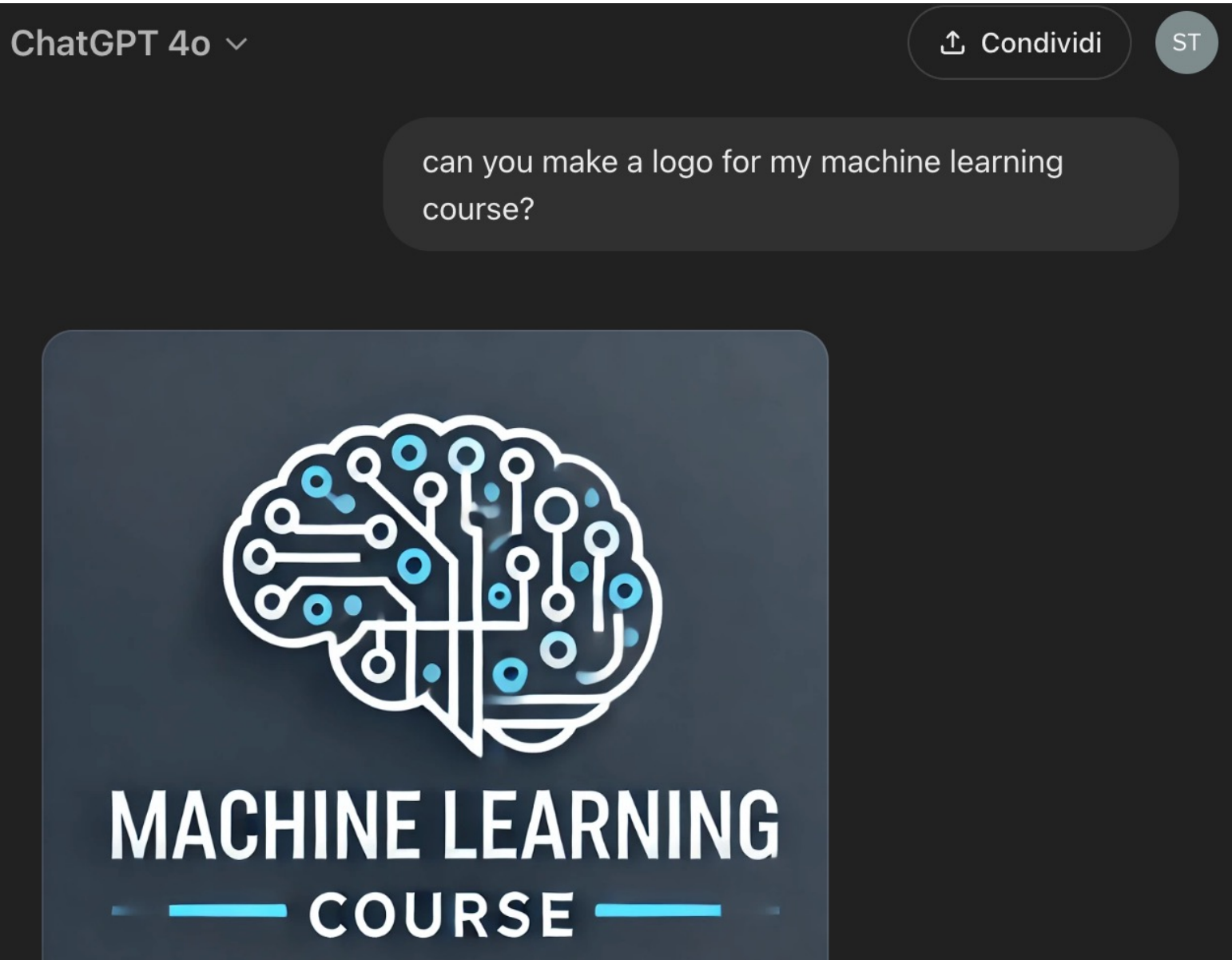
Subject: Why Study Machine Learning?

Dear [Student's Name],

Thank you for reaching out with your question about why studying Machine Learning (ML) is worthwhile. It's a great topic to reflect on, especially given the growing role of ML across industries and research fields.

Machine Learning is at the core of modern artificial intelligence and has transformative applications in fields ranging from healthcare and finance to engineering and automation. By studying ML, you'll gain the ability to develop models that can analyze patterns in data, make predictions, and automate decision-making processes—skills that are highly valued in both academia and

What an AI can do: create images!



What an AI can do: code!

can you create a neural network for image classification?

Here is a Python implementation of a **Convolutional Neural Network (CNN)** for image classification using **TensorFlow and Keras**. This model can be trained on datasets like **CIFAR-10** or **MNIST** to classify images into different categories.

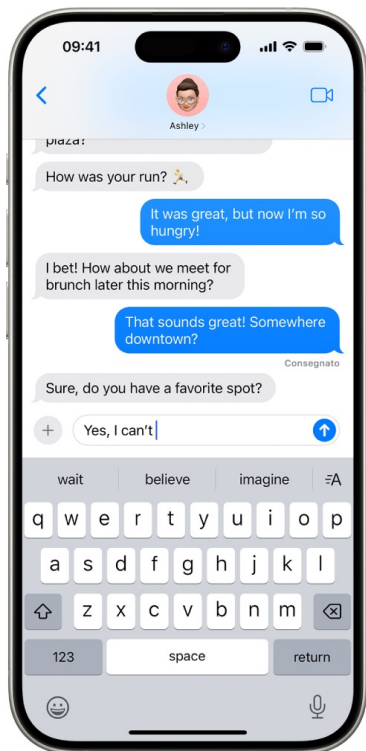
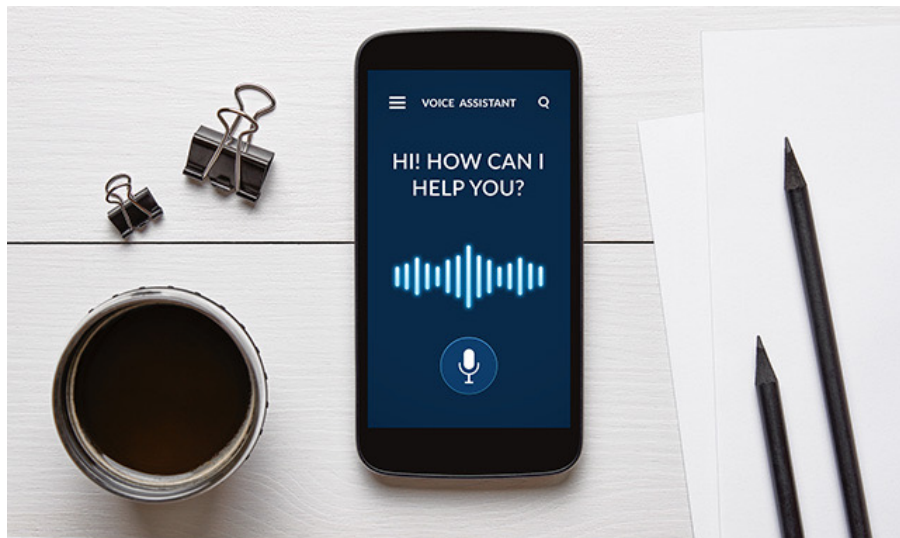
</> Cnn Image Classification

```
1 import tensorflow as tf
2 from tensorflow import keras
3 from tensorflow.keras import layers
4 import matplotlib.pyplot as plt
5 import numpy as np
6
7 # Load CIFAR-10 dataset
8 (x_train, y_train), (x_test, y_test) = keras.datasets.cifar10
9
```

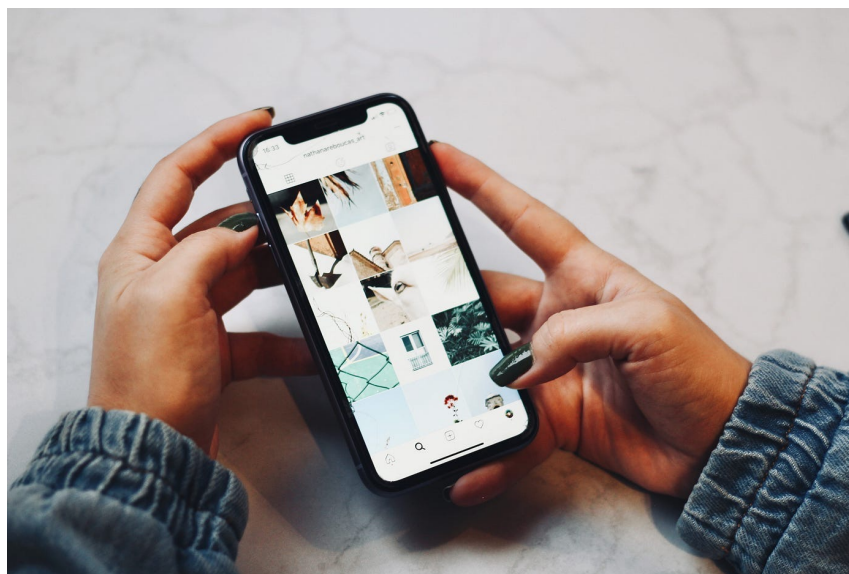


2. Have you interacted with an AI in the last 24 hours (beside ChatGPT)?

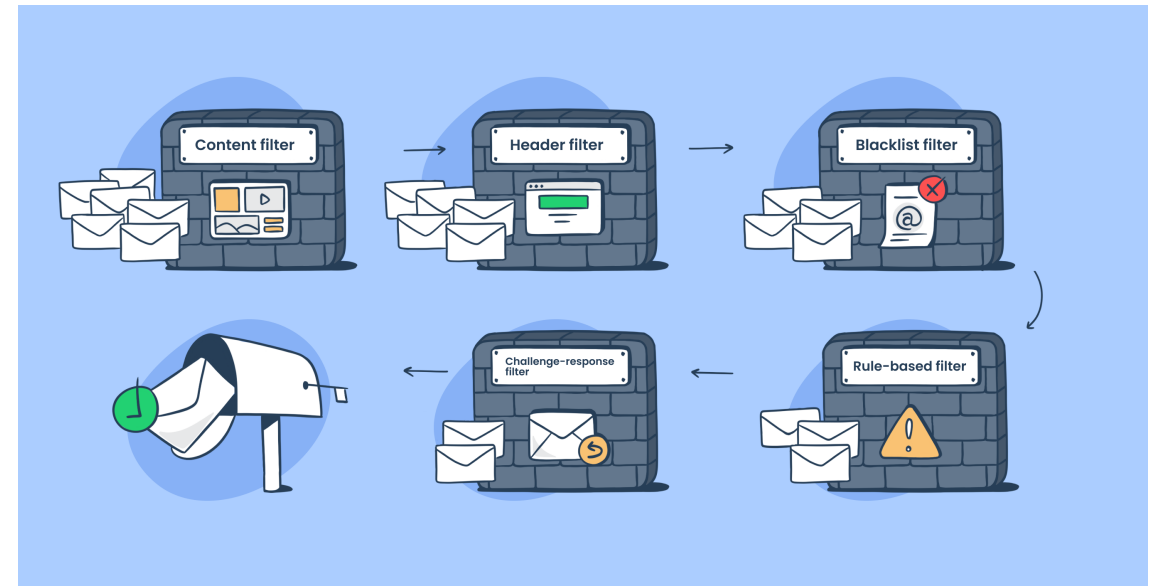
Probably, 20-50 AI techs



Testo predittivo; tocca un suggerimento per applicarlo.



Probably, 20-50 AI techs



Probably, 20-50 AI techs

Customers who viewed items in your browsing history also viewed

Page 1 of 2

Mini Buddha Board Art Set: Water Drawing Writing Board w/ Mini... ★★★★★ 1,556 \$17.95 Get it as soon as Friday, Dec 9 \$26.99 shipping	Presto 07047 Cool Touch Electric Griddle ★★★★★ 1,994 Amazon's Choice in Electric Griddles \$35.99 List: \$44.99 \$51.44 shipping	Presto Ceramic 22-inch 07062 Electric Griddle with removable handles, Black, One Size ★★★★★ 7,004 \$40.99 List: \$59.99 \$55.12 shipping	BELLA Electric Ceramic Titanium Griddle, Make 10 Eggs At Once, Healthy-Eco Non-stick... ★★★★★ 12,255 \$34.43 List: \$67.87 shipping	Presto 07072 Slimline Griddle, Black, 22" ★★★★★ 2,969 \$43.99 List: \$75.99 \$69.74 shipping	BELLA Electric Griddle w Warming Tray, Make 8 Pancakes or Eggs At... ★★★★★ 2,887 #1 Best Seller in Electric Griddles 20% off Deal \$25.50 List: \$33.99 \$73.41 shipping	BELLA XL Electric Ceramic Titanium Griddle, Make 15 Eggs... ★★★★★ 2,551 #1 Best Seller in Griddles 30% off Deal \$32.70 List: \$49.99 \$69.85 shipping	Presto 07046 Tilt 'n Drain Big Griddle Cool-Touch Electric Griddle ★★★★★ 8,478 \$63.10 List: \$78.86 shipping	DASH Deluxe Everyday Electric Griddle with Dishwasher Safe Removable Nonstick... ★★★★★ 3,609 \$59.99 List: \$69.99 \$65.15 shipping	Presto 07073 Electric Tilt-N-fold Griddle, 19", Black ★★★★★ 5,273 \$48.99 List: \$69.99 \$61.98 shipping
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Gift ideas inspired by your shopping history

Page 1 of 3

SAMSUNG Galaxy Tab A7 Lite 8.7" 32GB Android Tablet w/ Compact, Slim Design, Sturdy Metal... ★★★★★ 10,337 \$109.99 List: \$159.99 \$29.90 shipping	SAMSUNG Galaxy Tab A8 10.5" 32GB Android Tablet w/ LCD Screen, Long Lasting Battery... ★★★★★ 8,698 \$159.00 List: \$229.99 \$31.03 shipping	Lemovo Laptop Shoulder Bag T210, 15.6-inch Laptop or Tablet, Slee... ★★★★★ 17,240 Amazon's Choice in Messenger & Shoulder Bags \$15.95 List: \$19.99 \$40.22 shipping	Presto 06852 16-inch Electric Skillet with Glass Cover ★★★★★ 11,875 Amazon's Choice in Electric Skillets \$64.99 List: \$68.52 shipping	Crayola Colored Pencils Classpack, 240 Count, Bulk Classroom Supplies For Teachers, 12... ★★★★★ 5,108 19 offers from \$45.50	SAMSUNG Galaxy Tab A7 Lite 8.7" 32GB WiFi Android Tablet w/ Lon... ★★★★★ 10,337 Amazon's Choice in Computer Tablets \$109.00 List: \$159.99 \$30.18 shipping	Amazon Basics 6-Piece Nonstick, Carbon Steel Oven Bakeware Baking Set ★★★★★ 15,690 \$34.67 List: \$61.35 shipping	OXO Good Grips Silicone Flexible Pancake Turner ★★★★★ 4,833 \$14.95 \$31.01 shipping	Sceptre 24" Curved 75Hz Gaming LED Monitor Full HD 1080P HDMI VGA Speakers, VESA Wall... ★★★★★ 16,372 \$109.97 List: \$82.42 shipping	Crayola Bulk Broad Line Washable Markers, School Supplies Classpack, 200 Count... ★★★★★ 998 \$71.27 (50.56/Count) \$50.49 shipping
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NETFLIX Home TV Shows Movies Latest My List

Trending Now

- WAR
- DIE HARD 4.0
- STAR TREK DISCOVERY
- Private Lives
- BUMBLEBEE

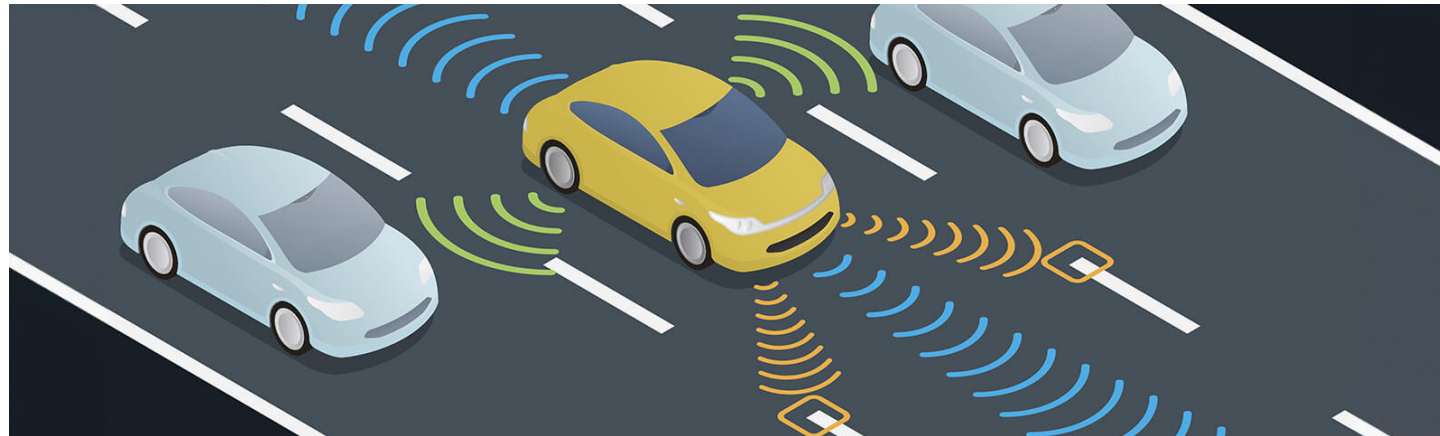
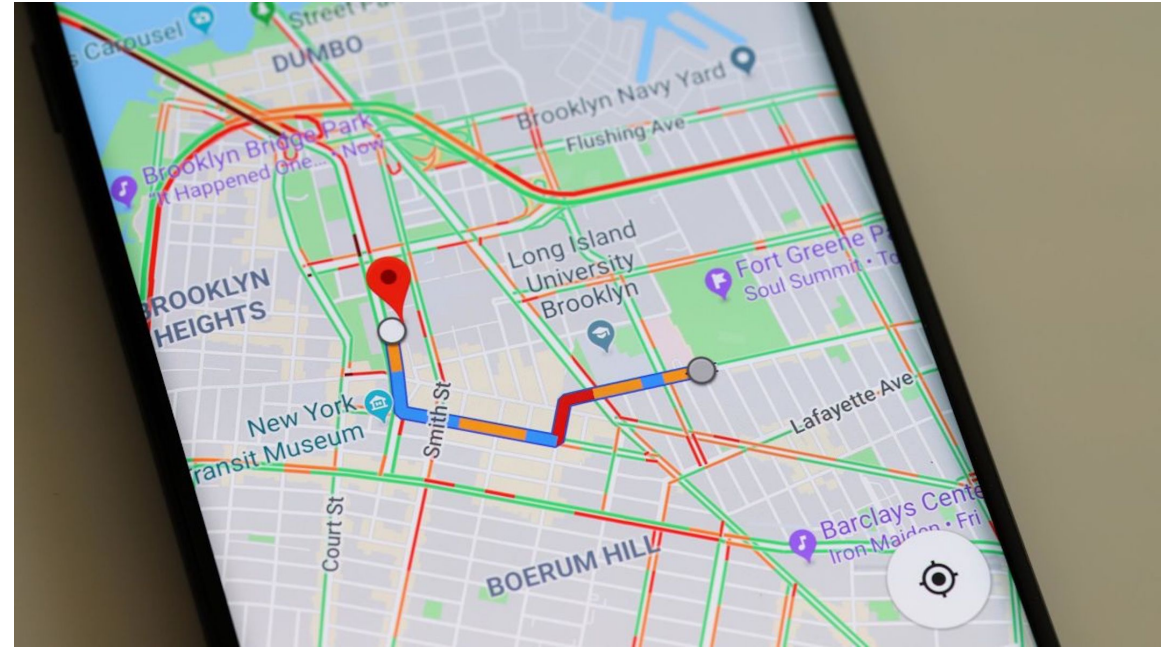
US Movies

- THE DAY THE EARTH STOOD STILL
- DOOMSDAY
- MISS PEREGRINES PECULIAR CHILDREN
- THE DAY AFTER TOMORROW
- DOOM

My List

- THE THIEVES
- START-UP
- THE FLASH
- DOOM
- UPGRADE

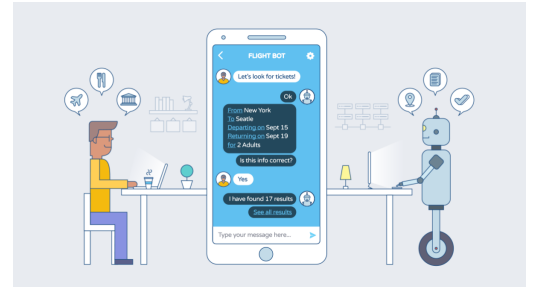
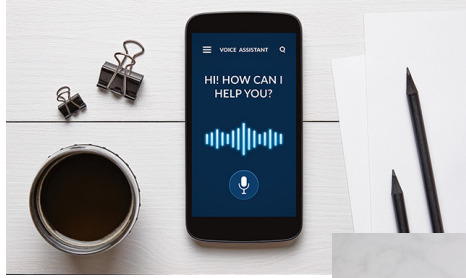
Probably, 20-50 AI techs



