Swiss Data Science Center

Artificial Intelligence: Recent Developments and Practical Use

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Le Swiss Data Science Center

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Enabling data-driven science & innovation for societal impact

An initiative from the ETH Domain

Large multidisciplinary team of 100+ data science professionals

Research, Innovation, Software & platforms, Education

Collaboration landscape

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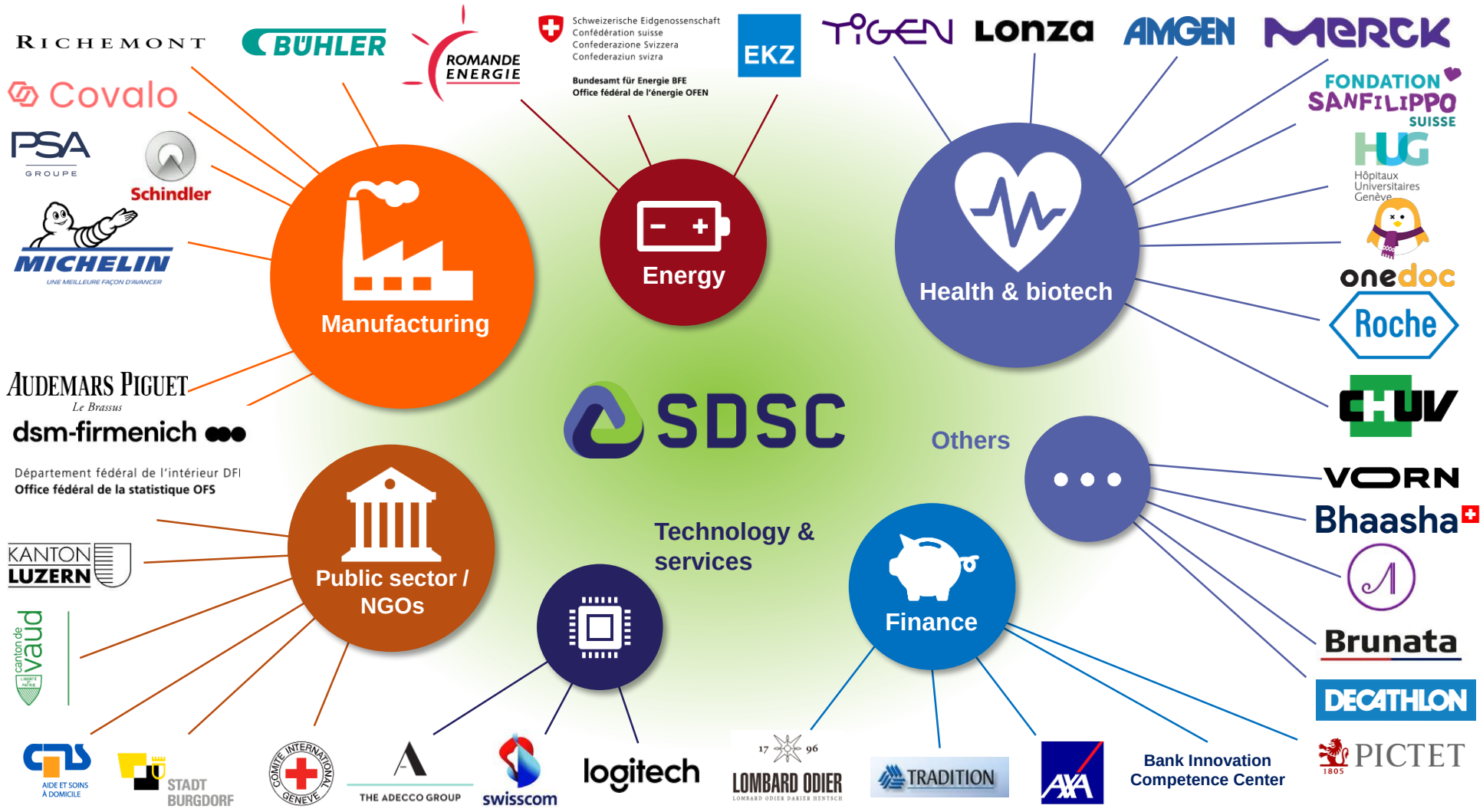