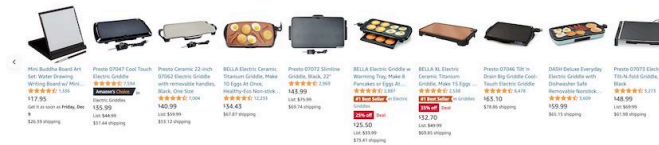
AI is pervasive



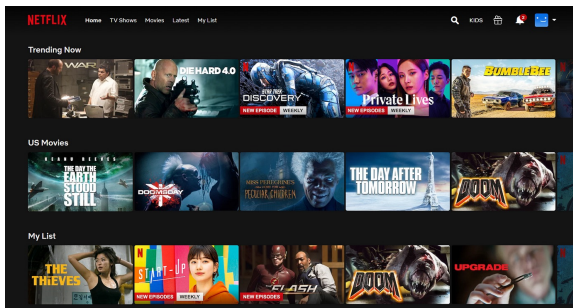
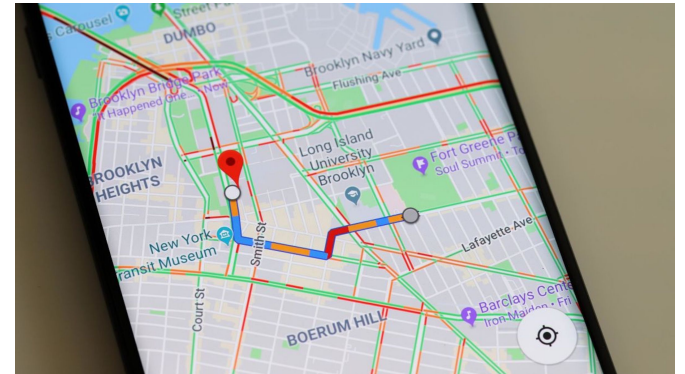
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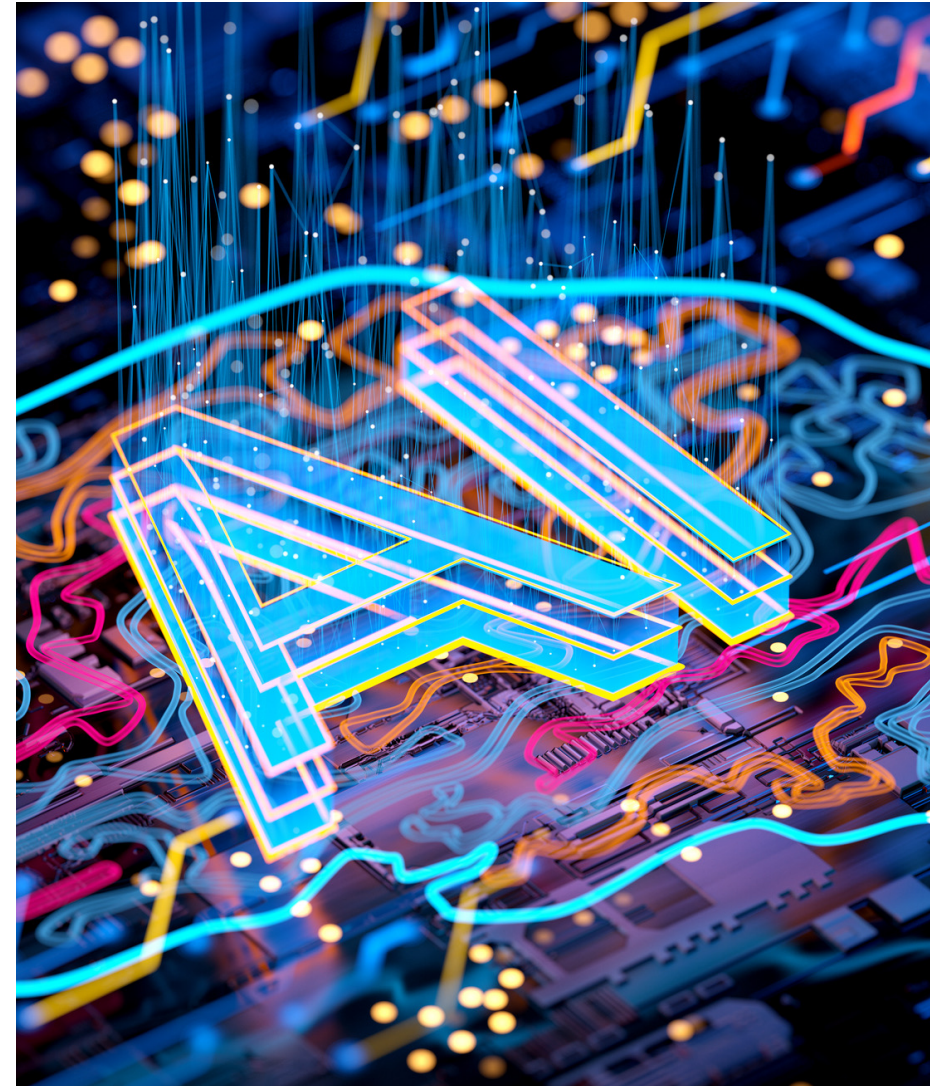


Gift ideas inspired by your shopping history

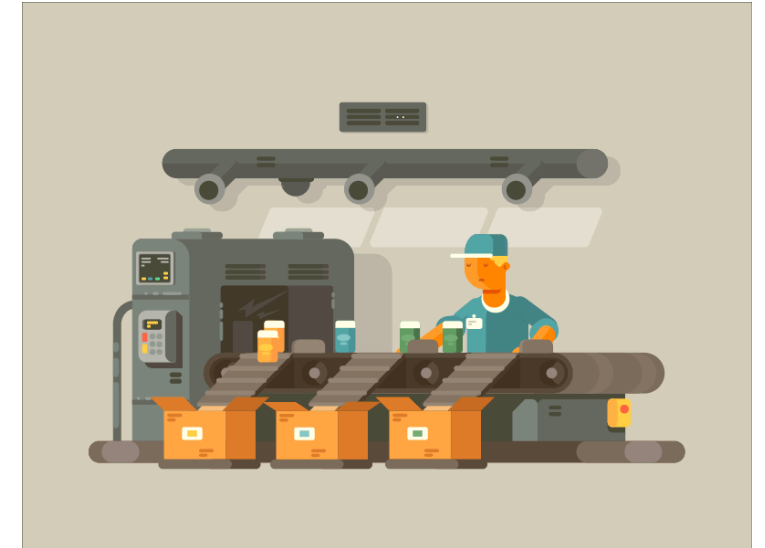
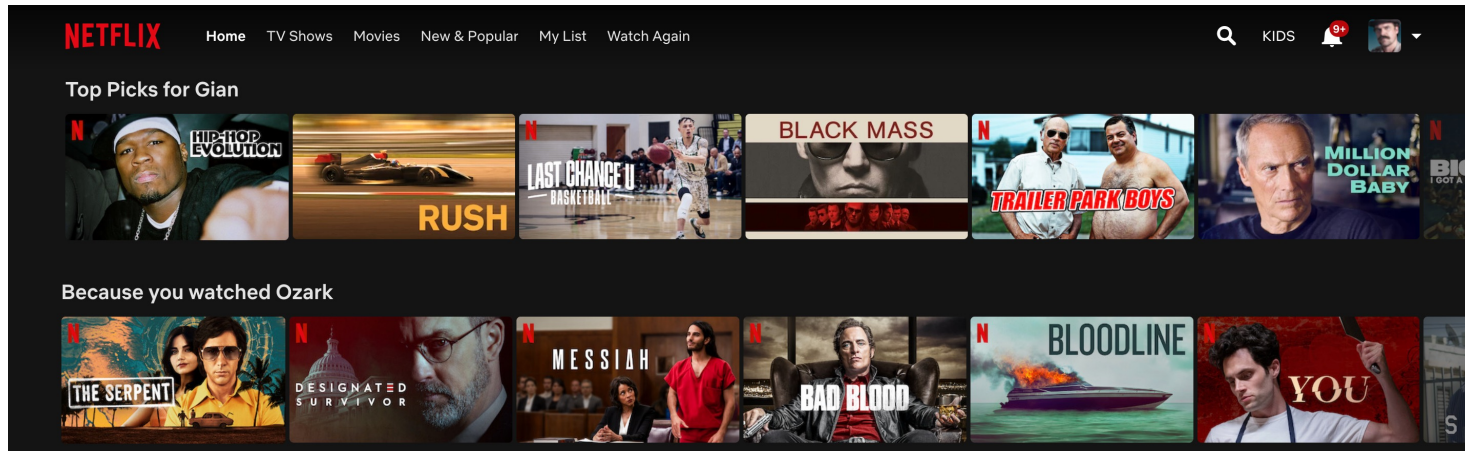


AI technologies performs really well in specific tasks

- While there are some AI tools (like ChatGPT) whose capabilities are quite broad and general, AI-based technologies solves well specific tasks
- And AI-based technologies are everywhere: we have countless AI-based tools for specific tasks



AI technologies performs really well in specific tasks... this is why AI is pervasive



AI is pervasive also in everyday discussions!

● Artificial intelligence
Field of study

+ Compare

Worldwide ▾

2004 – present ▾

All categories ▾

Web Search ▾

Interest over time ⓘ



AI is pervasive also in everyday discussions!

Finanza Microsoft, investimento miliardario in Giappone nell'Intelligenza artificiale

Finanza FTSE MIB 33902,85 -0,40% Spread BTP-Bund 10Y 135,79 +0,95% EUR/USD 1,074065

Servizio Big Tech

Microsoft, investimento miliardario in Giappone nell'Intelligenza artificiale

L'intento è rafforzare lo sviluppo di questa tecnologia nel Paese asiatico

di Redazione Finanza
10 aprile 2024

Sezioni Edizioni Locali Servizi

CORRIERE DELLA SERA



I NUOVI MODELLI LINGUISTICI

Llama 3 e Gpt-5 saranno le prime intelligenze artificiali generative «capaci di ragionare»? Cosa significa

di Eugenio Spagnuolo

Gli eredi di ChatGpt e Llama, l'AI di Open AI e Meta, promettono capacità di ragionamento umano. Ma cosa significa esattamente?

Il Messaggero

TECNOLOGIA



Scoperta la vulnerabilità dell'Intelligenza Artificiale grazie a una nuova tecnica

L'INCONTRO



"AttralAmo il futuro", il convegno su intelligenza artificiale e eccellenza delle filiere economiche

GALCIO MOTORI TENNIS CICLISMO ALTRI SPORT ... Risultati

FANTA CONSIGLI

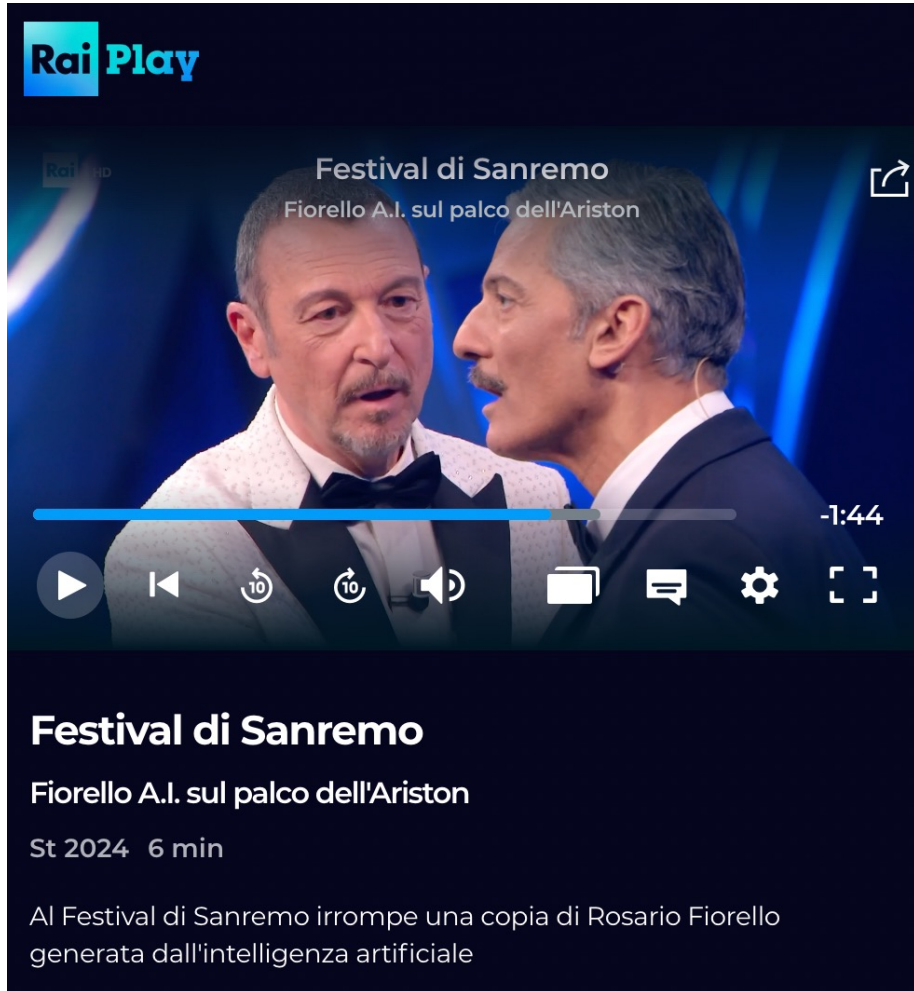


Da Carnesecchi a Bisseck, i consigli per la 32ª giornata al Fantacampionato

S. Mandaro • 49 minuti fa
Con l'aiuto dell'intelligenza artificiale, ecco i giocatore da schierare nel...

Tutto sulla Serie A >

AI is pervasive also in everyday discussions!



Rai Play

Festival di Sanremo
Fiorello A.I. sul palco dell'Ariston

Festival di Sanremo
Fiorello A.I. sul palco dell'Ariston
St 2024 6 min

Al Festival di Sanremo irrompe una copia di Rosario Fiorello generata dall'intelligenza artificiale



Finanza Microsoft, investimento miliardario in Giappone nell'Intelligenza artificiale

Finanza	FTSE MIB	Spread BTP-Bund 10Y	EUR/USD
Homepage Tutti i dati	33902,85 -0,40%	135,79 +0,95%	1,074065

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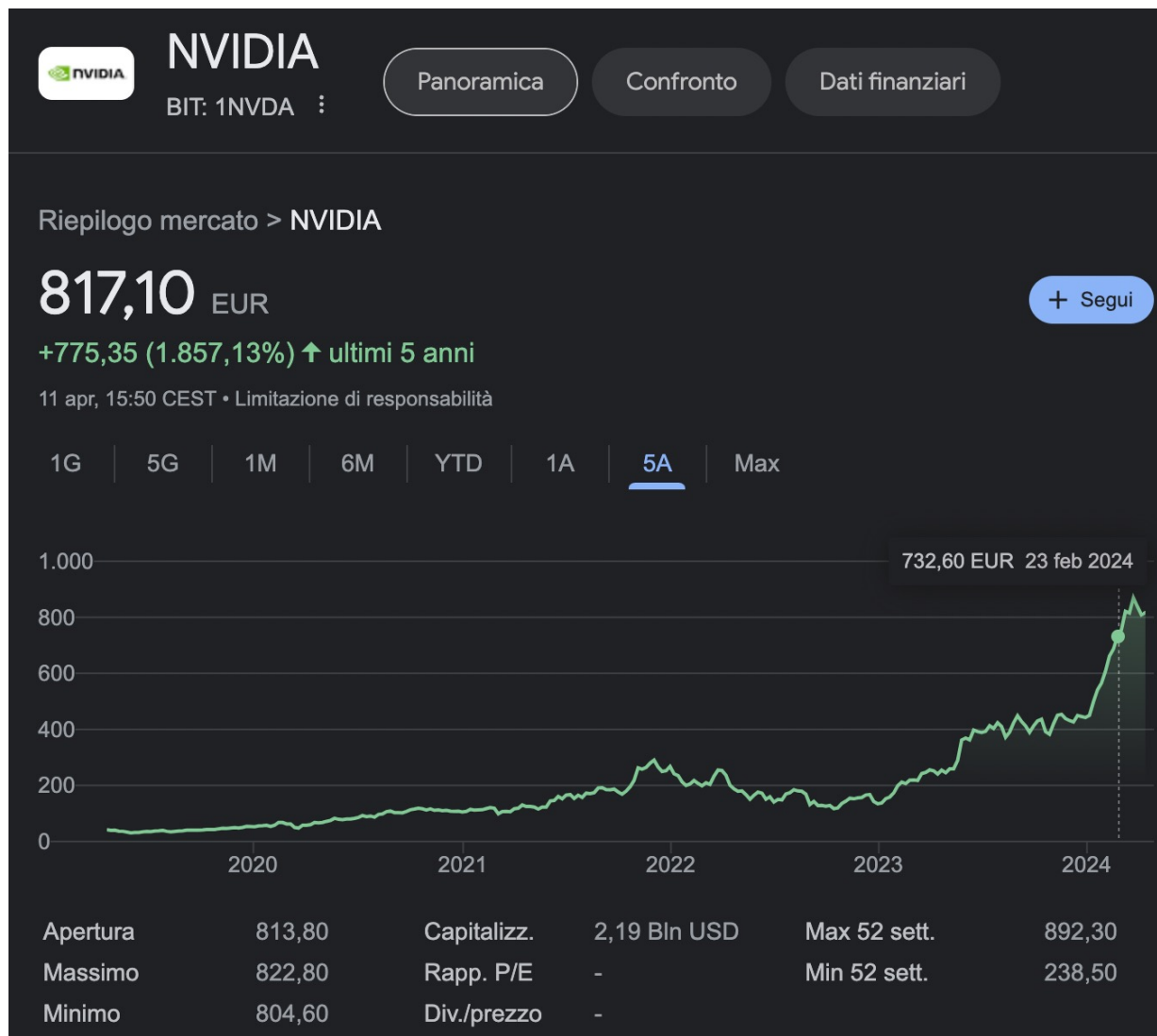
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Growth and impact of AI



**40B \$ market in 2022,
estimated market 1300B \$ in
2032**

Bloomberg

Bloomberg Intelligence Interactive Calculator: Generative AI Market Opportunity

(\$ million, unless otherwise specified)

Generative AI Revenue Projections	2022	2027E	2032E	2022-32E CAGR
Hardware	\$37,973	\$223,615	\$641,737	33%
Devices (Inference)				
Computer Vision AI Products	\$4,128	\$82,965	\$168,233	45%
Conversational AI Products	\$1,032	\$22,124	\$60,564	50%
Generative AI Products	\$3,096	\$60,841	\$107,669	43%
Infrastructure (Training)	\$33,845	\$140,650	\$473,505	30%
AI Server	\$22,563	\$49,641	\$133,817	19%
AI Storage	\$9,025	\$33,094	\$92,642	26%
Generative AI Infrastructure as a Service	\$2,256	\$57,915	\$247,046	60%
Software	\$1,493	\$58,826	\$279,899	69%
Specialized Generative AI Assistants	\$447	\$20,864	\$89,035	70%
Coding, DevOps and Generative AI Workflows	\$213	\$12,617	\$50,430	73%
Generative AI Workload Infrastructure Software	\$439	\$13,468	\$71,645	66%
Generative AI Drug Discovery Software	\$14	\$4,042	\$28,343	113%
Generative AI Based Cybersecurity Spending	\$9	\$3,165	\$13,946	109%
Generative AI Education Spending	\$370	\$4,669	\$26,500	53%
Generative AI Based Gaming Spending	\$190	\$20,668	\$69,414	80%
Generative AI Driven Ad Spending	\$57	\$64,358	\$192,492	125%
Generative AI Focused IT Services	\$83	\$21,690	\$85,871	100%
Generative AI Based Business Services	\$38	\$10,188	\$34,138	97%
Total	\$39,834	\$399,345	\$1,303,551	42%


Source: Bloomberg Intelligence, IDC, eMarketer, Statista

Growth and impact of AI



Ursula von der Leyen  · Following

President of the European Commission

1d · 

The AI race is just beginning. And Europe will become an AI continent.

To lead this race, we need massive investments.

This is why today, I am glad to announce InvestAI, a public-private partnership that aims to mobilise 200 billion euros in AI investments in Europe.

We will build European GigaAI factories. These massive computing hubs will be accessible to everyone – researchers and entrepreneurs – to push the innovation frontiers of AI.

EU launches InvestAI
€200 billion
of investment in
**Artificial
Intelligence**



Growth and impact of AI

Governo Italiano Presidenza del Consiglio dei Ministri

"L'Intelligenza Artificiale per l'Italia", il videomessaggio del Presidente Meloni

Martedì, 12 Marzo 2024

Il videomessaggio del Presidente del Consiglio, Giorgia Meloni, in occasione dell'evento "L'Intelligenza Artificiale per l'Italia", organizzato dal Dipartimento per la trasformazione digitale della Presidenza del Consiglio dei ministri e AgID - Agenzia per l'Italia Digitale.



POST

BITs | MONDO | Mercoledì 13 marzo 2024

Il Parlamento Europeo ha approvato l'AI Act, la prima legge al mondo per regolamentare l'intelligenza artificiale

Condividi | Aggiungi ai preferiti



CanadianPM @CanadianPM · Apr 7

AI has the potential to transform the economy. Today, PM Trudeau announced new #Budget2024 measures to harness the full potential of AI, which will create good-paying jobs for every generation while raising productivity, and growing our economy. Details:



From pm.gc.ca

301 | 100 | 198 | 24K

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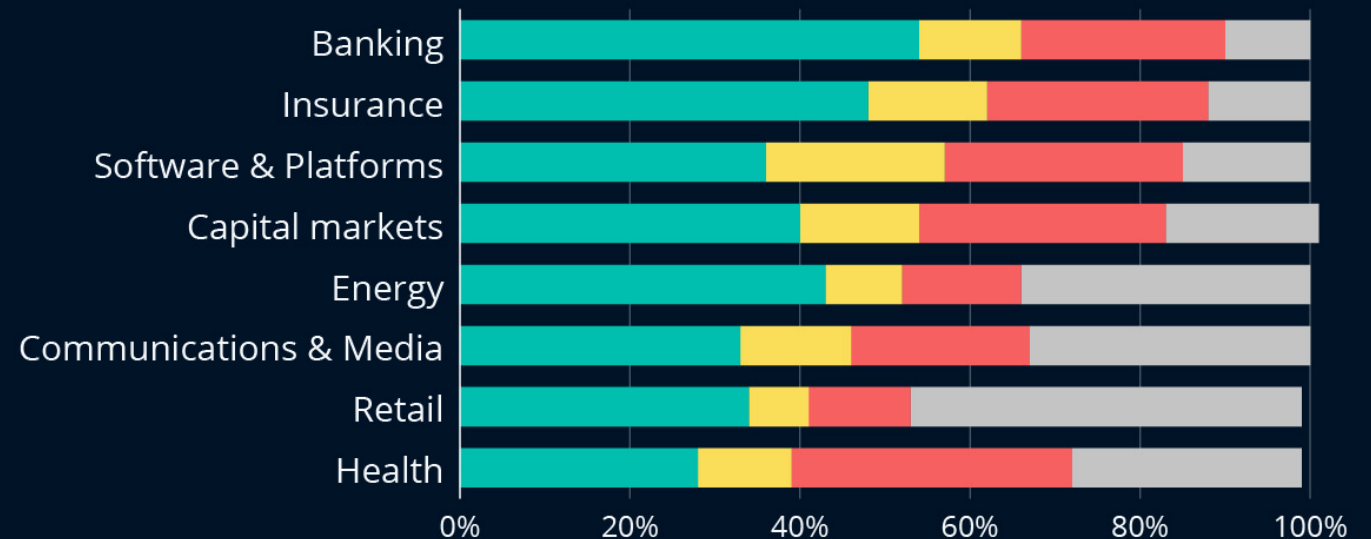
We will build European GigaAI factories. These massive computing hubs will be accessible to everyone – researchers and entrepreneurs – to push the innovation frontiers of AI.