Artificial Intelligence: 75 years of discovery

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Artificial Intelligence 1

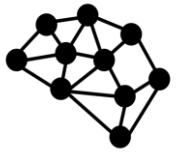
- Early-stage AI sparks excitement

Machine learning 2

- Learning from data becomes a widespread paradigm

Deep learning 3

- The achievements of deep learning lead to the AI boom



1950s — 1980s — 2010s

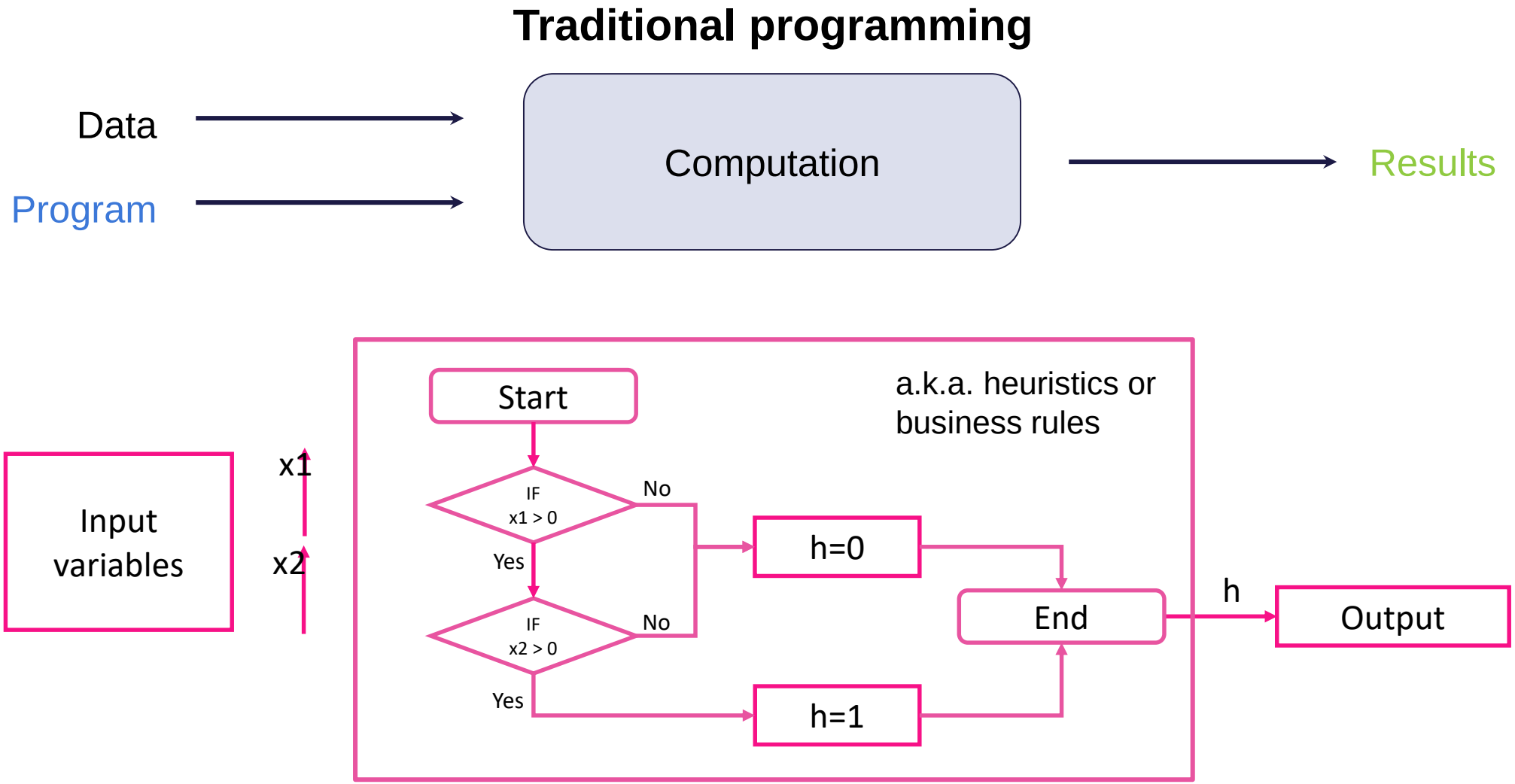
Data science
Techniques for extracting knowledge from data

Artificial Intelligence (IA)
A program that can feel, reason, behave and adapt by simulating human intelligence

Machine learning
Techniques allowing a machine to learn without being explicitly programmed thanks to algorithms that learn from data

Deep learning
Subset of machine learning where multi-layer neural networks learn from large amounts of data

ML vs Traditional Programming



ML vs Traditional Programming

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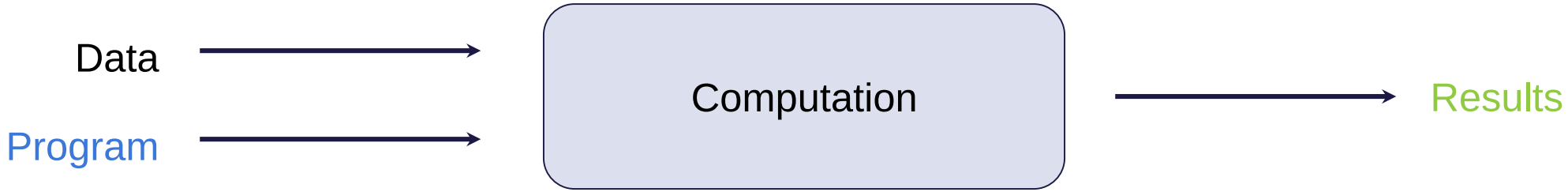
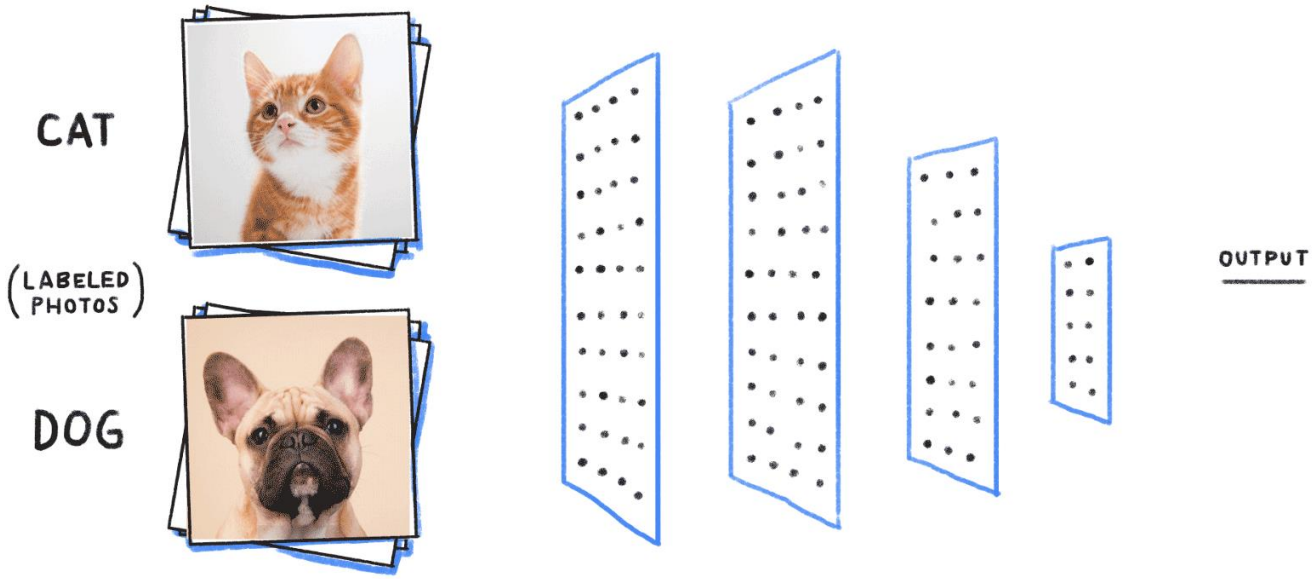
Traditional programming



Machine Learning Approach

No explicit instructions,
learn by examples!