AI: technological revolution!

In Which Industries Could AI Do Most of the Heavy Lifting?

Share of working hours in selected industries in the U.S. that could be automated/augmented by the use of AI

■ High potential for automation ■ High potential for augmentation
■ Low potential for automation/augmentation ■ Non-language tasks



Tasks with high potential for automation can be transformed by AI with little human involvement, tasks with high potential for augmentation require more human involvement

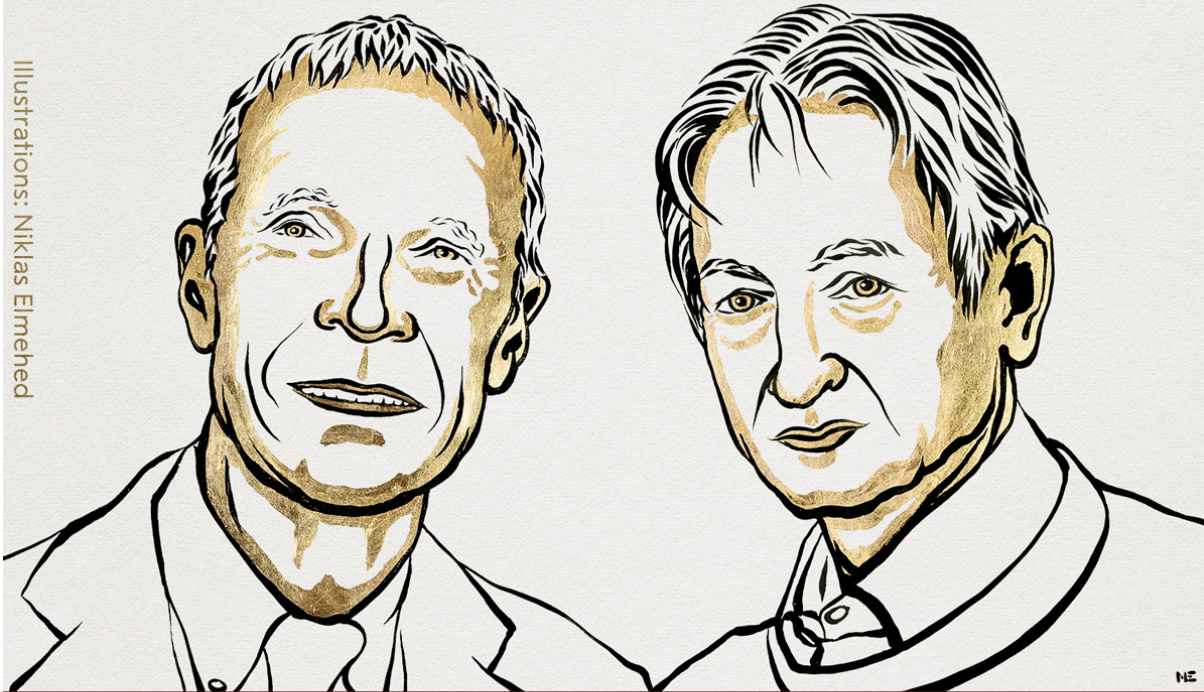
Source: Accenture



AI: scientific revolution!

THE NOBEL PRIZE IN PHYSICS 2024

Illustrations: Niklas Elmehed



John J. Hopfield

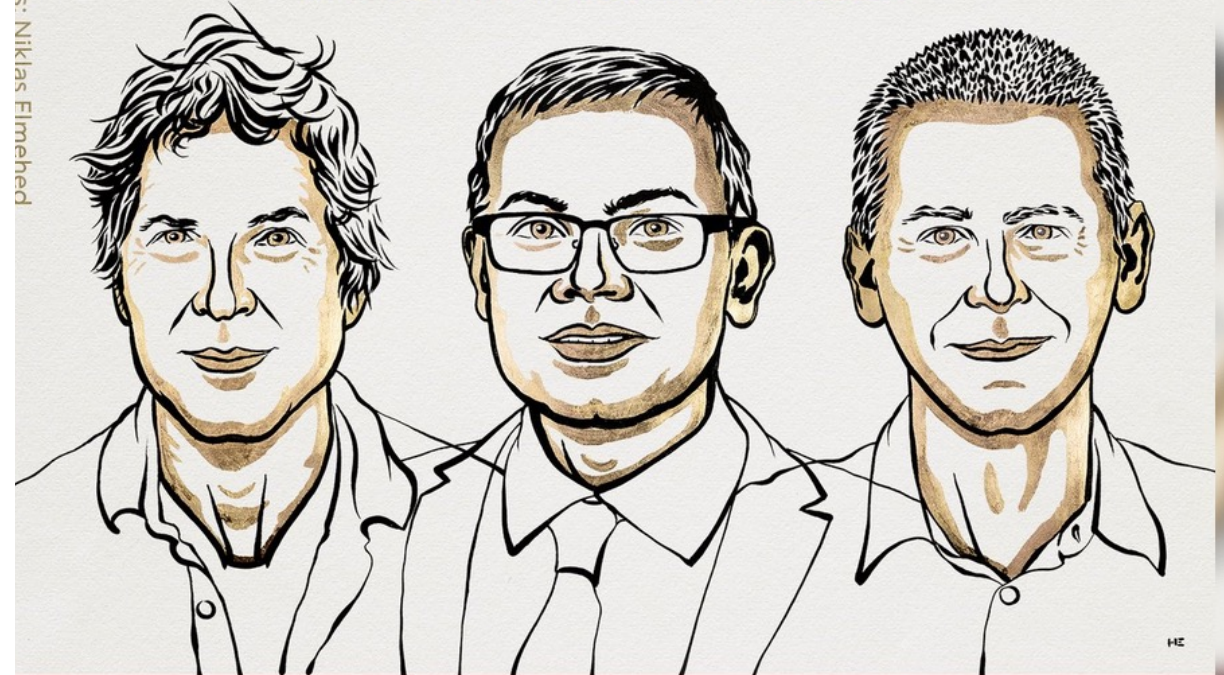
Geoffrey E. Hinton

“for foundational discoveries and inventions
that enable machine learning
with artificial neural networks”

THE ROYAL SWEDISH ACADEMY OF SCIENCES

THE NOBEL PRIZE IN CHEMISTRY 2024

Illustrations: Niklas Elmehed



**David
Baker**

**Demis
Hassabis**

**John M.
Jumper**

“for computational
protein design”

“for protein structure prediction”

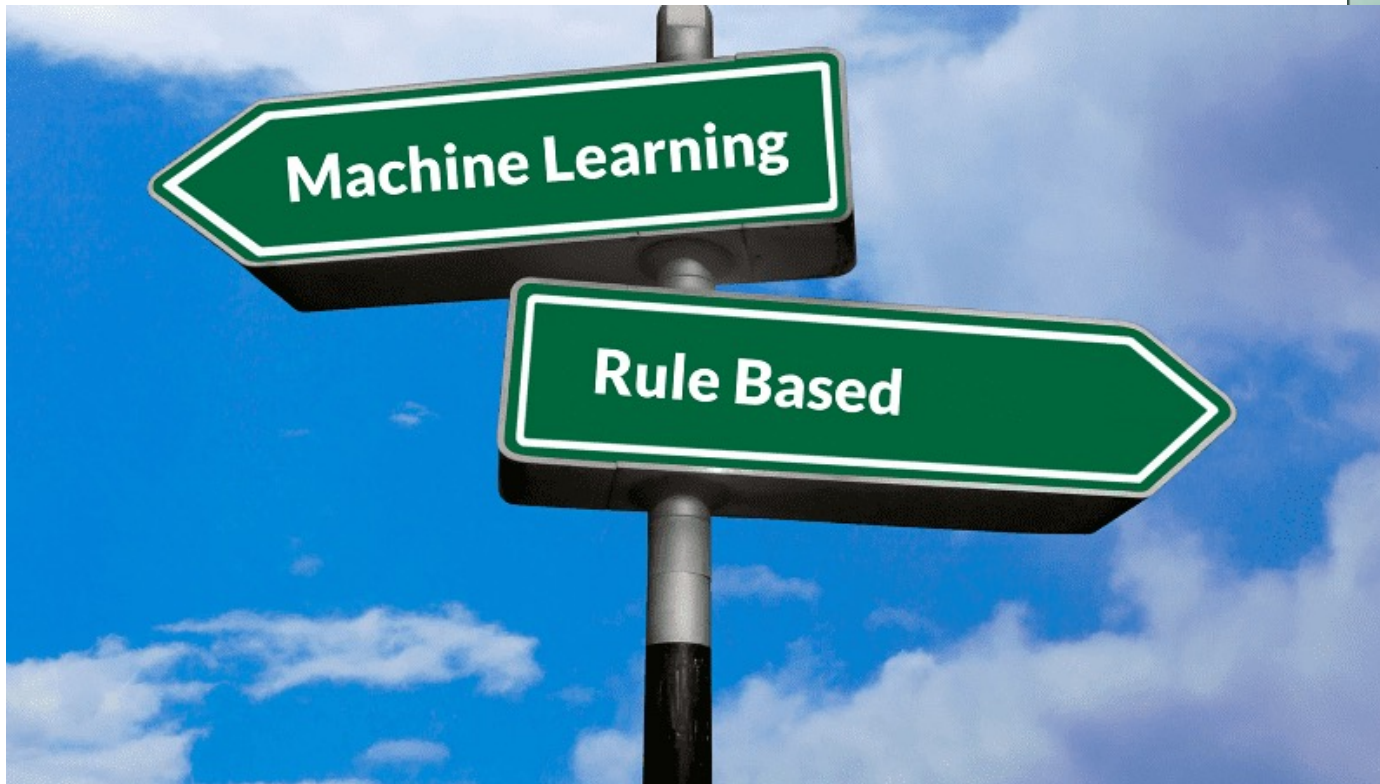
THE ROYAL SWEDISH ACADEMY OF SCIENCES

3. What is the difference between AI
and **Machine Learning**?

Difference between machine learning and AI:
If it is written in Python,
it's probably machine learning
If it is written in PowerPoint,
it's probably AI

From rules to data-driven AI

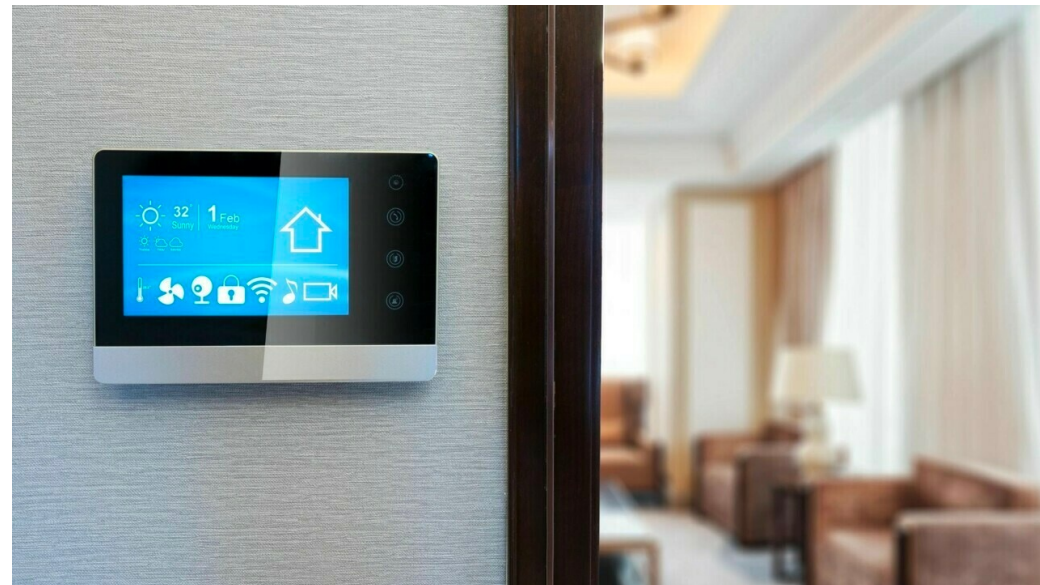
Machine Learning ('Apprendimento Automatico') is the part of AI that develops solutions based on data and not strictly on rules



From rules to data-driven AI



From rules to data-driven AI



Nowadays, most important AI technologies are data-driven, ie. Machine Learning-based technologies!



Outline

- Organizational Aspects
- Intro to Machine Learning
- Course Outline

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Lecturer



Gian Antonio Susto

gianantonio.susto@unipd.it

Research on:

- Reinforcement Learning
- Anomaly Detection
- Continual Learning
- Explainability and Fairness
- Deep Learning
- Machine Learning Applications

Lecturer



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- Continual Learning
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- **Deep Learning**
- Machine Learning Applications

Collaborations with several companies:
Statwolf, Infineon, Technogym, Diasorin,
LFoundry, Seagate, Breton, Swegon,
Galdi, Santex, GoldenGoose, Electrolux,
Zoppas Industries, Maschio Gaspardo,
Luxottica, Pietro Fiorentini, ...

Teaching Assistants



Francesco Borsatti, PhD Student

Mechatronic Engineer

Working on AI for edge applications & for heating elements systems

francesco.borsatti.1@phd.unipd.it



Valentina Zaccaria, PhD Student

Control Systems Engineer

Working on Anomaly Detection, Explainable Artificial Intelligence & Active Learning

valentina.zaccaria@unipd.it

Teaching Assistants



Marina Ceccon, PhD Student

Computer Engineer

Working on Deep Learning and Continual Learning for Fairness

marina.ceccon@phd.unipd.it



Matteo Cederle, PhD Student

Control Systems Engineer

Working on Smart Mobility, Autonomous Driving and Reinforcement Learning

matteo.cederle@phd.unipd.it

Lectures and Course Page

Lectures on:

Monday @ 12:30-14:00 – Room De

Thursday @ 12:30-14:00 – Room 14C
(Padiglione 14 Fiera)

Friday @ 12:30-14:00 – Room Ue/Te (if we are
having lab)
OR Room Me

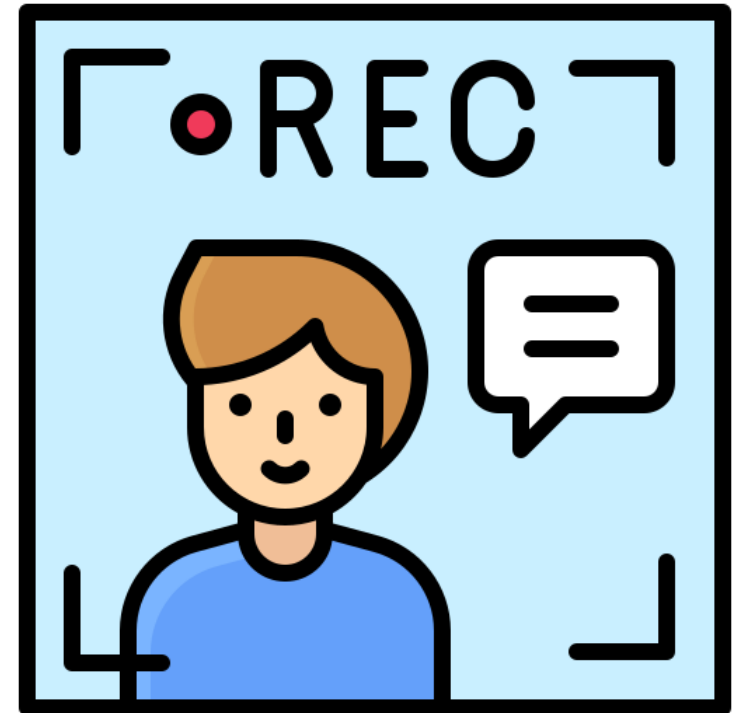
Moodle Page:

<https://stem.elearning.unipd.it/course/view.php?id=12269>



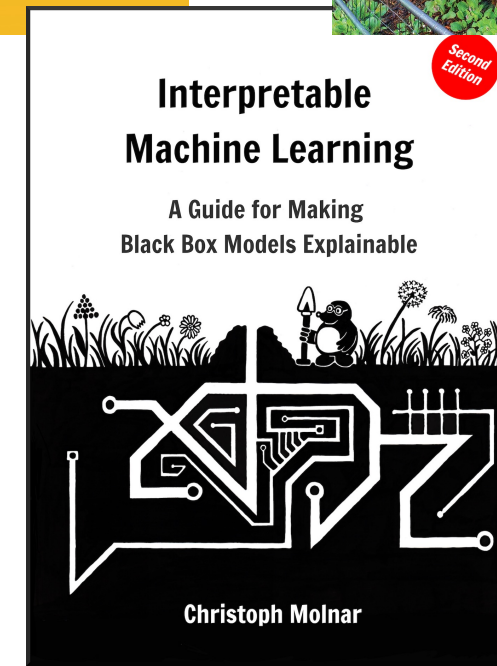
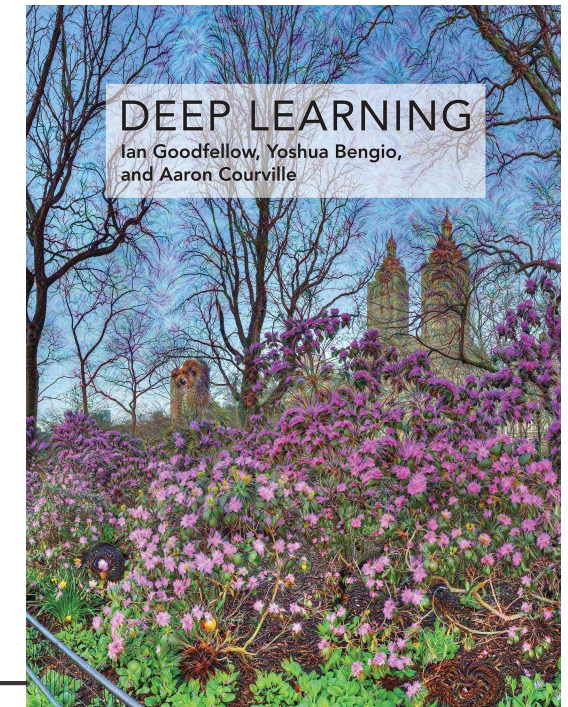
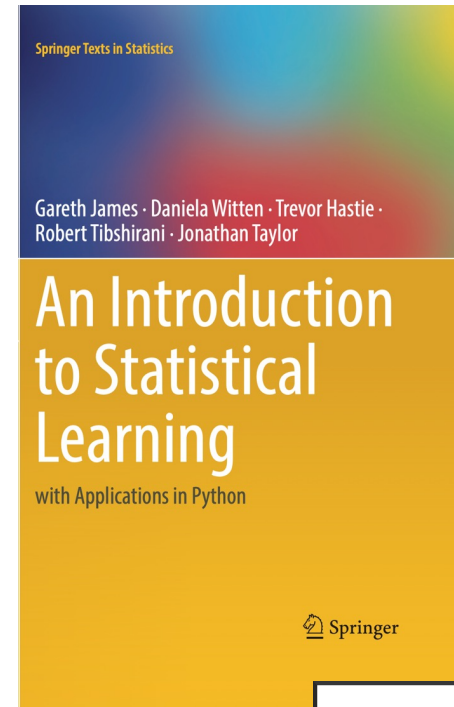
Course Recordings

Lecture and laboratories recordings will be made available shortly after the lecture.



Course Material

- Main reference:
 1. Course Slides
- Other reference:
 2. G. James et al. 'An Introduction to Statistical Learning'
<https://www.statlearning.com/>
 3. I. Goodfellow, Y. Bengio, A. Courville 'Deep Learning'
<https://www.deeplearningbook.org/>
 4. C. Molnar 'Interpretable Machine Learning'
<https://christophm.github.io/interpretable-ml-book/>



Exam

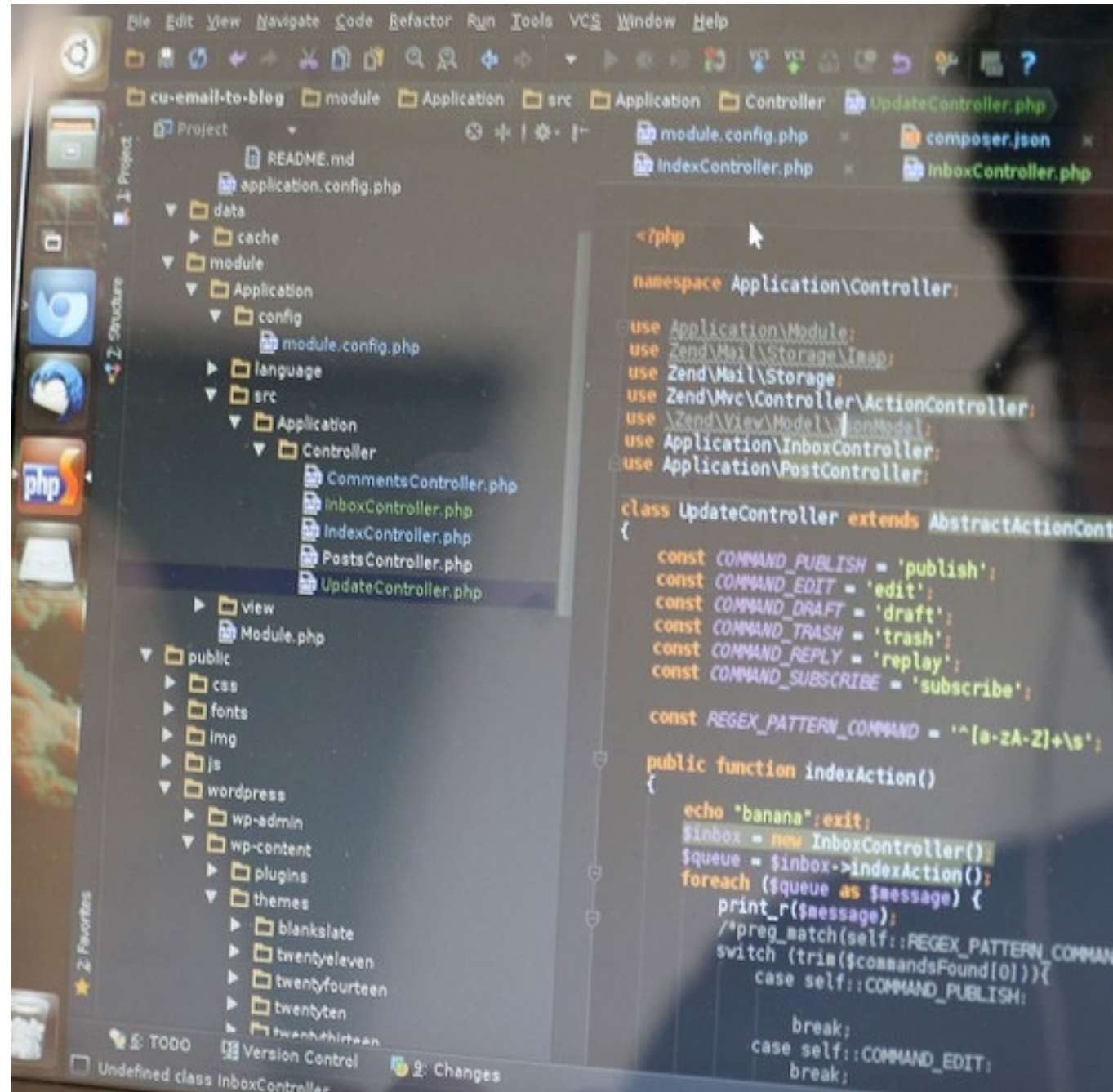
Written exam (on the same day):

1. Theoretic exam
2. *Python programming exam

*A student can take the programming exam only after achieving a sufficient score in the theoretical part

Dates

- June 17th, 2025 from 13:30
- July 3rd, 2025 from 13:30
- August 29th, 2025 from 9:00
- January 23rd, 2026 from 9:00



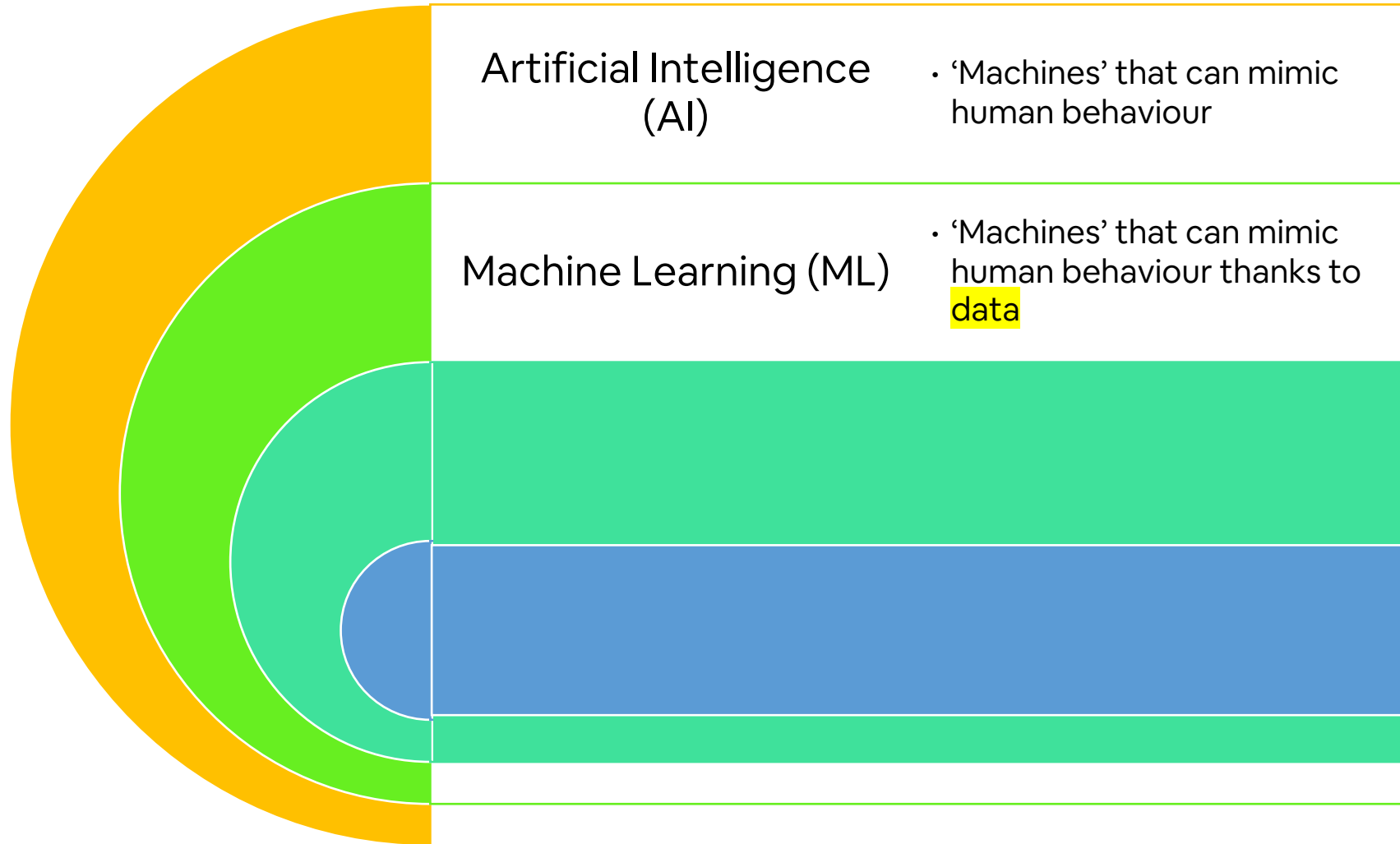
Communications

- In email communications, please use object '[ML2024-25] <your title>'
- If you have a question, probably your colleagues has the same/similar one: we will try to answer during the lectures

Outline

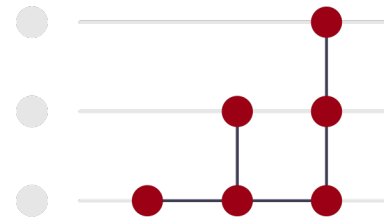
- Organizational Aspects
- Intro to Machine Learning
- Course Outline

The keywords

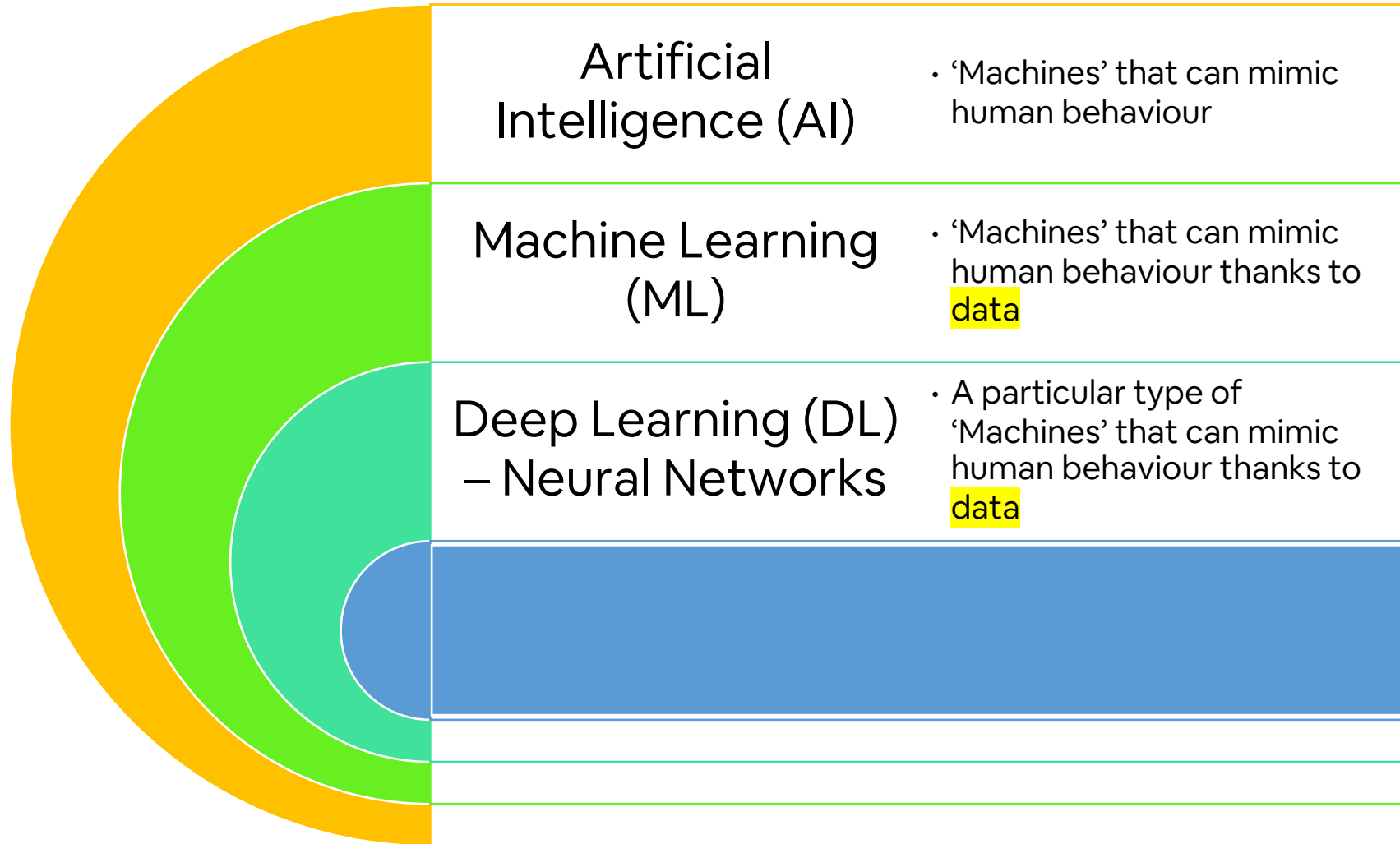


What Machine Learning algorithms can do:

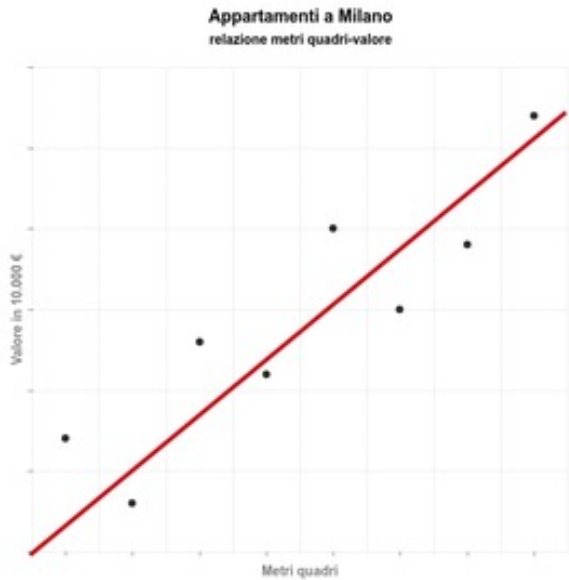
- Define the relationship between input and output and make predictions
- Find anomalies ('strange' data)
- Make forecast of time-series
- Find Groups in the data
- Find patterns
- Extract information from any type of data: tabular, images, video, text... you name it!



The keywords



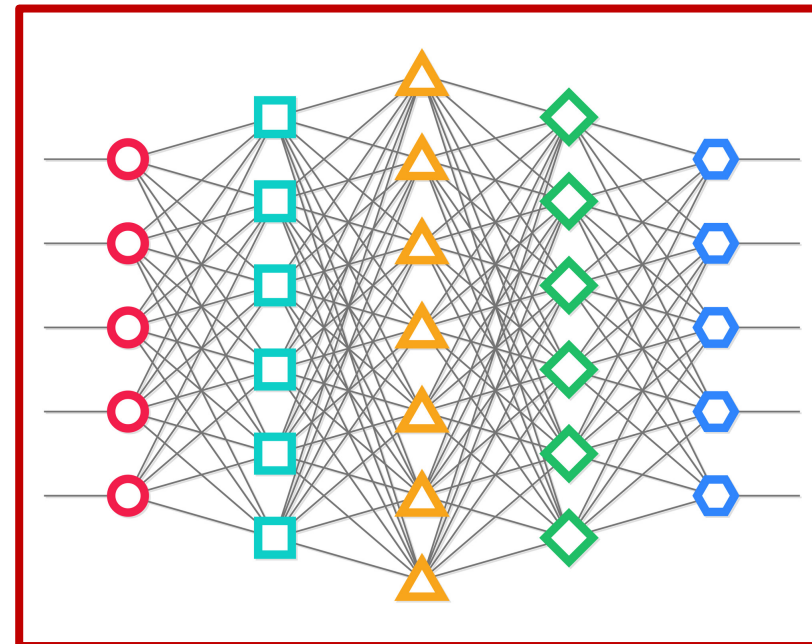
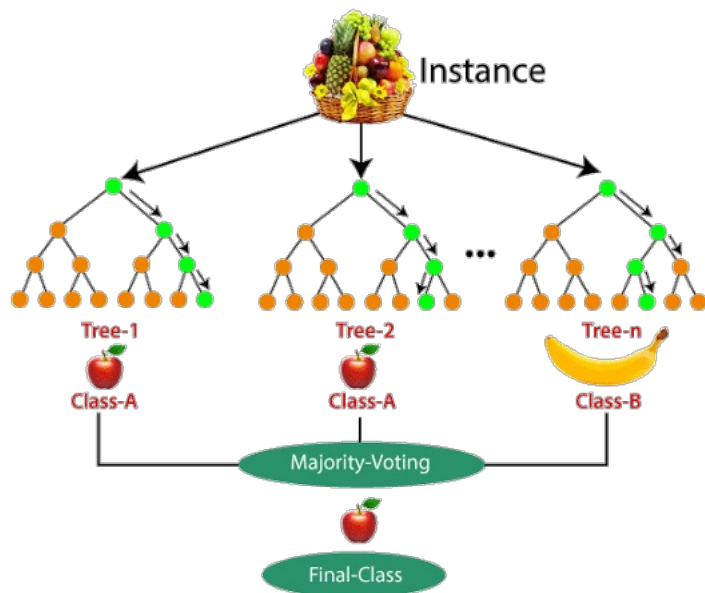
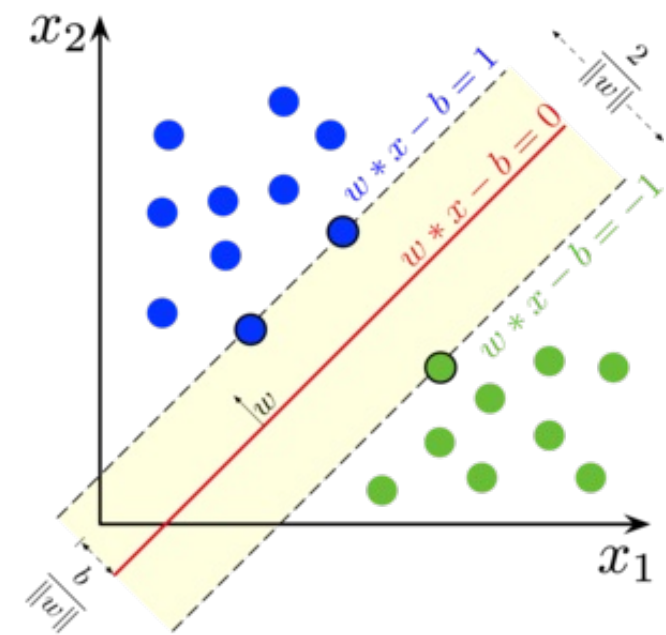
Machine Learning Approaches



La regressione lineare

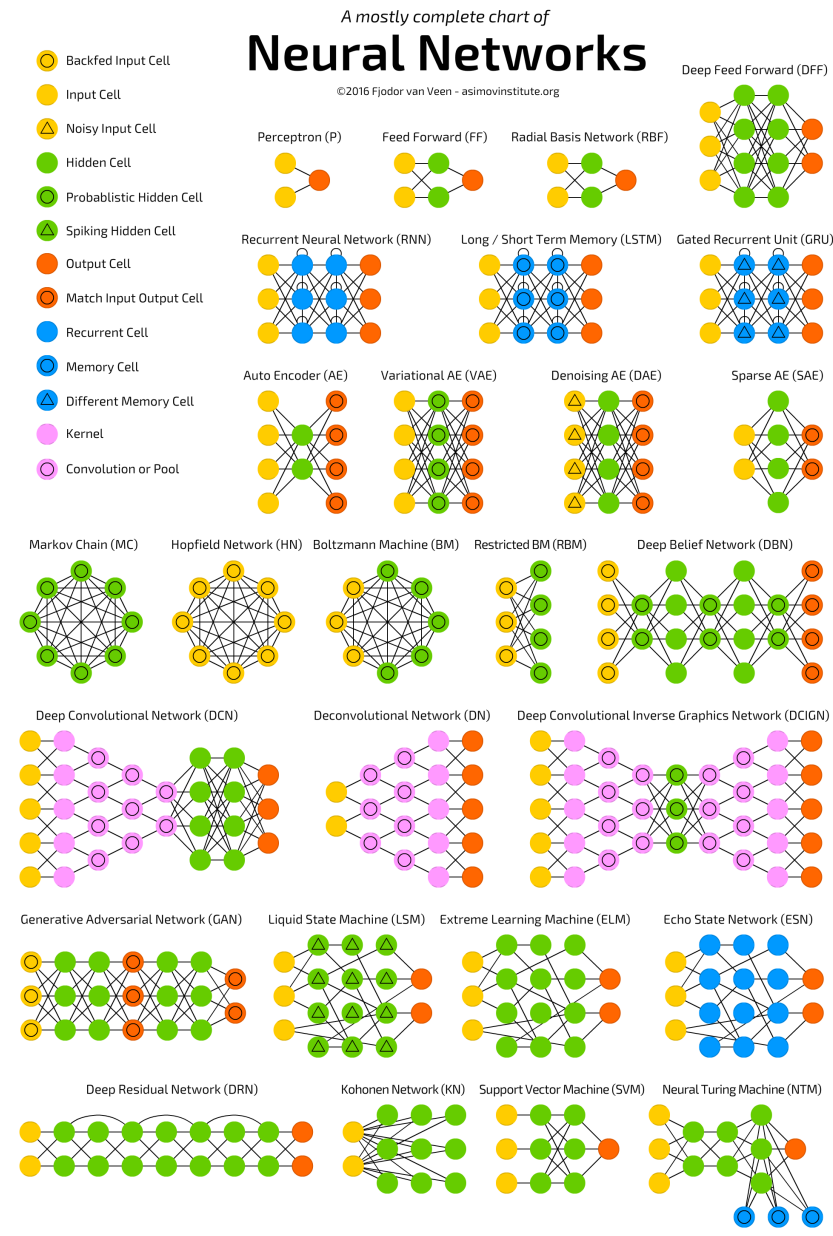
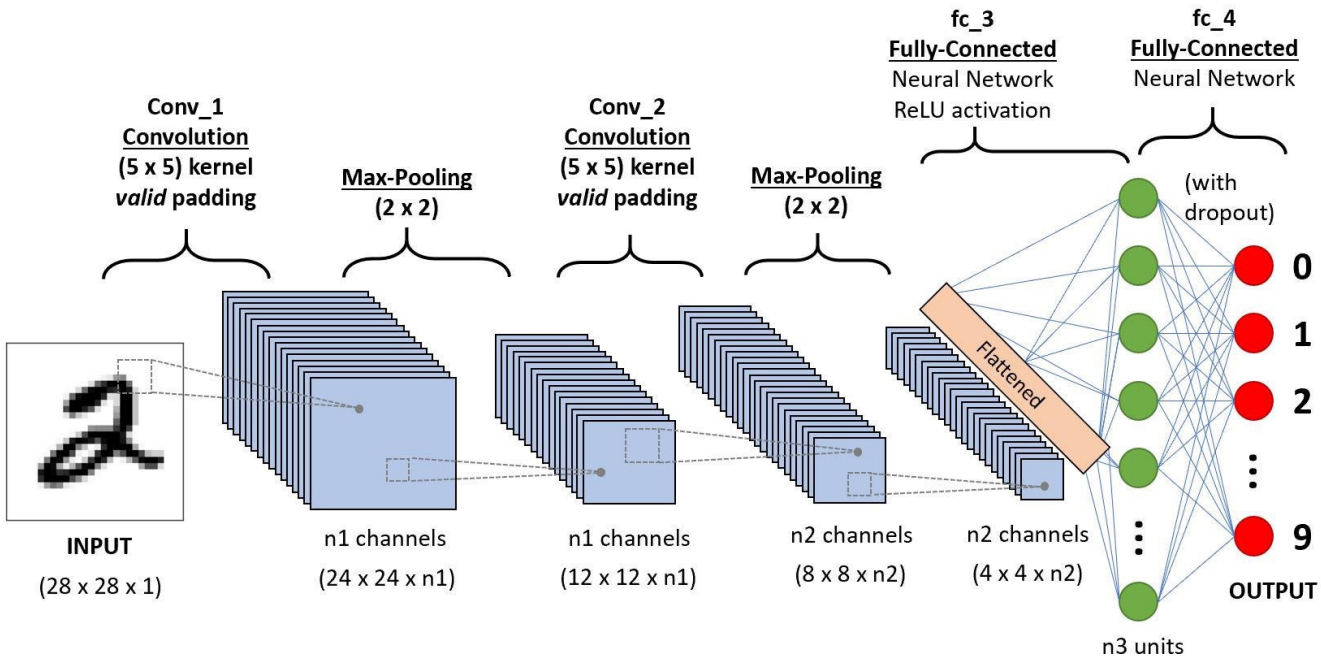
$$y = b + wx$$