Artificial intelligence: the “boom” of Deep learning



Deep learning

A subset of machine learning in which multilayer neural networks learn from large amounts of data

Recently, the general public has given extraordinary attention to a subset of deep learning techniques, more specifically to generative AI applications such as ChatGPT and Midjourney.

Generative AI: Between wonder and opportunities

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Generative AI: a field of deep learning giving machines the ability to generate content from training data.

How it works?

For text generation, we train large language models (like GPT4, the “base” of ChatGPT), which “observe” huge volumes of text and learn how to learn.

In other words, the power of these systems is to be able to carry out tasks without being optimized to do so… Even in a specific business domain!

The same goes for the generation of non-textual content, with tools like DALL-E and Midjourney which allow the creation of very realistic and “convincing” images – for example to assist in product design.

Capturing the context: understand the language

- 1950s: foundational idea of NLP
  - The meaning of a word is determined by the words around it - distributional semantics
  - Indeed, similar words appear in similar contexts
- 1970s: the vector space model
  - In a multi-dimensional space having as many dimensions as words in a vocabulary, sentences are vectors
  - Words and sentences as “one-hot” vectors

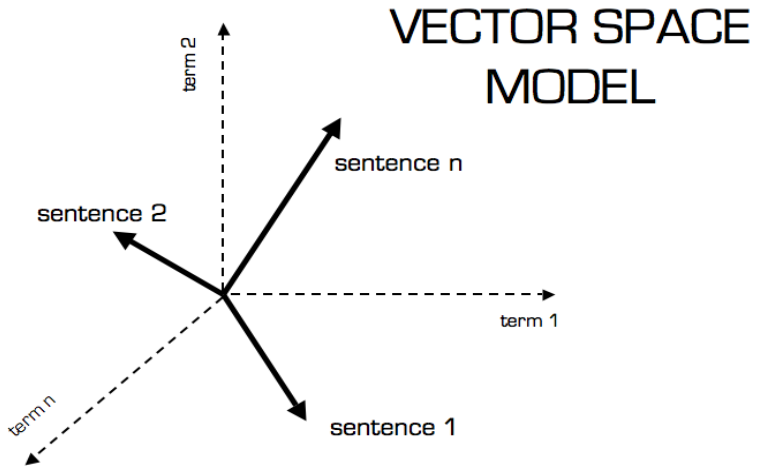
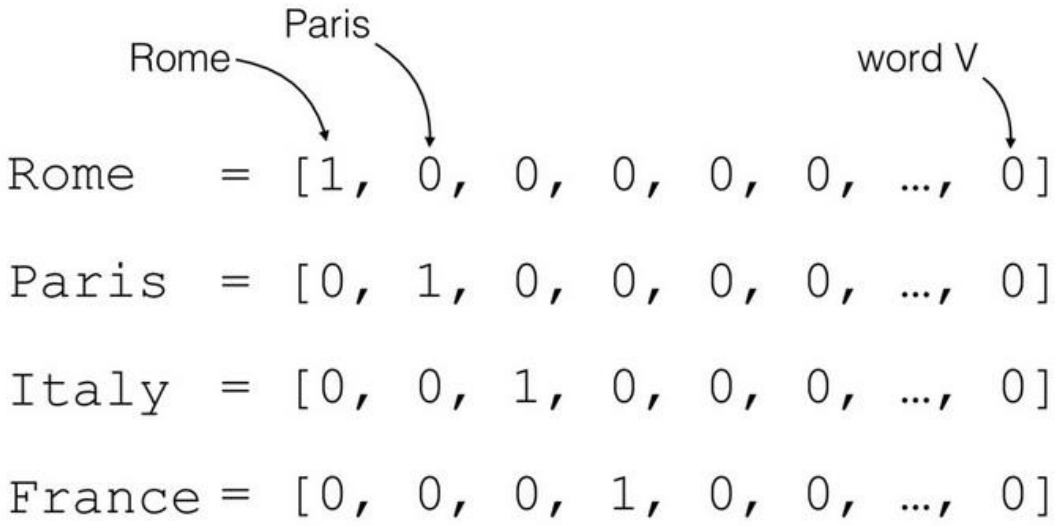
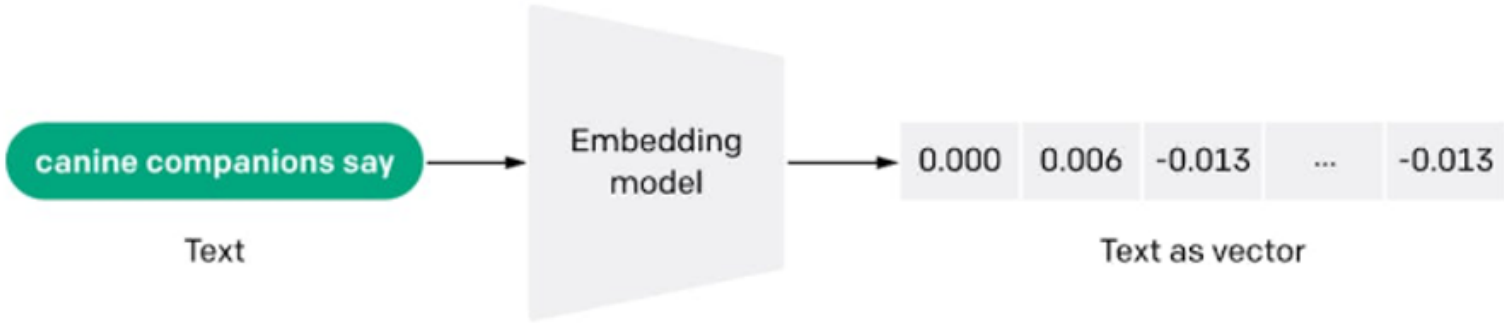