BIAS \uparrow PROPRIETA'
PREDIZIONE \downarrow PESO \downarrow

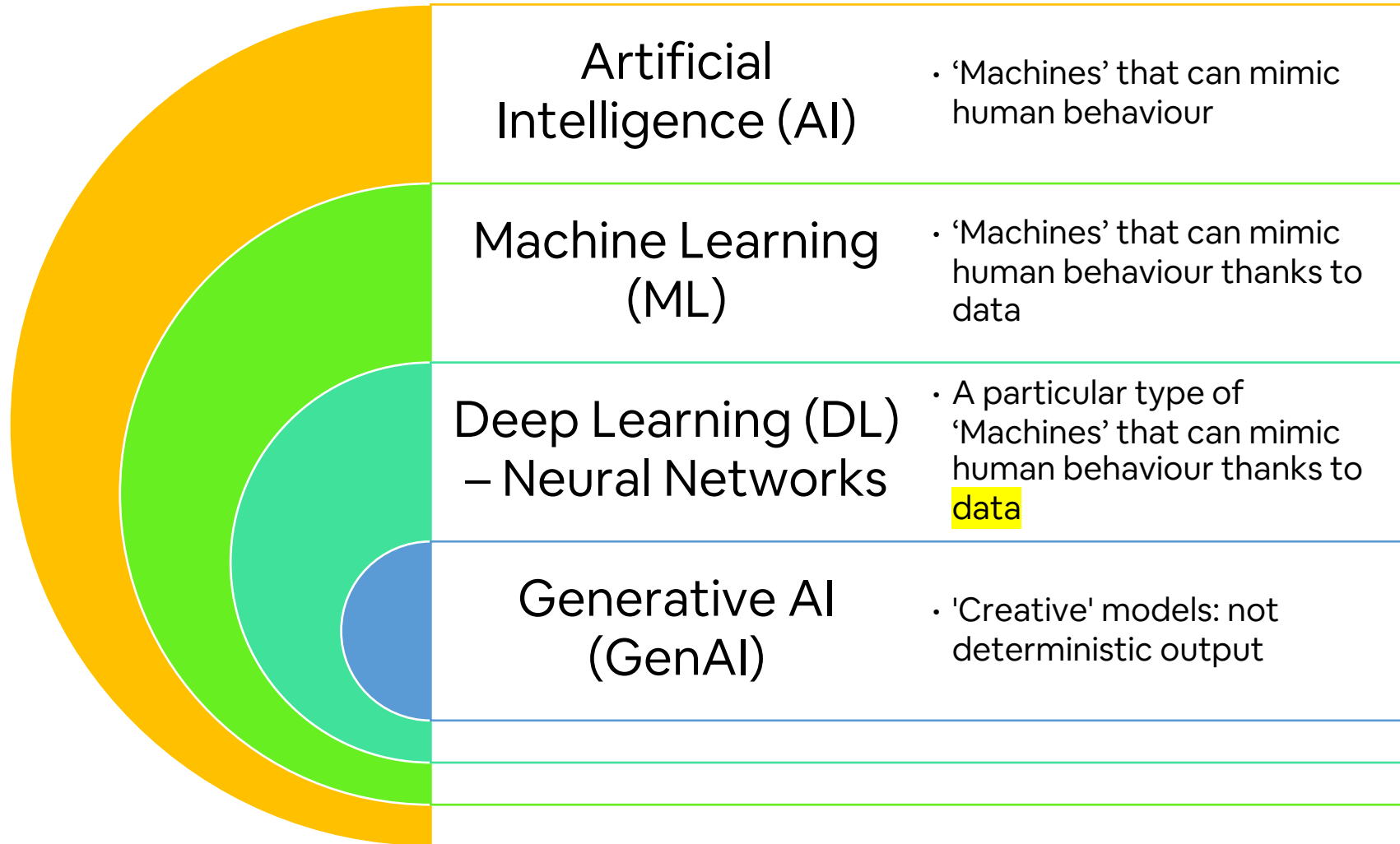


Neural
Networks
(Deep
Learning)

Neural Networks / Deep Learning

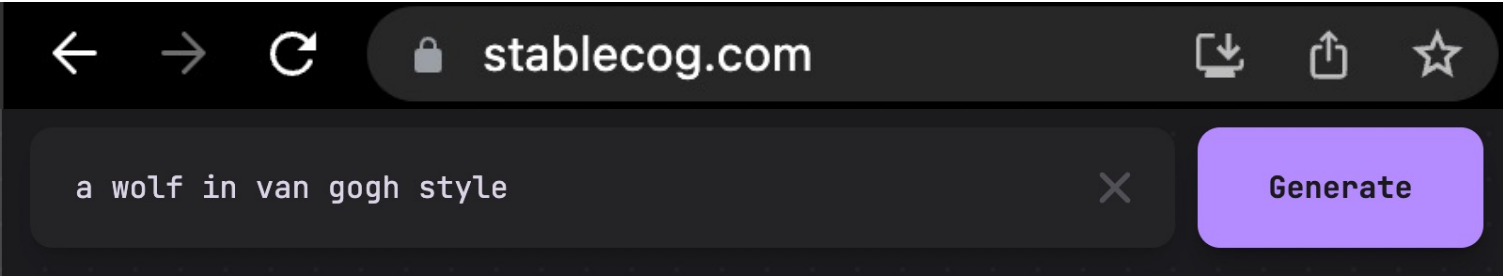


The keywords



Generative AI

Example: 1. text to image





Generative AI

Example: text to video

‘A panda eating bamboo under a rock’

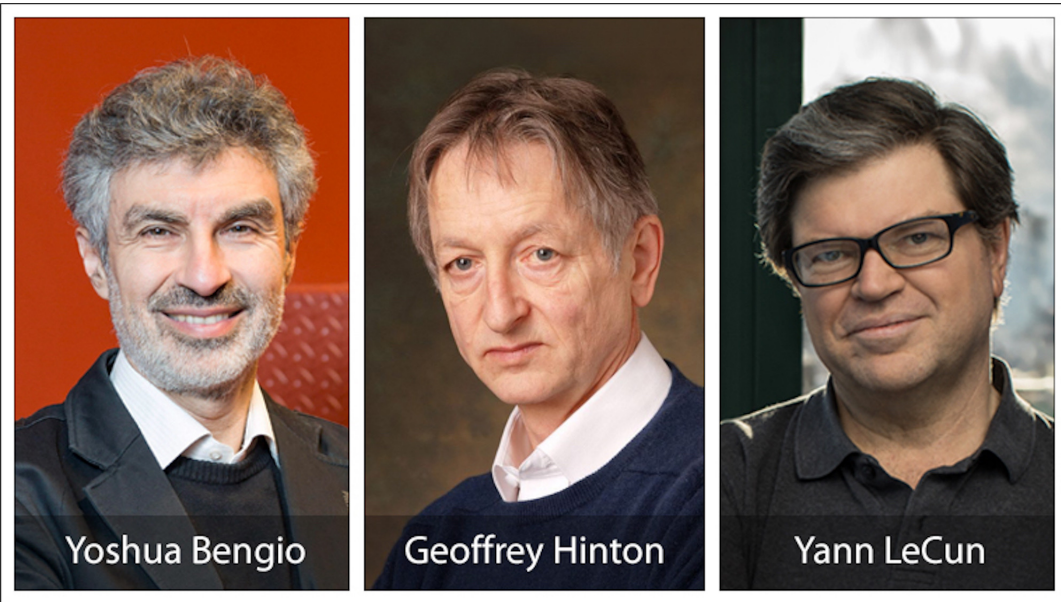


[2025 Question]

‘Is Machine Learning a new thing? It started with ChatGPT?’

Well, actually...



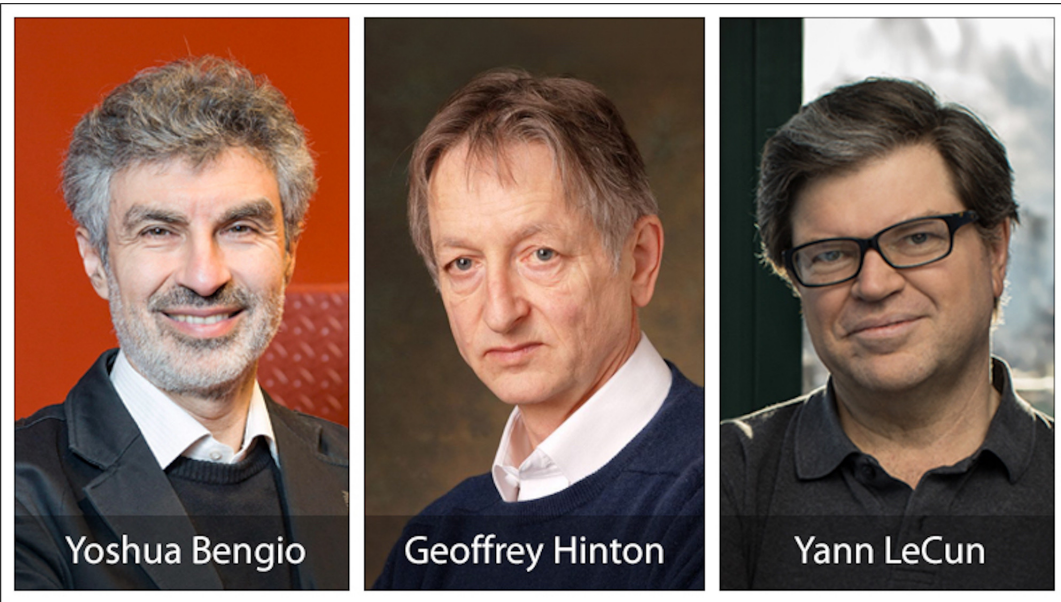


Yoshua Bengio

Geoffrey Hinton

Yann LeCun

2018 Turing Awards Recipients
(and on Nobel prize recipient!)



2018 Turing Awards Recipients (and on Nobel prize recipient!)



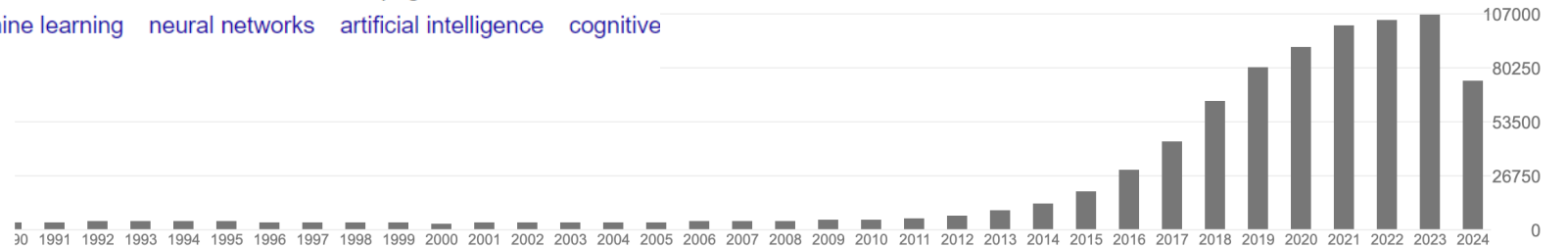
Geoffrey Hinton

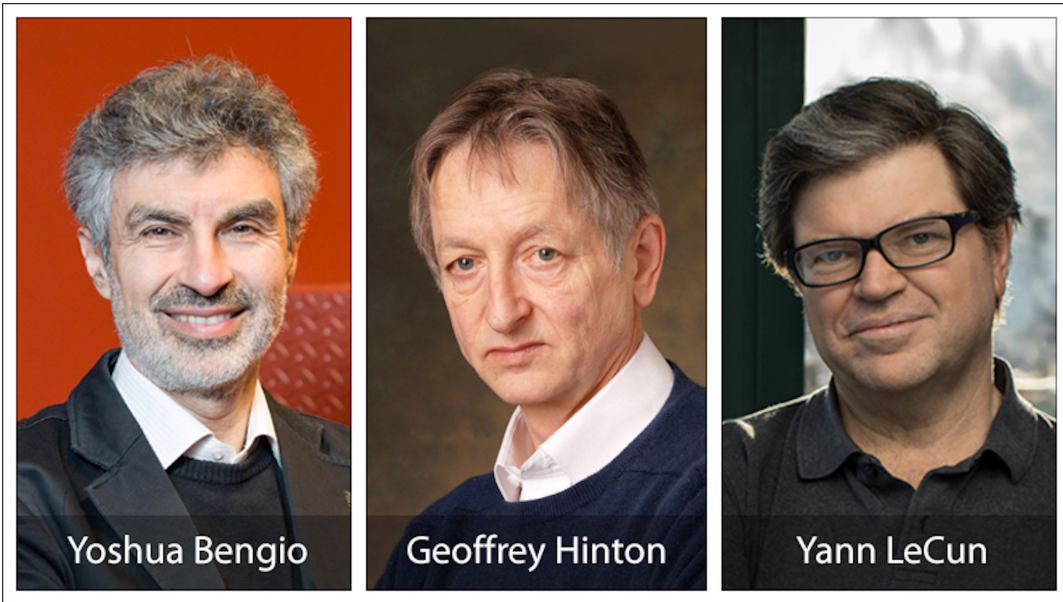
Emeritus Prof. Comp Sci, U.Toronto & Engineering Fellow, Google

Email verificata su cs.toronto.edu - [Home page](#)

[machine learning](#) [neural networks](#) [artificial intelligence](#) [cognitive](#)

Citazioni per anno





Why now?

2018 Turing Awards Recipients (and on Nobel prize recipient!)



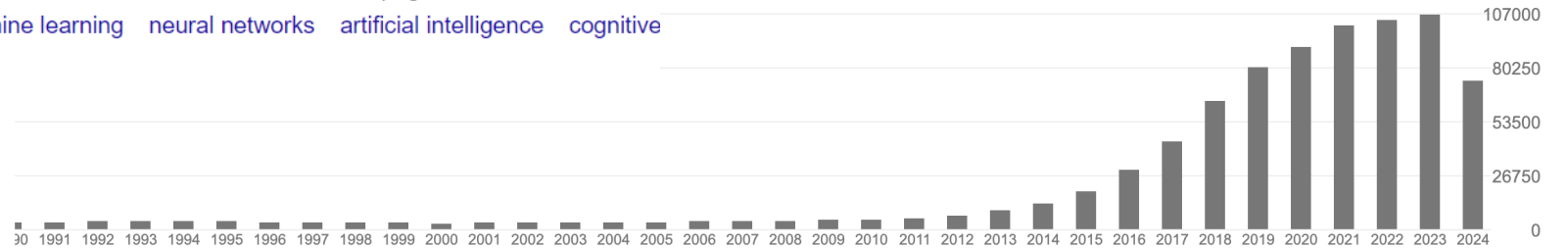
Geoffrey Hinton

Emeritus Prof. Comp Sci, U.Toronto & Engineering Fellow, Google

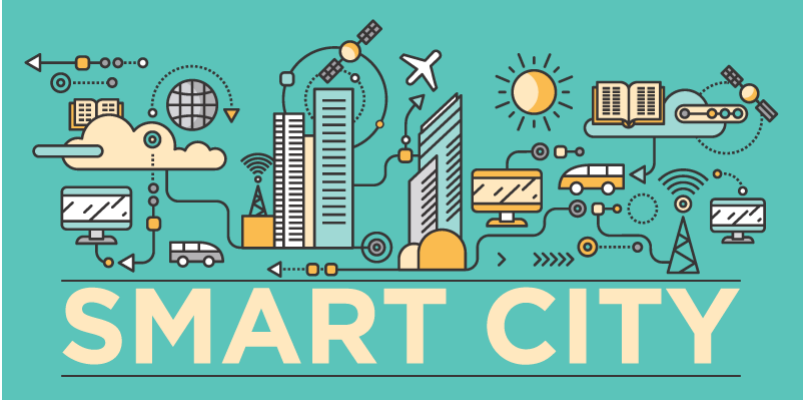
Email verificata su cs.toronto.edu - [Home page](#)

[machine learning](#) [neural networks](#) [artificial intelligence](#) [cognitive](#)

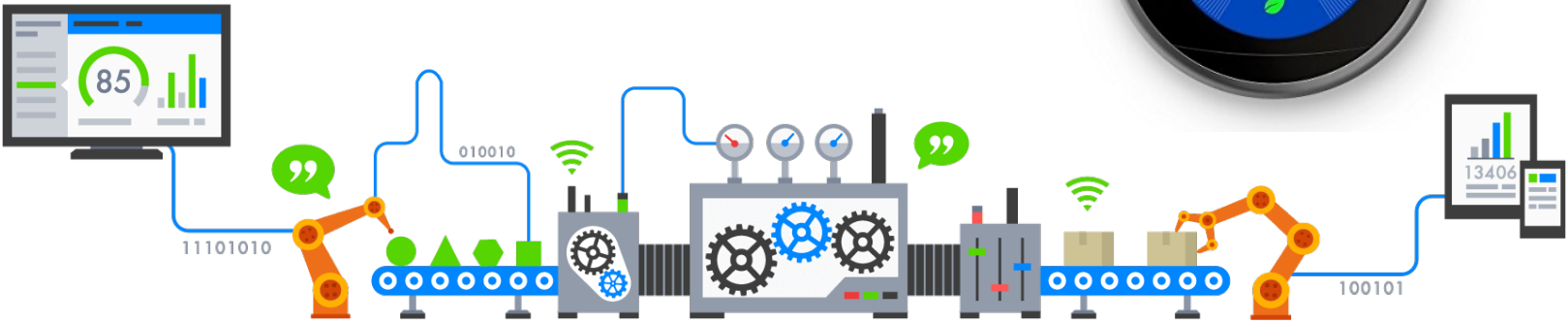
Citazioni per anno



1. Data



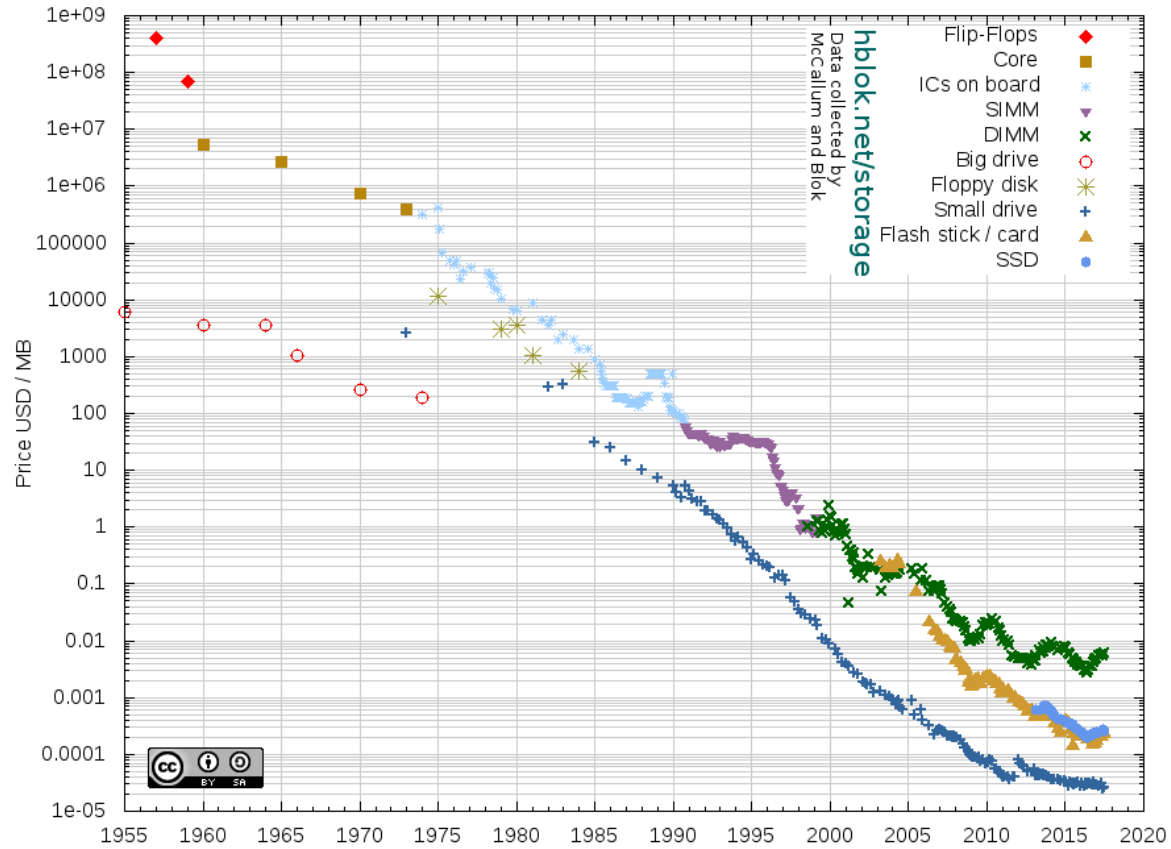
IMAGENET



WIKIPEDIA
The Free Encyclopedia

2. Hardware

Historical Cost of Computer Memory and Storage





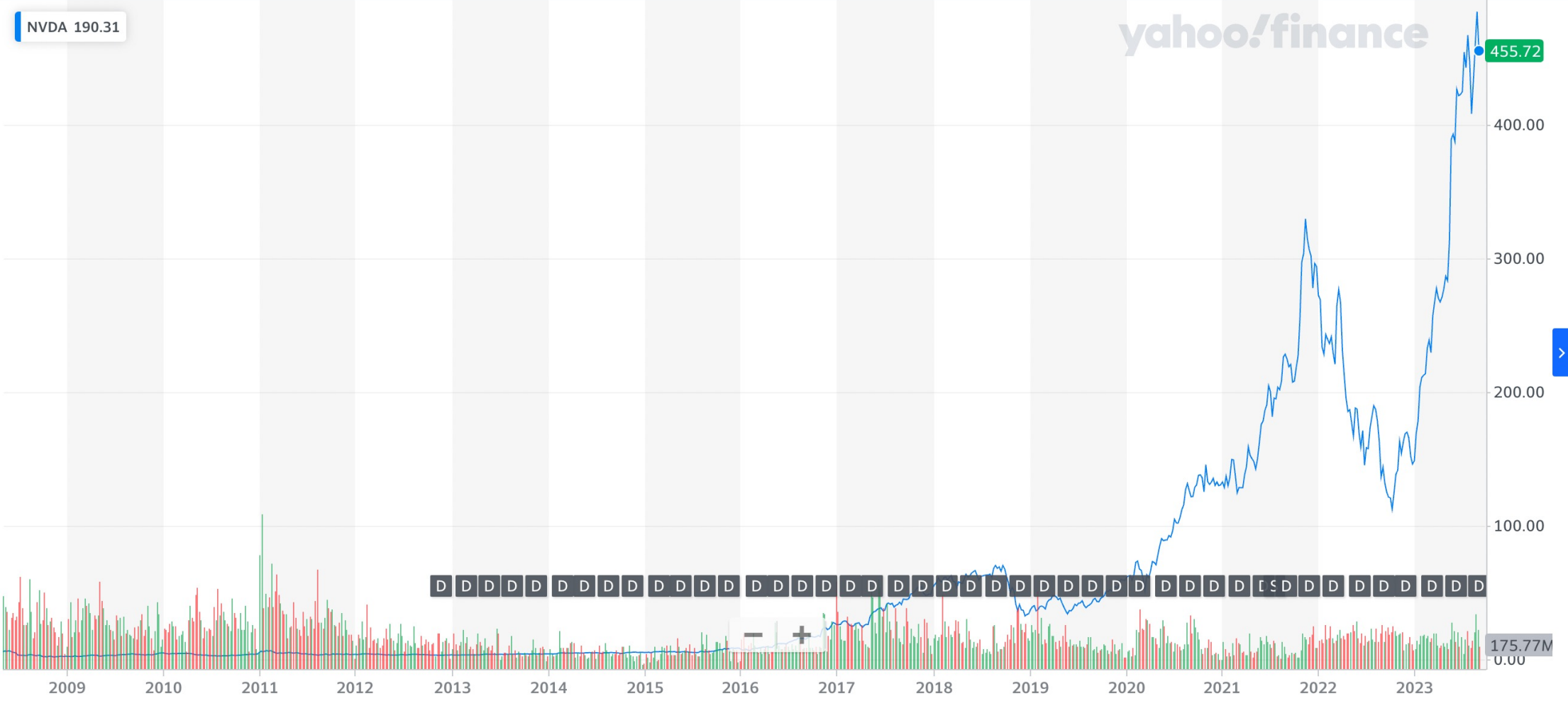
NVIDIA Corporation (NVDA) ☆

NasdaqGS - NasdaqGS Real Time Price. Currency in USD

455.72 -6.69 (-1.45%) **455.30** -0.42 (-0.09%)