Image credits: bitsearch.blogspot.com



Embeddings (“lexical embeddings”)

- Recently, deep learning has revolutionized the field thanks to embeddings, compact vector representations of the meaning of words
- Obtained by training neural networks to solve tasks such as “predicting the missing word in a sentence”



How hard can it be? Ambiguity & context

THE NEWS-GAZETTE

NATION / WO

PRESIDENT'S FIRST PHYSICAL

Doctor: No heart, cognitive issues

But Trump needs to reduce his cholesterol, lose weight

By JILL COLVIN

6-foot-3 president weighed in at 239 pounds — three pounds heavier than he was in September 2016, the last time Trump revealed his weight to the public.

Trump's blood pressure was 122 over 74, and his

with no medical issues." Trump has no heart disease and no family history of it.

The 71-year-old president performed "exceedingly well" on cognitive screening, which is not

White H
reporter

theguardian

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Rio de Janeiro

Mutilated body washes up on Rio beach to be used for Olympics beach volleyball

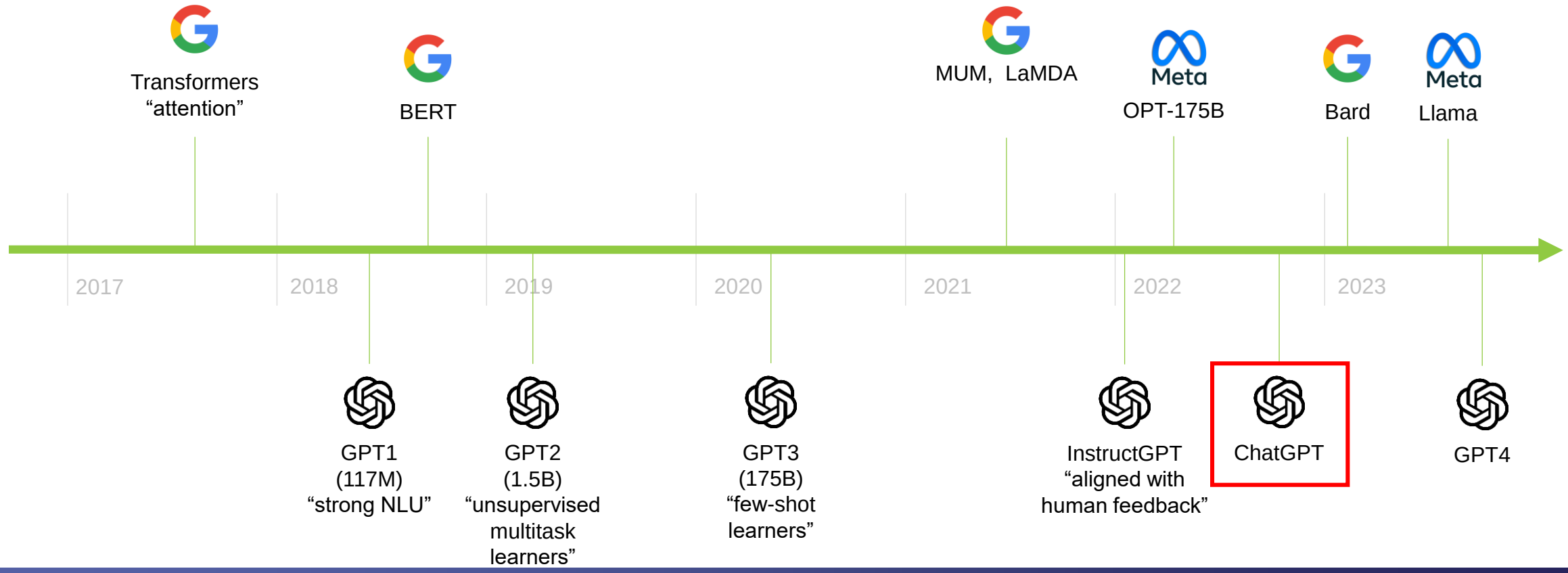
6/29/16, 1:48 PM

New representation of the language

- Remember one-hot vectors?
- Embedding vectors are more compact and surprisingly good at capturing associations!

Skip-gram embeddings computed using Reuters news

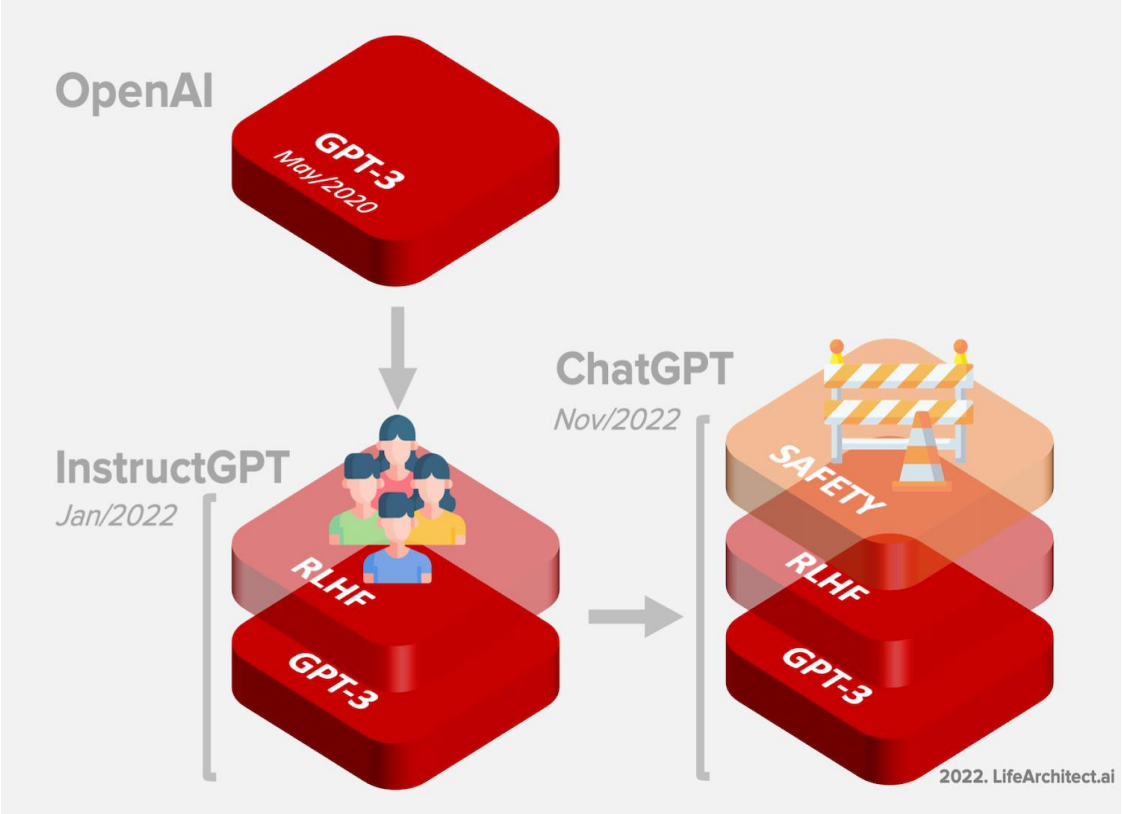
The path to ChatGPT…and its successors



ChatGPT

- Much of today's hype about generative AI technology is due to ChatGPT, a conversational software application developed by the company OpenAI

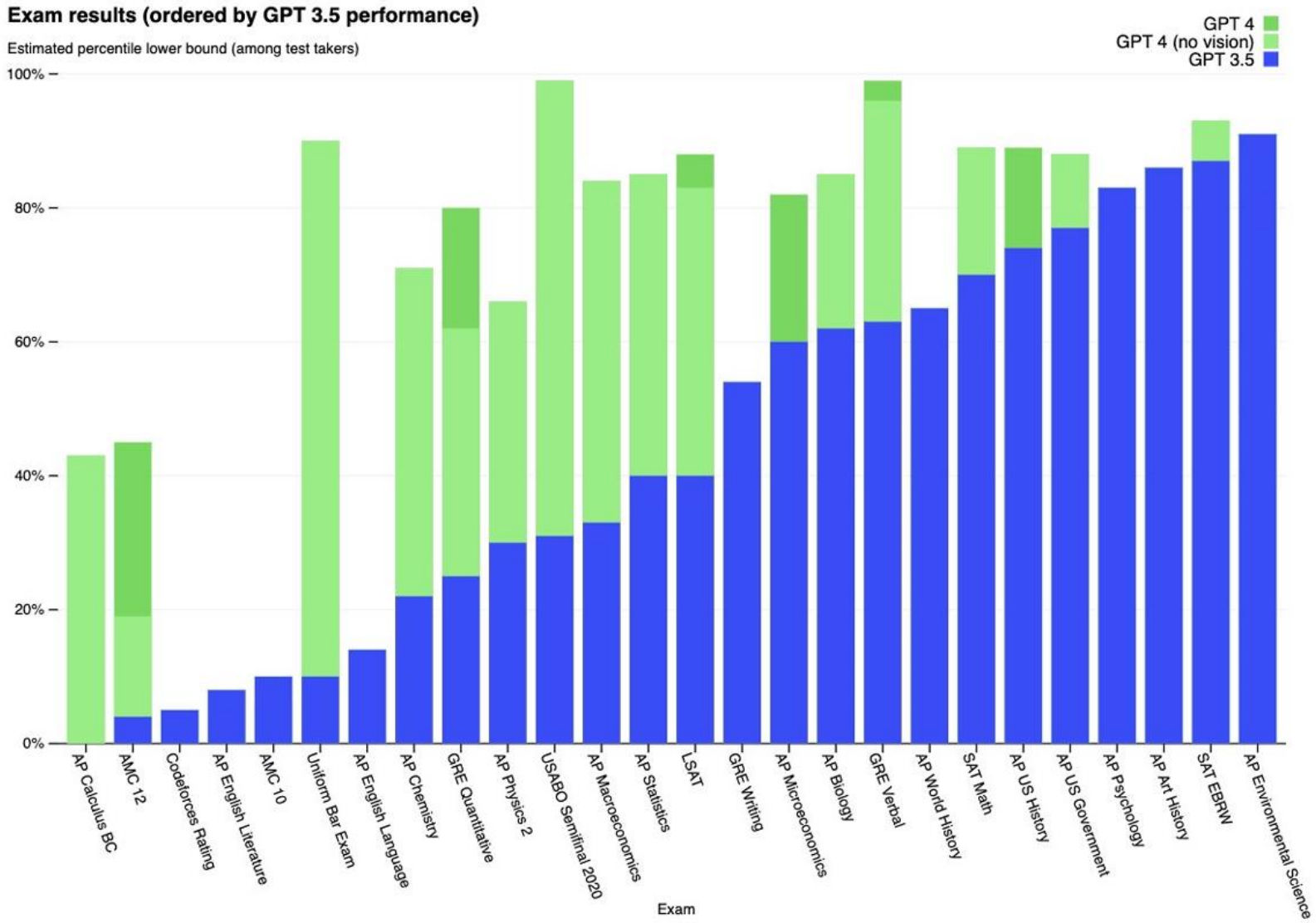
- Released in November 2022, it is based on a specialized version of the GPT-3 model called **InstructGPT** – with additional safeguards



How is ChatGPT “disruptive”?