At close: September 8 04:00PM EDT After hours: 07:59PM EDT

Indicators Comparison Events Date Range 1D 5D 1M 3M 6M YTD 1Y 2Y 5Y Max Interval 1W Line Draw Settings Share Reset



Recently Viewed

Symbol	Last Price
NVDA	455.72 -6.69 -1.45%

Cryptocurrencies

Symbol	Last Price
BTC-USD	25,869.82 +62.18 (+0.24%)
ETH-USD	1,634.09 +6.51 (+0.40%)
USDT-U...	1.00 -0.00 -0.00%
BNB-USD	214.89 +0.85 (+0.40%)
XRP-USD	0.5040 +0.0021 (+0.417)

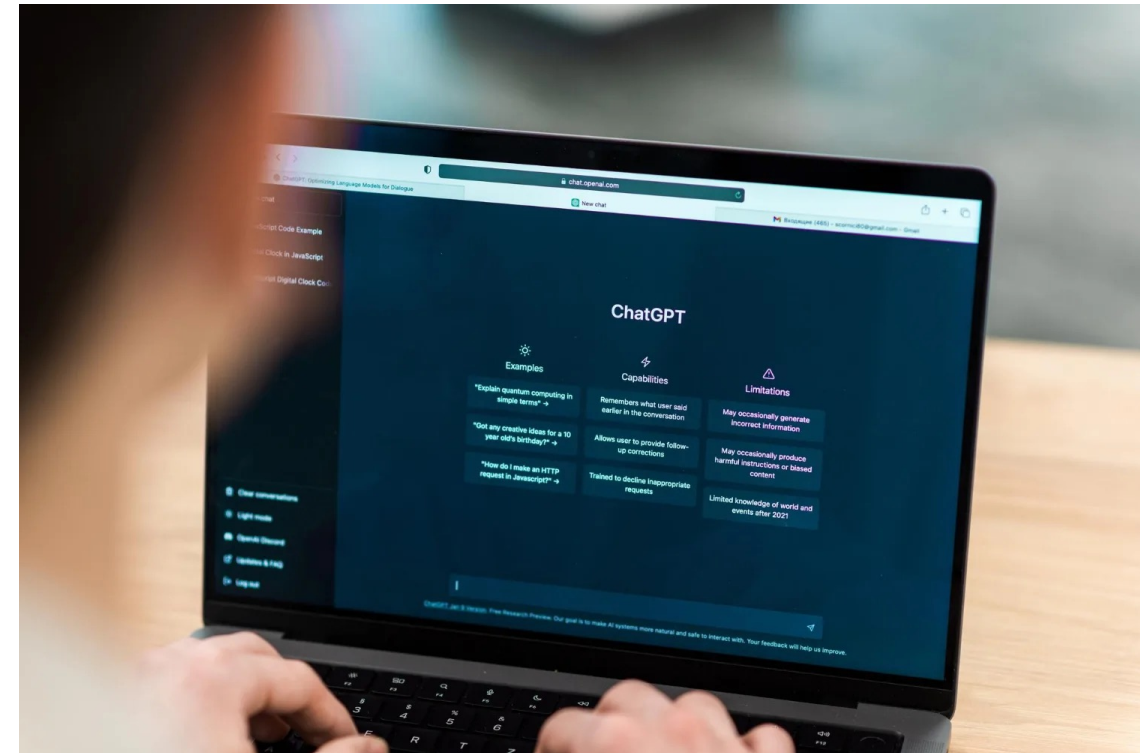
Trending Tickers

Symbol	Last Price
BTC-USD	25,869.82 +62.18 (+0.24%)
ETH-USD	1,634.09 +6.51 (+0.40%)

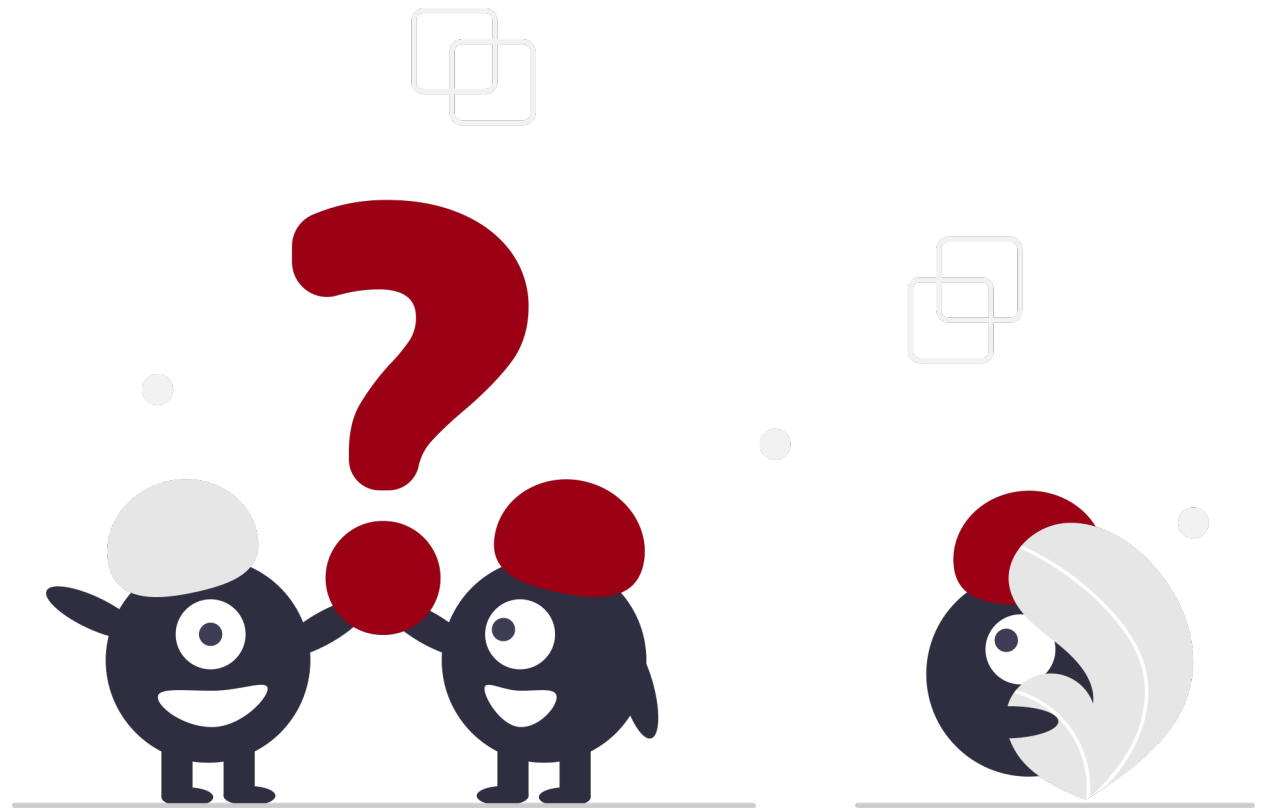
3. Software and Community



paperswithcode.com



Is everything
'solved' then? Is
AI just a 'simple'
and positive
thing?



Attitudes towards AI/Machine Learning



From the web

The overly skeptical

‘It is just a thing for Amazon, Apple, Google and Facebook... I pass’ – ‘AI will have a negative impact on humanity’

Attitudes towards AI/Machine Learning



From the web

The overly skeptical

‘It is just a thing for Amazon, Apple, Google and Facebook... I pass’ – ‘AI will have a negative impact on humanity’



From the web

The overly excited

‘This is the best thing ever! I’m going to plug AI in my system/product and it is done’ – ‘AI will save humanity’

Attitudes towards AI/Machine Learning



From the web

The overly skeptical

‘It is just a thing for Amazon, Apple, Google and Facebook... I pass’ – ‘AI will have a negative impact on humanity’



Both views are wrong!
There are many aspects to
be considered when
developing and ‘judging’ AI

‘This is the best thing ever! I’m going to plug AI in my system/product and it is done’ – ‘AI will save humanity’

#1 Without data, no ML

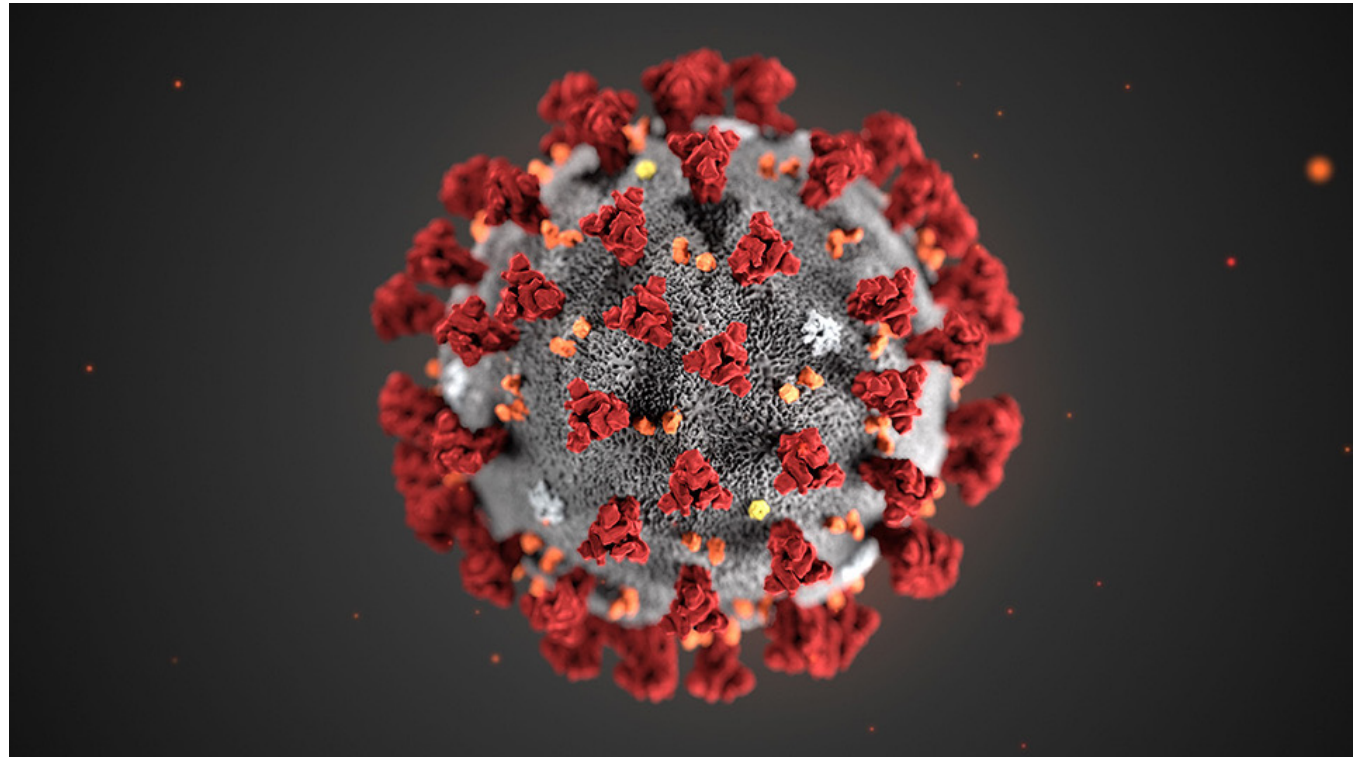
Machine Learning is not black magic, but it is a science based on the availability of data

Without data (or a data strategy) there is no way to implement a Machine Learning solution!



From the web

#2 Some phenomena are 'unpredictable'



#2 Some phenomena are 'unpredictable'

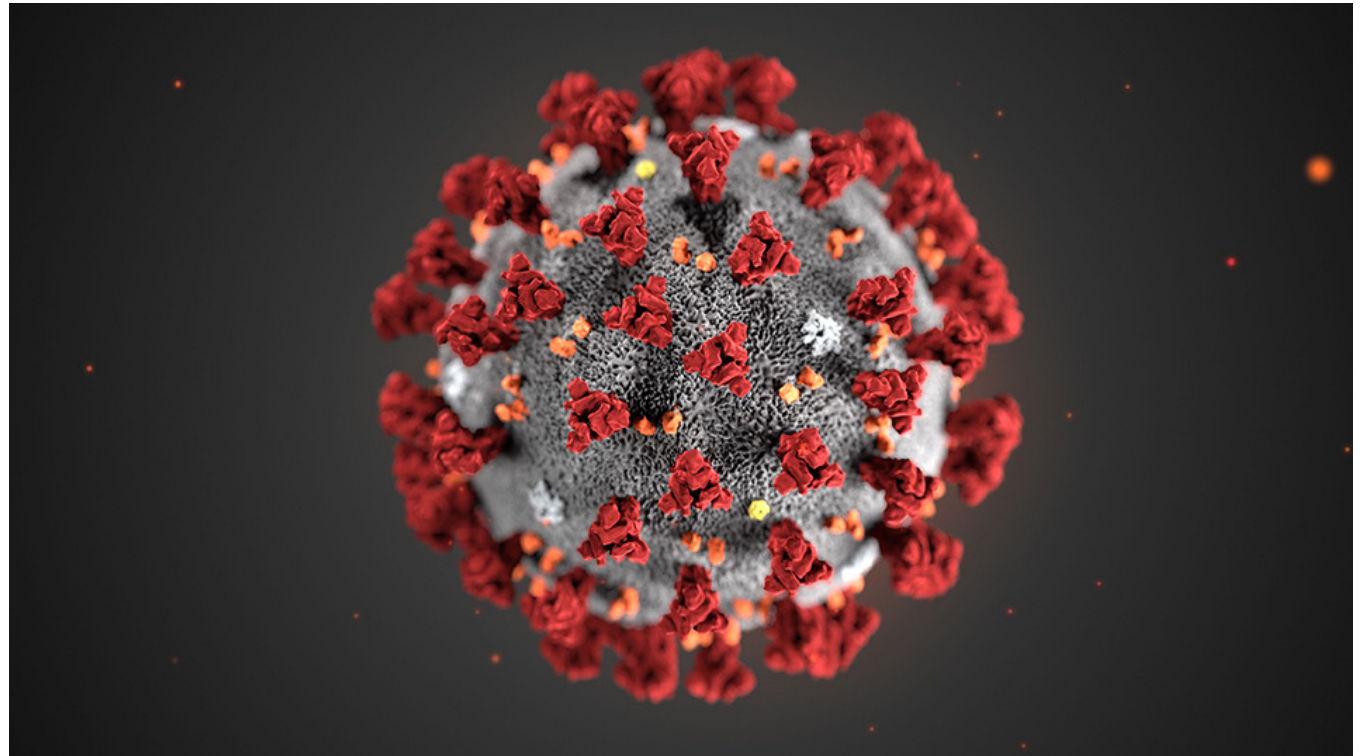
≡ WIRED

GREGORY BARBER

BUSINESS 05.19.2020 06:00 AM

Why Didn't Artificial Intelligence Save Us From Covid-19?

Wikipedia



#2 Some phenomena are 'unpredictable'

WIRED

GREGORY BARBER

BUSINESS 05.19.2020 06:00 AM

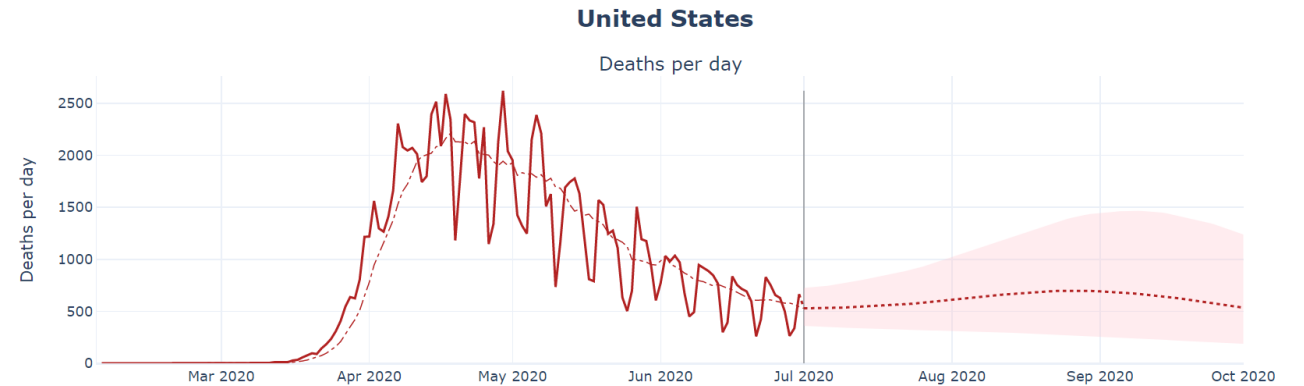
Why Didn't Artificial Intelligence Save Us From Covid-19?

Wikipedia

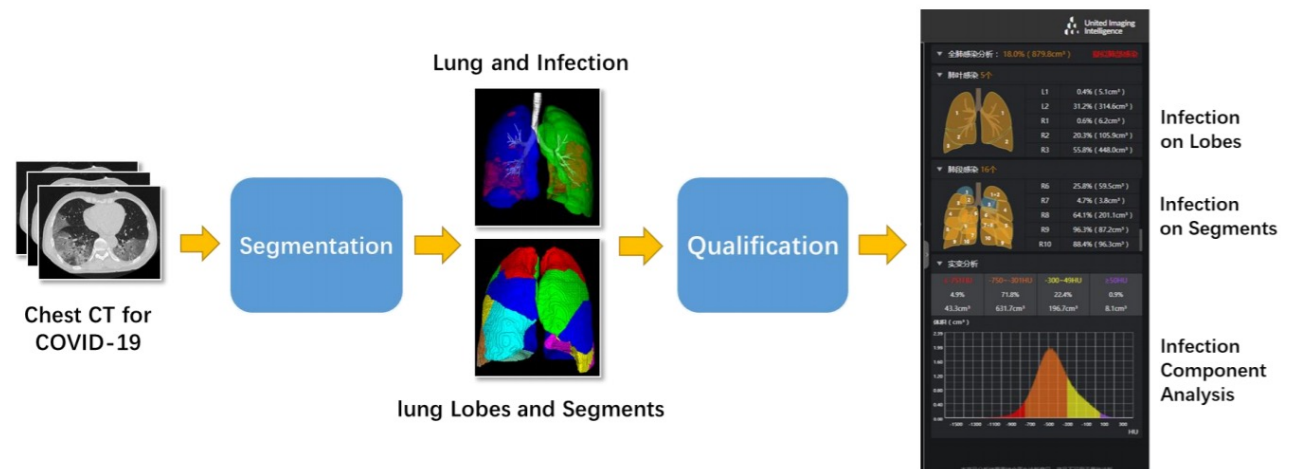
Machine learning using intrinsic genomic signatures for rapid classification of novel pathogens: COVID-19 case study

Gurjit S. Randhawa, Maximilian P. M. Soltysiak, Hadi El Roz, Camila P. E. de Souza, Kathleen A. Hill, Lila Kari

Published: April 24, 2020 • <https://doi.org/10.1371/journal.pone.0232391>



<https://covid19-projections.com/>

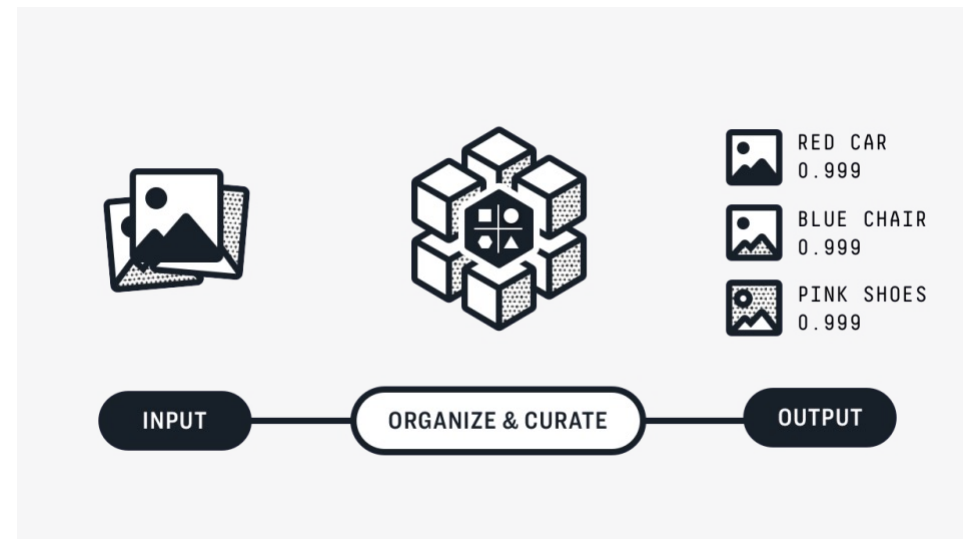


<https://arxiv.org/abs/2003.04655>

#3 Are Machine Learning systems able to generalize? Or they can just understand/predict what they have seen in the past?



The following example was inspired by Prof. Pietro Perona of CalTech



[GENERAL](#) [FACE](#) [NSFW](#) [COLOR](#)[MORE MODELS](#)

General

[VIEW DOCS](#)

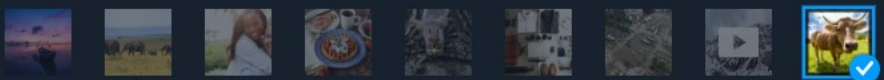
LANGUAGE

PREDICTED CONCEPT

PROBABILITY

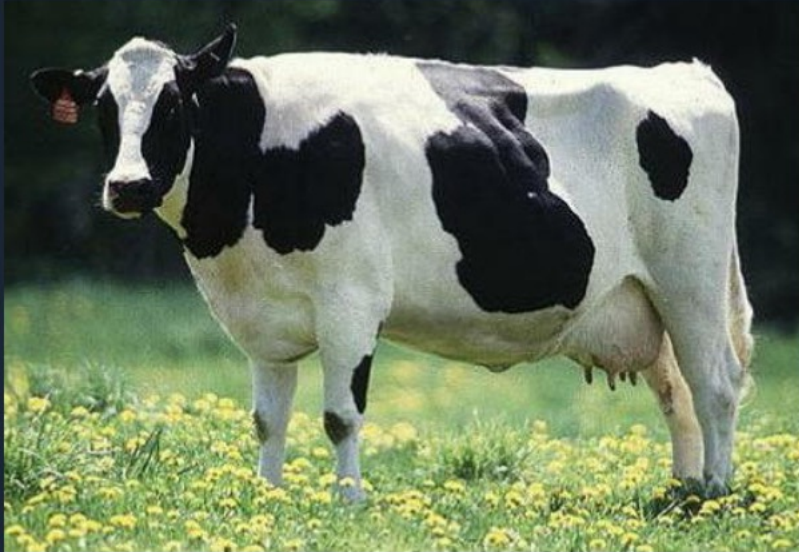
mucca (bovina)	0.999
agricoltura (azienda commerciale)	0.998
bestiame	0.995
latte	0.994
bovini da carne	0.994
pascolo	0.994
bos taurus	0.994
fattoria	0.993
campo di fieno	0.993
erba (botanica)	0.991
campo	0.990
area rurale	0.988

TRY YOUR OWN IMAGE OR VIDEO



GENERAL FACE NSFW COLOR

MORE MODELS



General

[VIEW DOCS](#)

LANGUAGE

Italian (it)

PREDICTED CONCEPT

PROBABILITY

mucca (bovina)	1.000
latte	0.999
agricoltura (azienda commerciale)	0.999
bestiame	0.998
fattoria	0.998
bovini da carne	0.998
caseificio	0.998
bos taurus	0.997
campo di fieno	0.994
pascolo	0.994
erba (botanica)	0.994
mammalia	0.991

TRY YOUR OWN IMAGE OR VIDEO



[GENERAL](#) [FACE](#) [NSFW](#) [COLOR](#)[MORE MODELS](#)

General

[VIEW DOCS](#)

LANGUAGE

Italian (it)

PREDICTED CONCEPT

PROBABILITY

nessuna persona

0.992

spiaggia

0.990

Acque

0.985

sabbia

0.981

mare

0.979

viaggiare

0.978

costa

0.971

estate

0.952

cielo

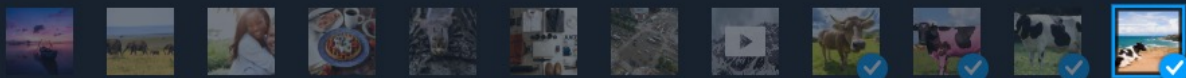
0.945

all'aperto

0.942



TRY YOUR OWN IMAGE OR VIDEO



[GENERAL](#) [FACE](#) [NSFW](#) [COLOR](#)[MORE MODELS](#)

General

[VIEW DOCS](#)

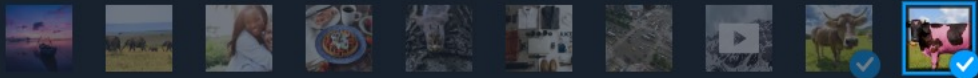
LANGUAGE

PREDICTED CONCEPT

PROBABILITY

mucca (bovina)	0.994
mammalia	0.991
erba (botanica)	0.990
pascolo	0.986
agricoltura (azienda commerciale)	0.983
area rurale	0.981
bestiame	0.979
campo	0.978
campo di fieno	0.978
bos taurus	0.977
terreni agricoli (paese)	0.971
fattoria	0.965

TRY YOUR OWN IMAGE OR VIDEO

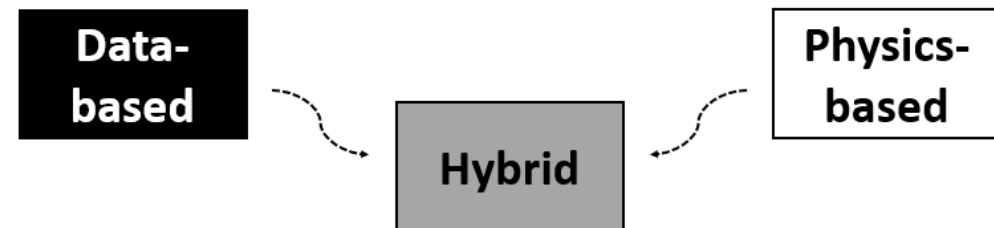


#4 In many (most) areas/tasks effective Machine Learning is not plug-and-play



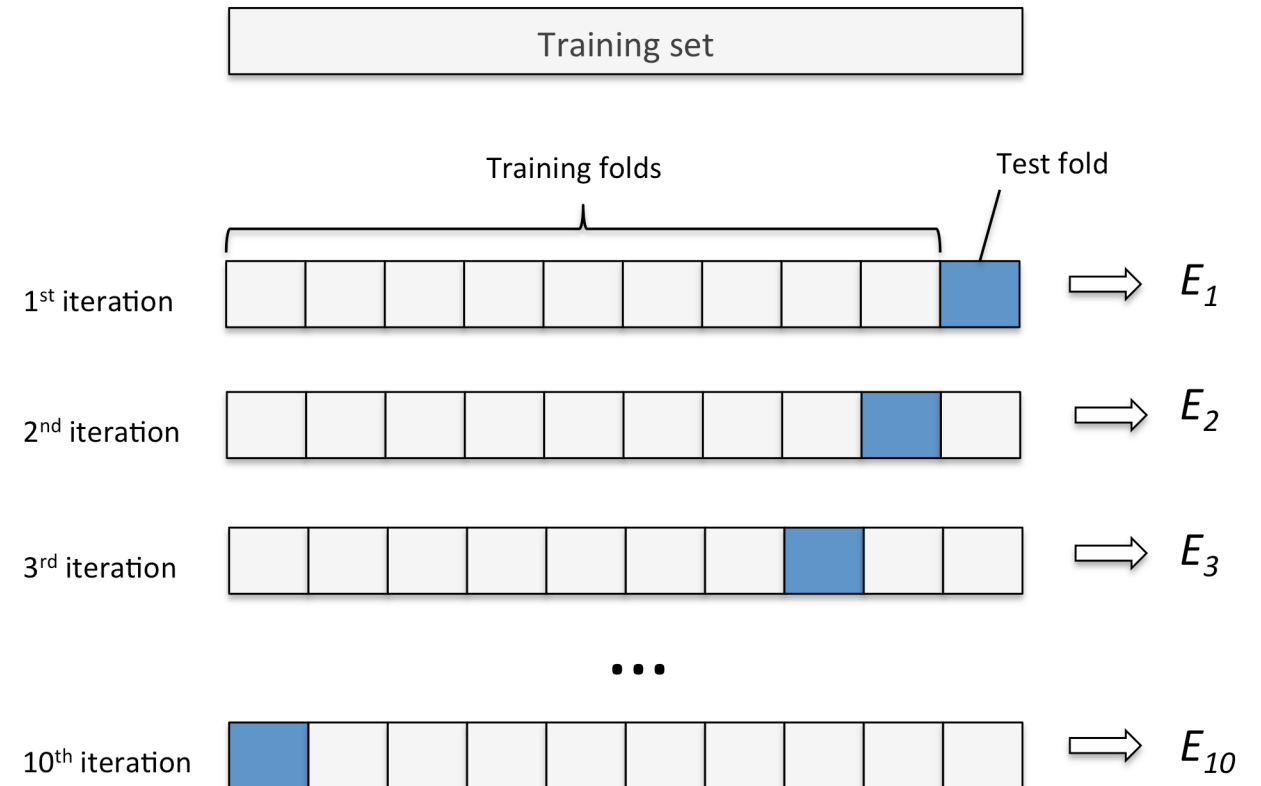
- Machine Learning solutions require a development process.

- Domain expertise is fundamental in many areas/tasks

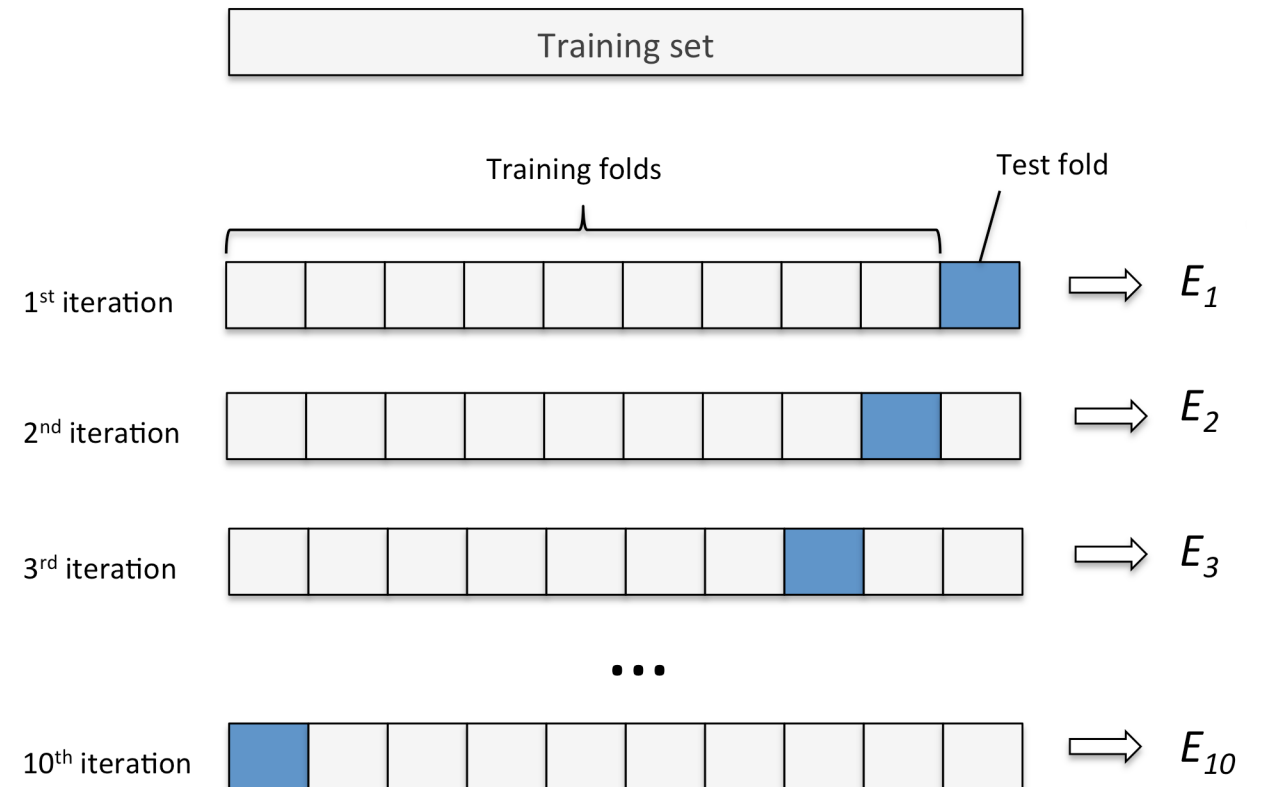
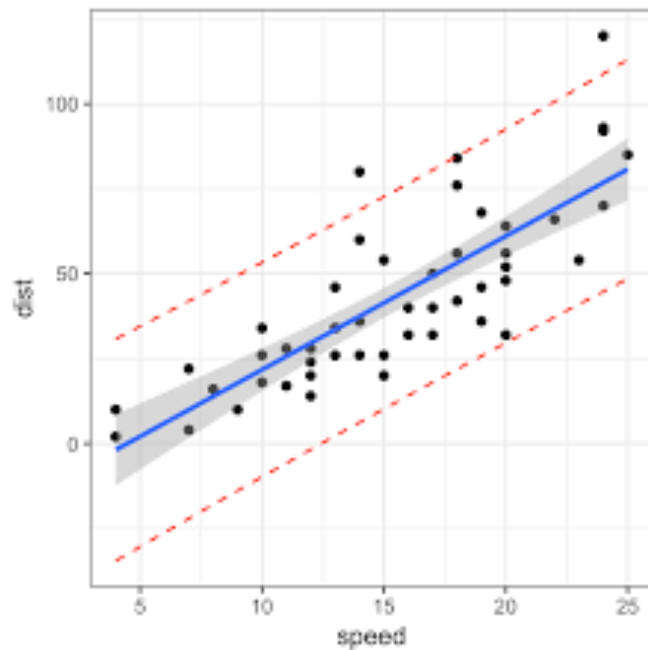


#5 There is no a-priori
knowledge on Machine
Learning performances

#5 There is no a-priori knowledge on Machine Learning performances



#5 There is no a-priori knowledge on Machine Learning performances

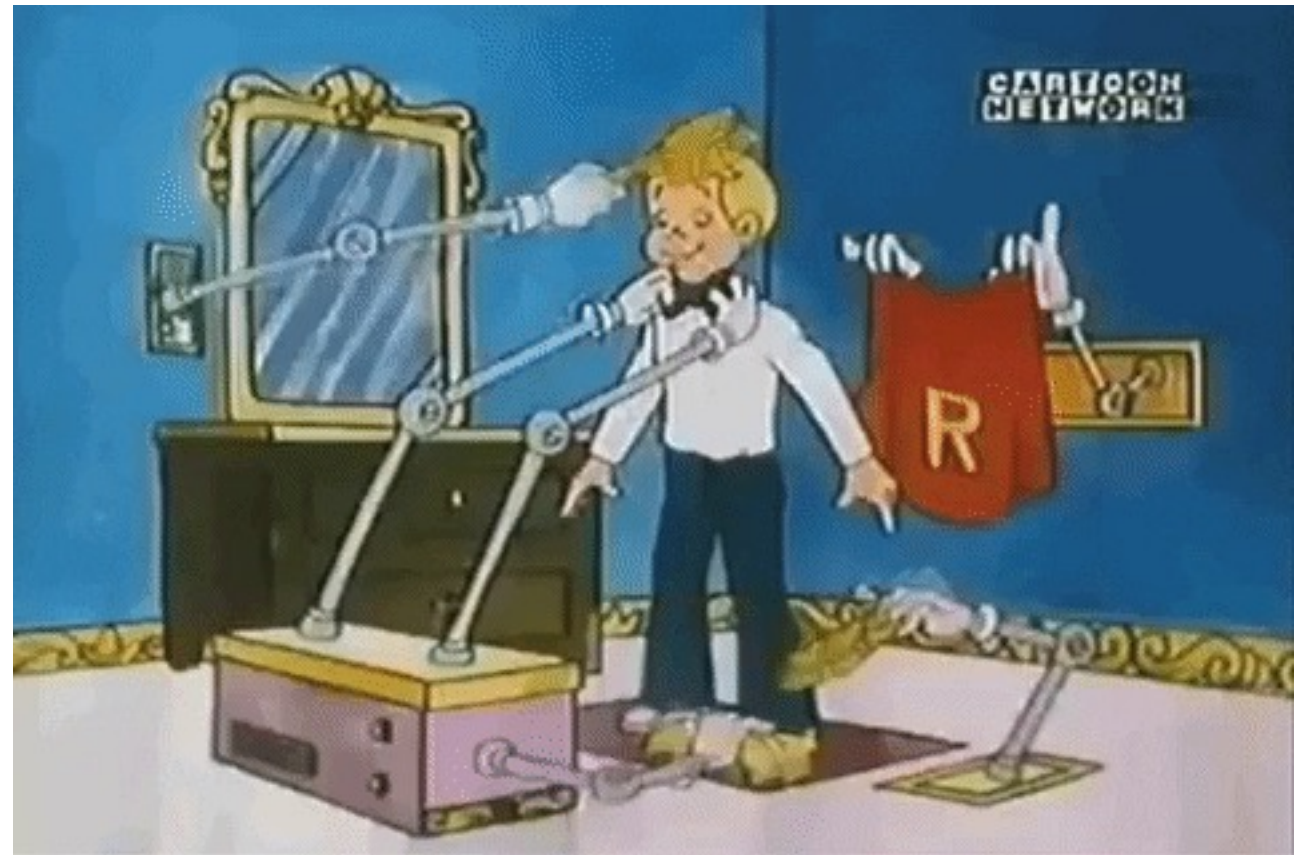
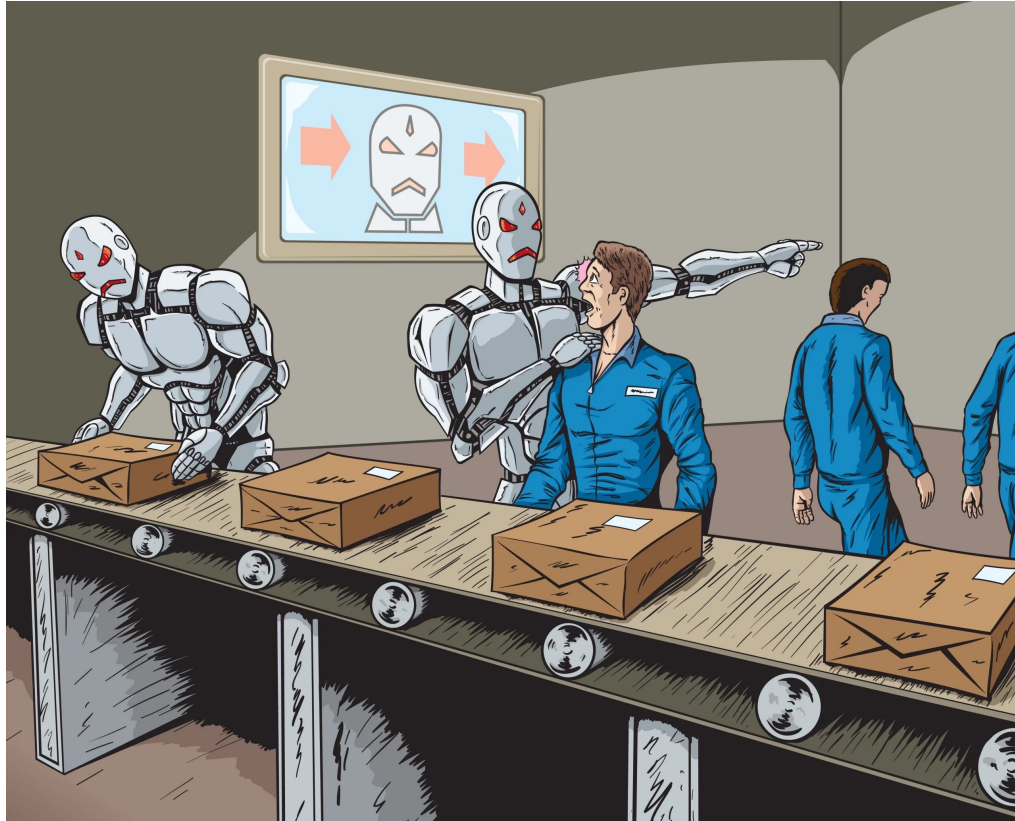


#5 There is no a-priori knowledge on Machine Learning performances...

Especially when dealing with 'private' (ie. company-specific) data!



#6 We will lose all our jobs because of AI



#6 We will lose all our jobs because of AI

ChatGPT Is Passing the Tests Required for Medical Licenses and Business Degrees

GPT-3 would have received a B to B- on an MBA Wharton final exam.