- Different complementary aspects, e.g.:
  - A dialog interface capable of maintaining the context of the conversation for a “natural” experience
  - Direct access to a type of logic previously only available “behind the scenes” of applications like Google Search and Meta’s Facebook platform

How do GPT models perform in human tasks?



“Incredibly smart and shockingly stupid”

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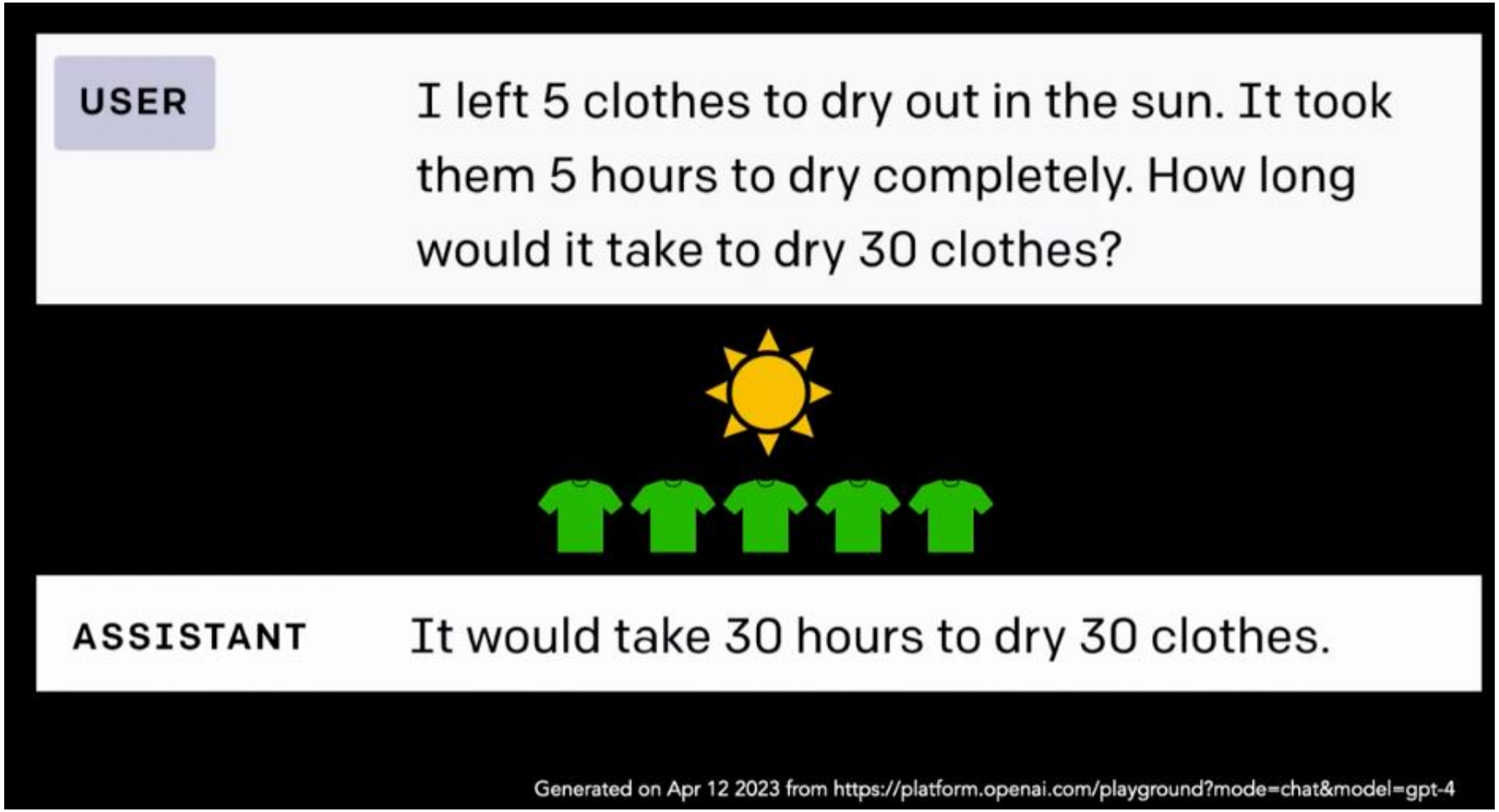
- Logic gaps observed in GPT4 (and its predecessors)



How to take advantage of AI?

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Important to know that AI has been part of our daily lives for years

Lately, the integration of AI solutions has become “disruptive” in many areas:

- Computer code generation (Copilot)
- Language learning (Duolingo)
- Assisted image generation (Firefly)
- Automatic session summary (Teams)
- Personalized medicine (Isomorphic labs)

Disruption evidenced by market investments:

- Ca. $10B invested by Microsoft in OpenAI in January 2023
- McKinsey: generative AI could add $2.6 to $4.4 trillion annually to the global economy - banking sector in primis

It’s hard to miss this potential!

Select Generative AI Use Cases by Industry

	Industries							
	Automotive and Vehicle Manufacturing	Media	Architecture and Engineering	Energy and Utilities	Healthcare Providers	Electronic Product Manufacturing	Manufacturing	Pharmaceutical
Drug Design								●
Material Science	●			●		●		
Chip Design						●		
Synthetic Data	●		●	●	●	●	●	●
Generative Design (Parts)	●		●				●	

gartner.com

Source: Gartner
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Gartner

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Applications

Reducing sepsis mortality rate

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CHUV Centre hospitalier universitaire vaudois

CONTEXT

At CHUV there are **>500 sepsis cases per year** with a mortality rate of ~25%. The key to survival in case of sepsis are **early detection and treatment**. However, there is no simple way of detecting sepsis, as sepsis shows up as a rapid decline in patient's condition in many different aspects.

OBJECTIVES

Create an **easy-to-query semantic data base** integrating all relevant data sources.

Develop an interactive dashboard displaying relevant metrics describing clinical procedures.

Develop **accurate and context-aware sepsis predictors** based on ML.

BENEFITS

A pilot project with **early warning alerts** and the interactive dashboard is currently running in several units of the hospital, collecting the gold-standard sepsis labels and **providing clinicians with new quality of care insights**.

Assessing fall risk in the elderly home care population

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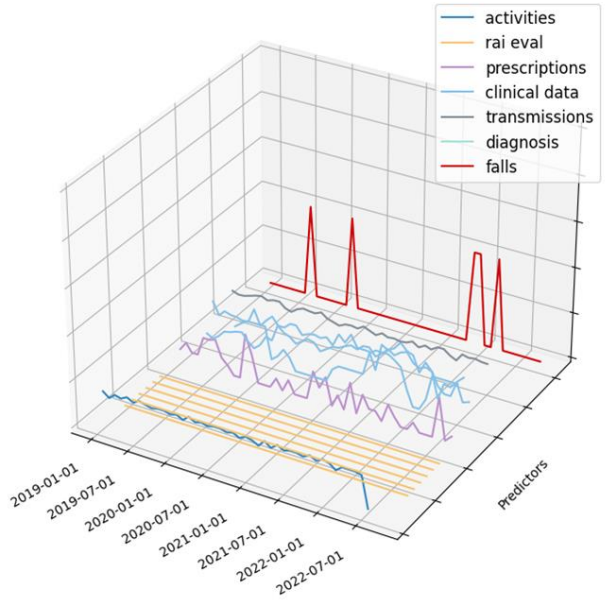
AIDE ET SOINS À DOMICILE

CONTEXT

Fall detection and prevention is a global healthcare priority due to high **economical** and **personal** costs

OBJECTIVES

Develop a prototype solution to identify and rank clients at risk of falling



BENEFITS

Prioritize in-depth health evaluations and **preventive measures**

Increase patients' life quality and reduce healthcare costs

Forecasting volumes of product repairs

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RICHEMONT

CONTEXT

Repairing a luxury watch is a delicate operation **requiring time and specialized manpower**.

New manufacturing strategies and marketing actions will soon perturb current repair activities.

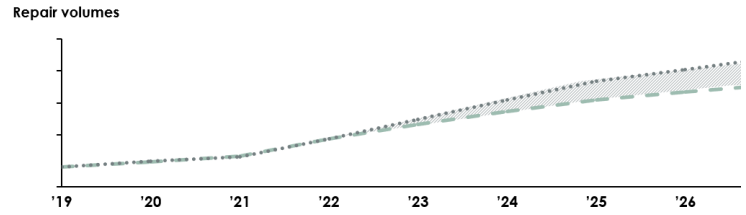
OBJECTIVES

Forecast volumes of watch repairs based on:

- Sale data and projections
- Warranty extension plans
- Quality improvements for new products

BENEFITS

We delivered a decision support tool that **automatically adapts to market** changes and **instantly simulates different scenarios**. The model generates yearly forecasts of repair volumes for different watch models across the Richemont group.



Route and schedule optimization

CONTEXT

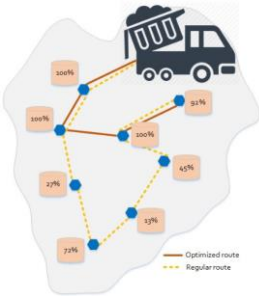
Containers are currently emptied when they are about **40-60% full**. Since the process relies on fixed schedules and fixed routes to collect the containers.

OBJECTIVES

Optimize the routes such that the container capacity is **utilized better and fewer collections are needed**. Compare several state-of-the-art algorithms: local search, global search and exact algorithms.

BENEFITS

Early results show a **reduction of travel distance and time by 20 - 40%** for collecting glass and can waste. As a result the collection cost and CO2 emissions in waste management is reduced significantly.



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Thank you!

www.datascience.ch

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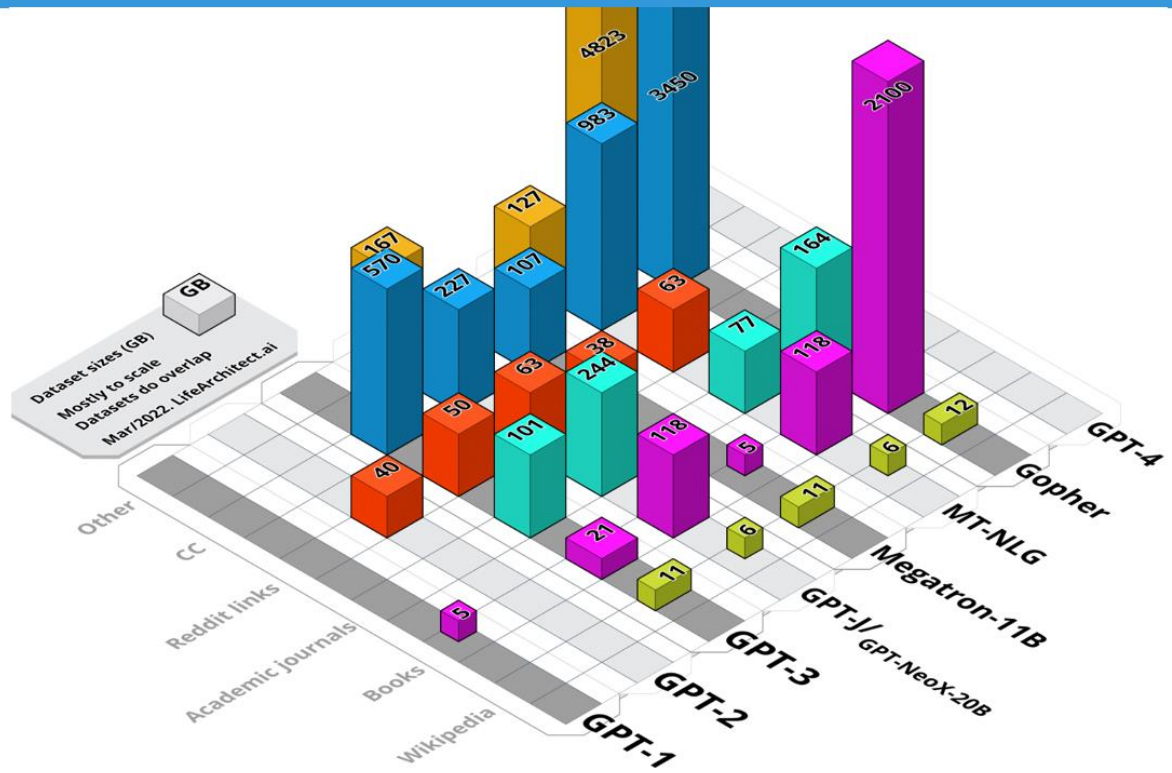
EPFL