By [Chloe Xiang](#)

24 January 2023, 1:46am



#6 We will lose all our jobs because of AI

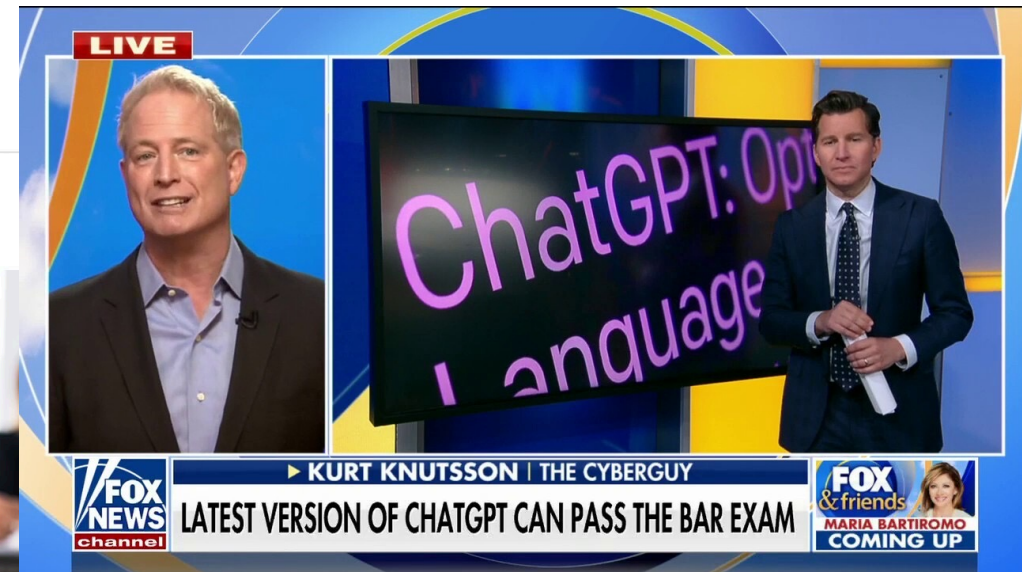
ChatGPT Is Passing the Tests Required for Medical Licenses and Business Degrees

GPT-3 would have received a B to B- on an MBA Wharton final exam.



By [Chloe Xiang](#)

24 January 2023, 1:46am



#6 We will lose all our jobs because of AI

HOME > TECH

Medical experts prefer ChatGPT to a real physician 78.6% of the time — because it has more time for questions

Aaron Mok and Hilary Brueck May 2, 2023, 10:00 AM CEST



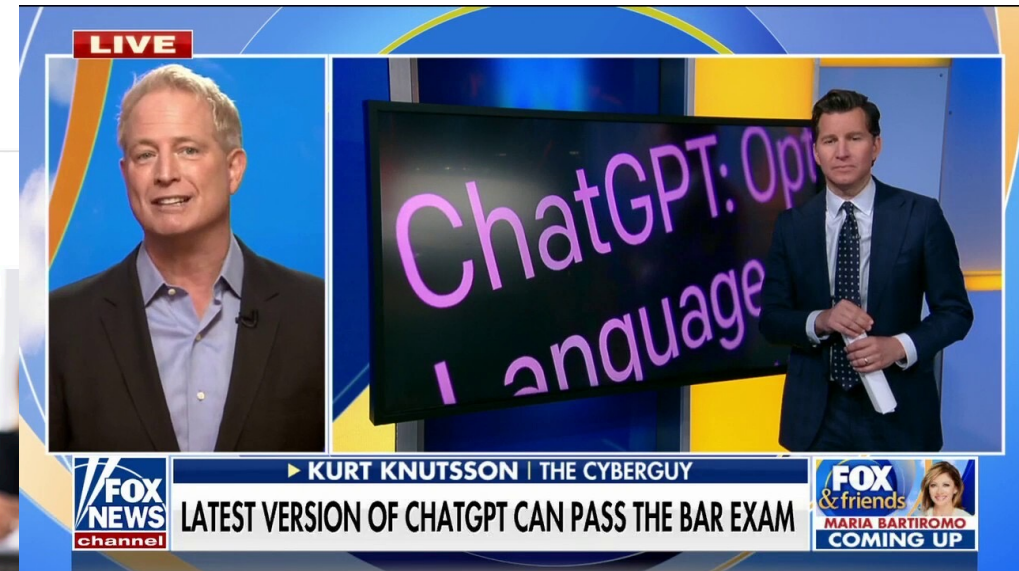
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24 January 2023, 1:46am



#6 We will lose all our jobs because of AI

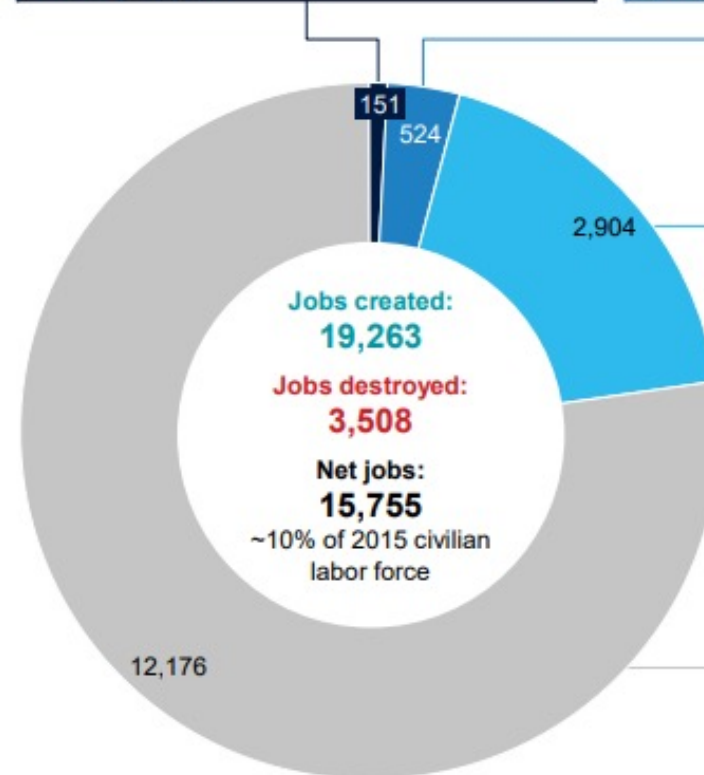
Most likely AI will replace jobs (accordingly also to major analysts, such as PwC or McKinsey)

Example: Personal computers

Total US jobs created and destroyed by personal computers (examples listed are not comprehensive)
Thousand jobs

Direct Computer equipment manufacturing, 1970–2015	
▲ Assorted managers and administrators	31
▲ Computer software developers (in-industry equipment)	27
▲ Computer scientists	18
▼ Office machine manufacturers (typewriters)	-61

Indirect Computer suppliers, 1970–2015	
▲ Managers	42
▲ Semiconductor manufacturing occupations	31
▲ Printed circuit assembly occupations	26
▼ Typewriter indirect occupations	-79



Enabled Computer software and service industries, 1970–2015	
▲ Software developers (software and apps)	768
▲ Computer scientists	686
▲ Managers	416
▼ Typewriter repair	-32

Utilizers Computer-utilizing industries, 1980–2015	
▲ Customer service reps	3,205
▲ Computer scientists (not in computer industry)	1,873
▲ Stock and inventory clerks	1,517
▼ Bookkeepers and auditing clerks	-881
▼ Secretaries	-823
▼ Typists	-562

#7 Deep Fakes



#7 Deep Fakes

Original (Amini)



Synthesized (Obama)



#8 Fairness

Women less likely to be shown ads for high-paid jobs on Google, study shows

theguardian



DYLAN FUGETT	BERNARD PARKER
Prior Offense 1 attempted burglary	Prior Offense 1 resisting arrest without violence
Subsequent Offenses 3 drug possessions	Subsequent Offenses None
LOW RISK 3	HIGH RISK 10

For all these aspects, a starting course in Machine Learning should make sense...



Course Outline

Course Outline (tentative)

The goal of the course is to provide an overview of the most common algorithms in ML. The course also aims at providing programming experiences on basic ML tasks.

We will cover:

- Basics of Statistics
- Supervised Learning Approaches (Regression & Classification)
- Unsupervised Learning Approaches (Anomaly Detection & Clustering)
- Elements of Neural Networks
- Elements of eXplainable Artificial Intelligence & Fairness

Supervised Learning



Setup: Observation of the environment

Data: (x,y)

Task: learn a map from inputs x to outputs y

Supervised Learning

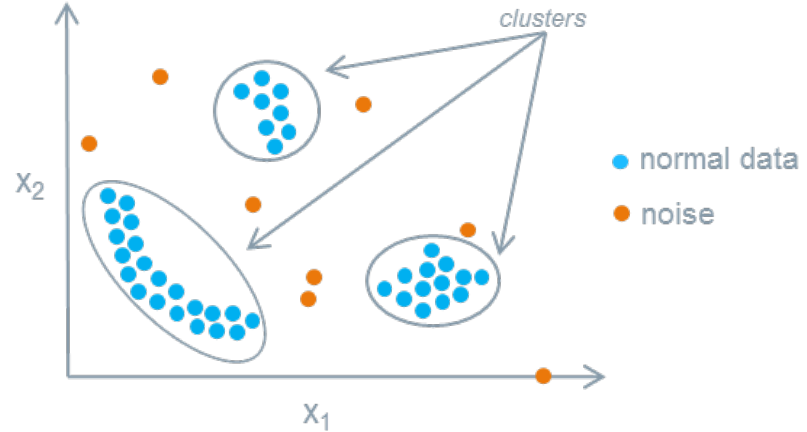


Setup: Observation of the environment

Data: (x,y)

Task: learn a map from inputs x to outputs y

Unsupervised Learning



Setup: Observation of the environment

Data: x (no labels)

Task: learn patterns in input data

Supervised Learning

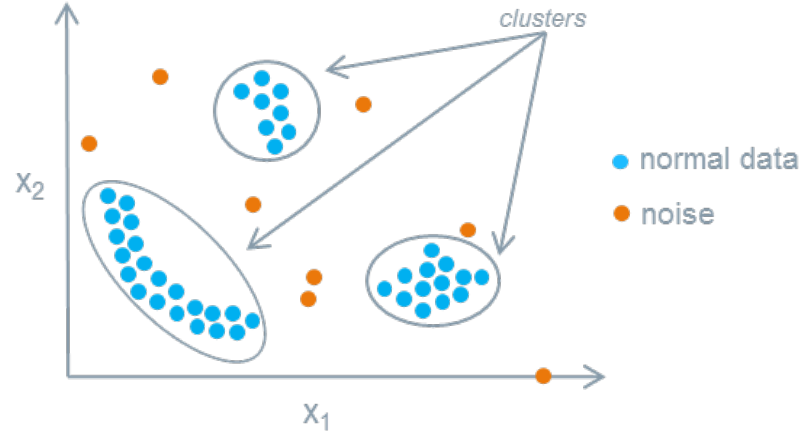


Setup: Observation of the environment

Data: (x,y)

Task: learn a map from inputs x to outputs y

Unsupervised Learning



Setup: Observation of the environment

Data: x (no labels)

Task: learn patterns in input data

Reinforcement Learning

(there is a Master class)

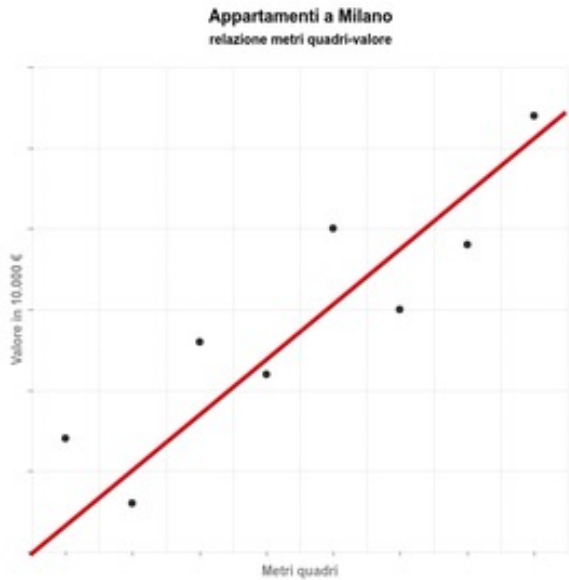


Setup: Interaction with the environment

Data: (state,action, rewards)

Task: learn policies that maximize rewards

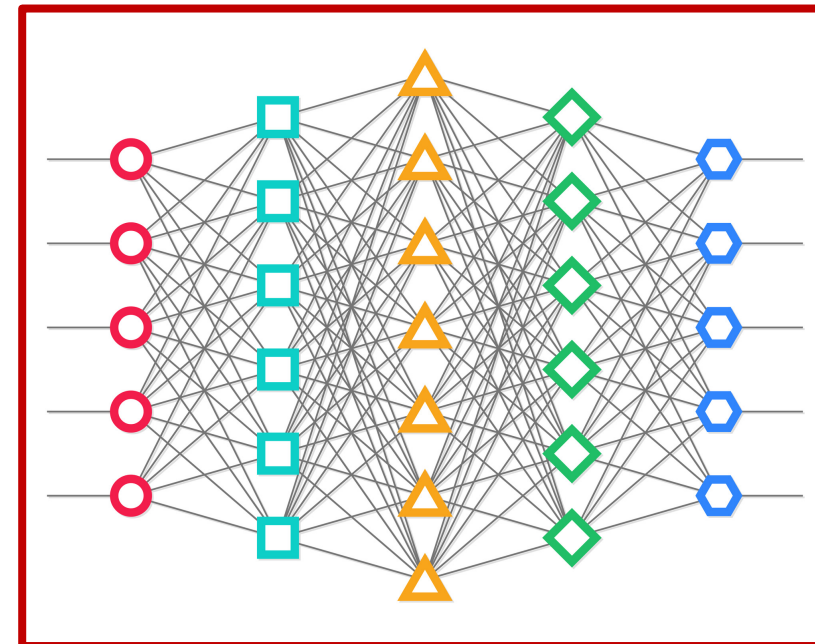
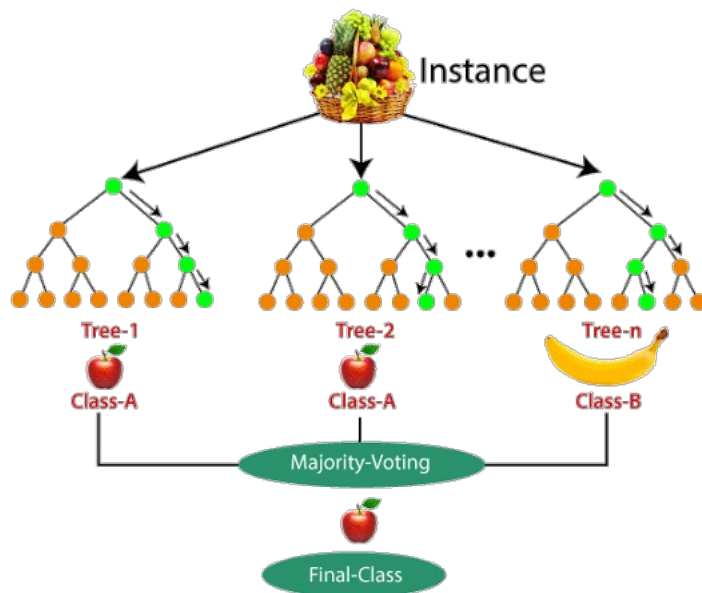
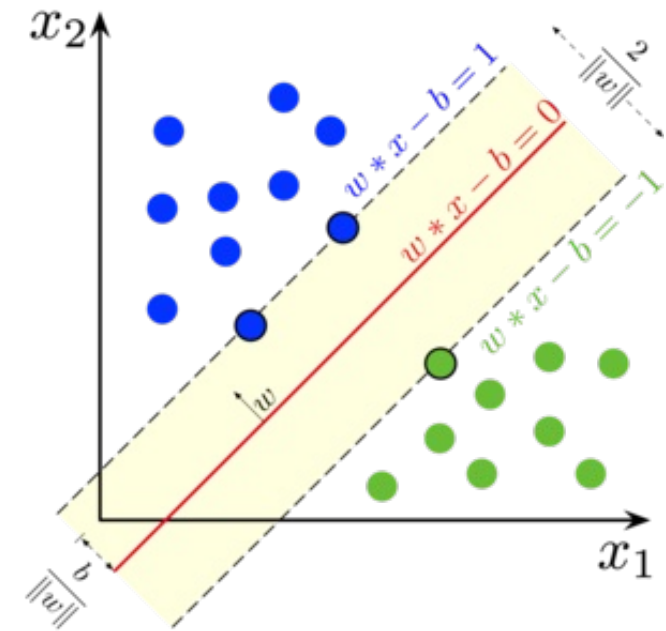
Machine Learning Approaches



La regressione lineare

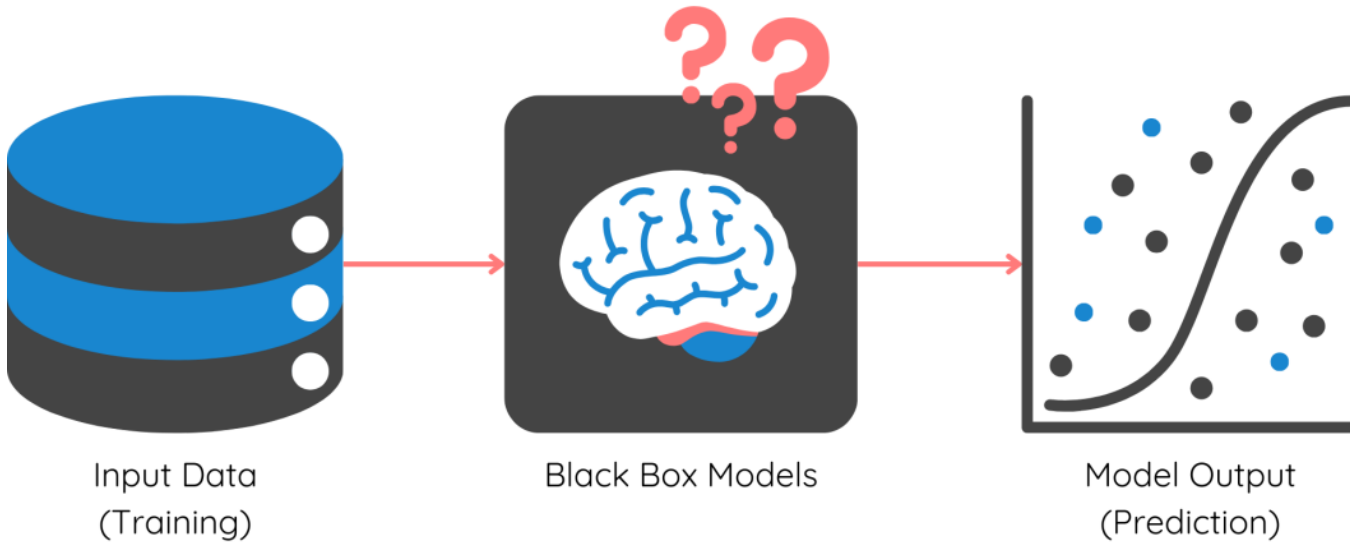
$$y = b + wx$$

BIAS \uparrow PROPRIETA'
PREDIZIONE \downarrow PESO \downarrow



Neural
Networks
(Deep
Learning)

Beyond accuracy



DYLAN FUGETT	BERNARD PARKER
Prior Offense 1 attempted burglary	Prior Offense 1 resisting arrest without violence
Subsequent Offenses 3 drug possessions	Subsequent Offenses None
LOW RISK 3	HIGH RISK 10



Course Outline and Calendar 1/4

WEEK 01

2025-02-24 Monday - Lecture 01: Course introduction & Motivation & Taxonomy of ML

2025-02-27 Thursday - Lecture 02: Introduction to Statistics for Machine Learning

2025-02-28 Friday - Lecture 03 (Lab 01): Introduction to Python

WEEK 02

2025-03-01 Monday - Lecture 04: Data Visualization, GIT

2025-03-04 Thursday - Lecture 05: Principal Component Analysis

2025-03-05 Friday - Lecture 06 (Lab 02): Elaborate and Visualize data

WEEK 03

2025-03-10 Monday - Lecture 07: Supervised Learning, linear regression, training vs testing

2025-03-13 Thursday - Lecture 08: Overfitting and Ridge Regression, crossvalidation

2025-03-14 Friday - Lecture 09 (Lab 03): Linear Regression and Ridge Regression

WEEK 04

2025-03-17 Monday - Lecture 10: Ridge Regression vs LASSO, gradient descent

2025-03-20 Thursday - Lecture 11: Classification, Logistic Regression

2025-03-21 Friday - Lecture 12 (Lab 04): Regularization & Classification

Course Outline and Calendar 2/4

WEEK 05

2025-03-24 Monday - Lecture 13: Multiclass Classification and Softmax Regression, Introduction to performance metrics: accuracy, precision, recall, F1-score / Handling unbalanced data

2025-03-27 Thursday - Lecture 14: Decision trees, overfitting and pruning

2025-03-28 Friday - Lecture 15 (Lab 05): Decision Trees

WEEK 06

2025-03-31 Monday - Lecture 16: Ensemble Methods: Bagging, Random Forests, bootstrap aggregating

2025-04-03 Thursday - Lecture 17: AdaBoost, XGBoost, Catboost

2025-04-04 Friday - Lecture 18 (Lab 06): Ensemble approaches

WEEK 07

2025-03-17 Monday - Lecture 19: Support Vector Machines (SVM), Linear and kernel-based approaches, Concept of the margin and kernel trick

2025-04-10 Thursday - Lecture 20: Unsupervised Learning: K-Means Clustering. Evaluating clustering performance.

2025-04-11 Friday - Lecture 21 (Lab 07): SVM and Clustering

Course Outline and Calendar 3/4

WEEK 08

2025-04-14 Monday - Lecture 22: Anomaly Detection

2025-04-17 Thursday - Lecture 23: Introduction to Neural Networks, Activation functions (ReLU, sigmoid, softmax), Perceptrons

WEEK 09

2025-04-24 Thursday - Lecture 24: Training of NN #01

WEEK 10

2025-04-28 Monday - Lecture 25: Training of NN #02

WEEK 11

2025-05-05 Monday - Lecture 26: CNN

2025-05-08 Thursday - Lecture 27: Autoencoders

2025-05-09 Friday - Lecture 28 (Lab 08): NN #01

WEEK 12

2025-05-13 Monday - Lecture 29: RNN

2025-05-15 Thursday - No Lecture

2025-05-16 Friday - Lecture 30 (Lab 09): NN #02

Course Outline and Calendar 4/4

WEEK 13

2025-05-19 Monday - No Lecture

2025-05-22 Thursday - No Lecture

2025-05-23 Friday - No Lecture

WEEK 14

2025-05-26 Monday - Lecture 31: XAI #01

2025-05-29 Thursday - Lecture 32: XAI #02

2025-05-30 Friday - Lecture 33 (Lab 10): XAI

WEEK 15

2025-06-05 Thursday - Lecture 34: Fairness in ML

2025-06-06 Friday - Lecture 35: Real-world Applications and MLOps

WEEK 16

2025-06-09 Monday - Lecture 36: What's next

2025-06-12 Thursday - FREE



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Thank you!

Gian Antonio Susto