Data underlying GPT models

2022 WHAT'S IN MY AI? – ALT VIEW



Common Crawl	
Google Patents	0.48%
The New York Times	0.06%
Los Angeles Times	0.06%
The Guardian	0.06%
Public Library of Science	0.06%
Forbes	0.05%
Huffington Post	0.05%
Patents.com	0.05%
Scribd	0.04%
Other	99.09%

Reddit links	
Google	3.4%
Archive	1.3%
Blogspot	1.0%
GitHub	0.9%
The New York Times	0.7%
Wordpress	0.7%
Washington Post	0.7%
Wikia	0.7%
BBC	0.7%
Other	89.9%

English Wikipedia	
Biography	27.8%
Geography	17.7%
Culture and Arts	15.8%
History	9.9%
Biology, Health, Medicine	7.8%
Sports	6.5%
Business	4.8%
Other society	4.4%
Science & Math	3.5%
Education	1.8%

BookCorpus (GPT-1 only)	
Romance	26.1%
Fantasy	13.6%
Science Fiction	7.5%
New Adult	6.9%
Young Adult	6.8%
Thriller	5.9%
Mystery	5.6%
Vampires	5.4%
Horror	4.1%
Other	18.0%

LifeArchitect.ai/whats-in-my-ai

Limitations and caveats - 2

- Does the training set comply with copyrights?
- Several ongoing litigations:
  - Getty Images Vs Stability AI
  - Class action against Copilot
  - …

ARTIFICIAL INTELLIGENCE / TECH / LAW

Getty Images is suing the creators of AI art tool Stable Diffusion for scraping its content

An image created by Stable Diffusion showing a recreation of Getty Images' watermark. Image: The Verge / Stable Diffusion

/ Getty Images claims Stability AI 'unlawfully' scraped millions of images from its site. It's a significant escalation in the developing legal battles between generative AI firms and content creators.

By JAMES VINCENT
Jan 17, 2023, 11:30 AM GMT+1 | 18 Comments / 18 New

Preventing near-future churn of patients

CONTEXT

Persistence in the treatment is beneficial both from a medical and a business point of view.

To date, there is no real-world data driven **estimation of the typical duration of treatment** with the electronic auto-injector devices, nor of the factors that influence it.

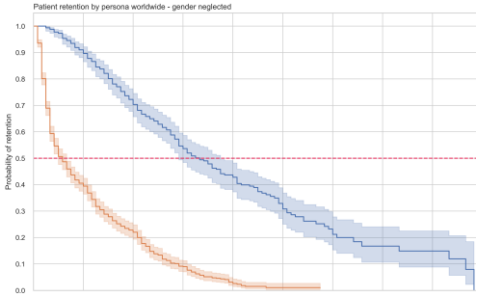
OBJECTIVES

Develop a model that allows extracting the **factors associated to a long duration of use**.

Estimate the **individual risk of churning** in the following half a year for patients currently under treatment.

BENEFITS

We identified the top 10 **factors with significant impact on retention time** and used them to **recommend personalized actions** for patients at high risk of churning. Healthcare professional access the results via an **interactive dashboard** application.



Repurposing drugs for the Sanfilippo syndrome

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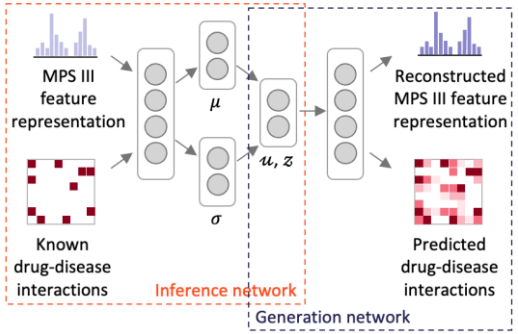
CONTEXT

Mucopolysaccharidosis type III (MPS III), also called Sanfilippo syndrome, is a rare disease characterized by a **rapid and severe intellectual deterioration**. Patients with the most severe subtype have a lifespan of up to 20 years.
No treatment exists up to date, partly due to the lack of commercial incentive in face of high drug development costs.

OBJECTIVES

Identify therapeutic candidates for the Sanfilippo syndrome from the pool of already FDA-approved molecules, using **large databases of drug and disease characteristics** and **deep learning**.

Predict potential associations between drugs and MPS III subtypes



BENEFITS

Drug **development time and costs are significantly lower** when repurposing drugs. Drug candidates predicted by the model encompass a **wide breadth of possible therapies** and provide novel treatment avenues in the fight against rare diseases.