



CEARÁ
GOVERNO DO ESTADO

SECRETARIA DA EDUCAÇÃO

Centro de Formação e Desenvolvimento para Profissionais
de Educação do Estado do Ceará Profª. Maria Neli
Sobreiras de Oliveira (**FormaCE**)

IA & Educação

Aplicações de Modelos de Linguagem

Michael Souza (UFC)

Da Curiosidade à Necessidade

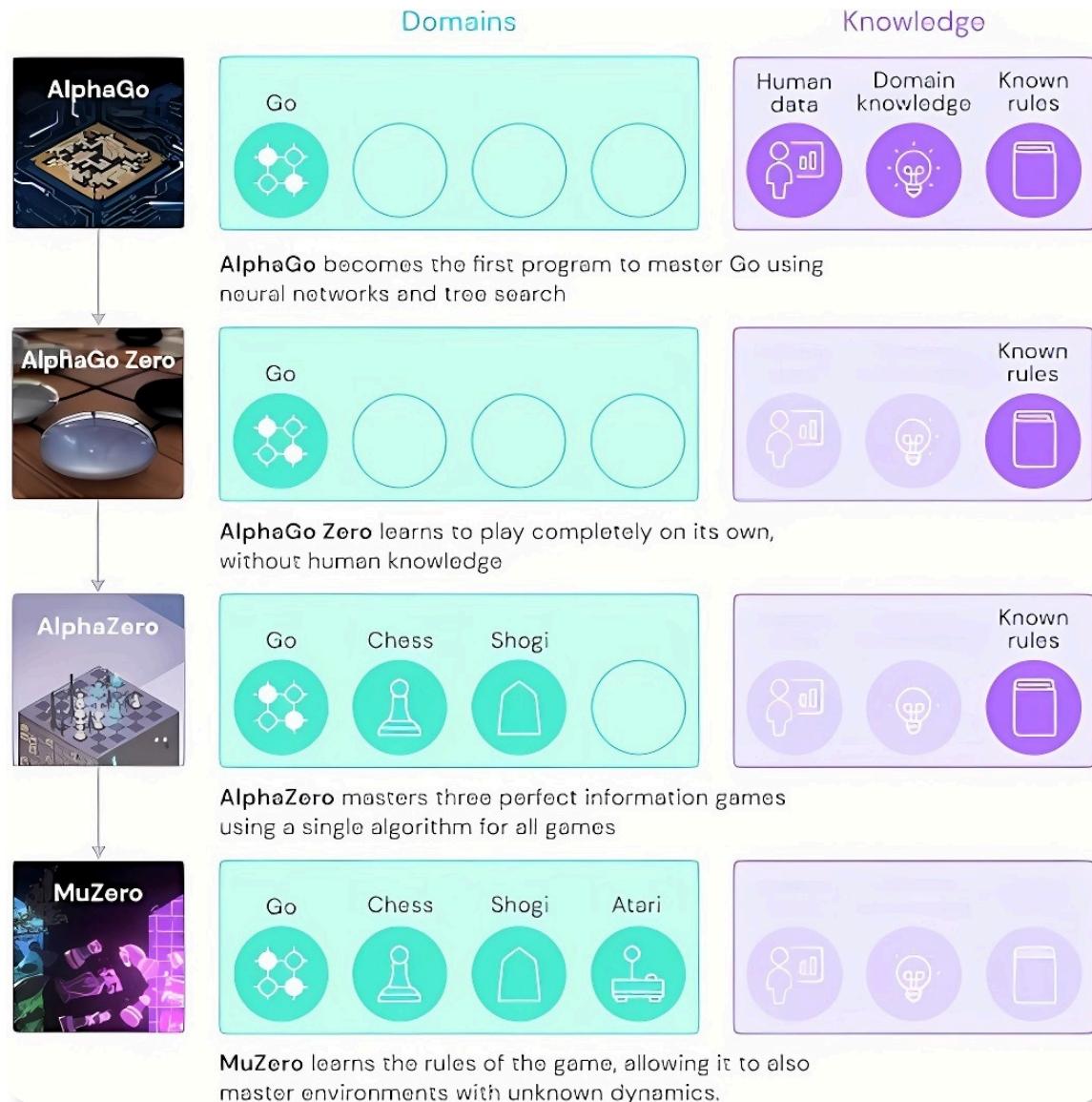
"IA é o avanço tecnológico mais significativo desde a interface gráfica. Assim como o microprocessador e a Internet, ela transformará a maneira como trabalhamos, aprendemos, viajamos e nos comunicamos."

Bill Gates
Microsoft



The Age of AI has begun [Bill Gates, 2023]

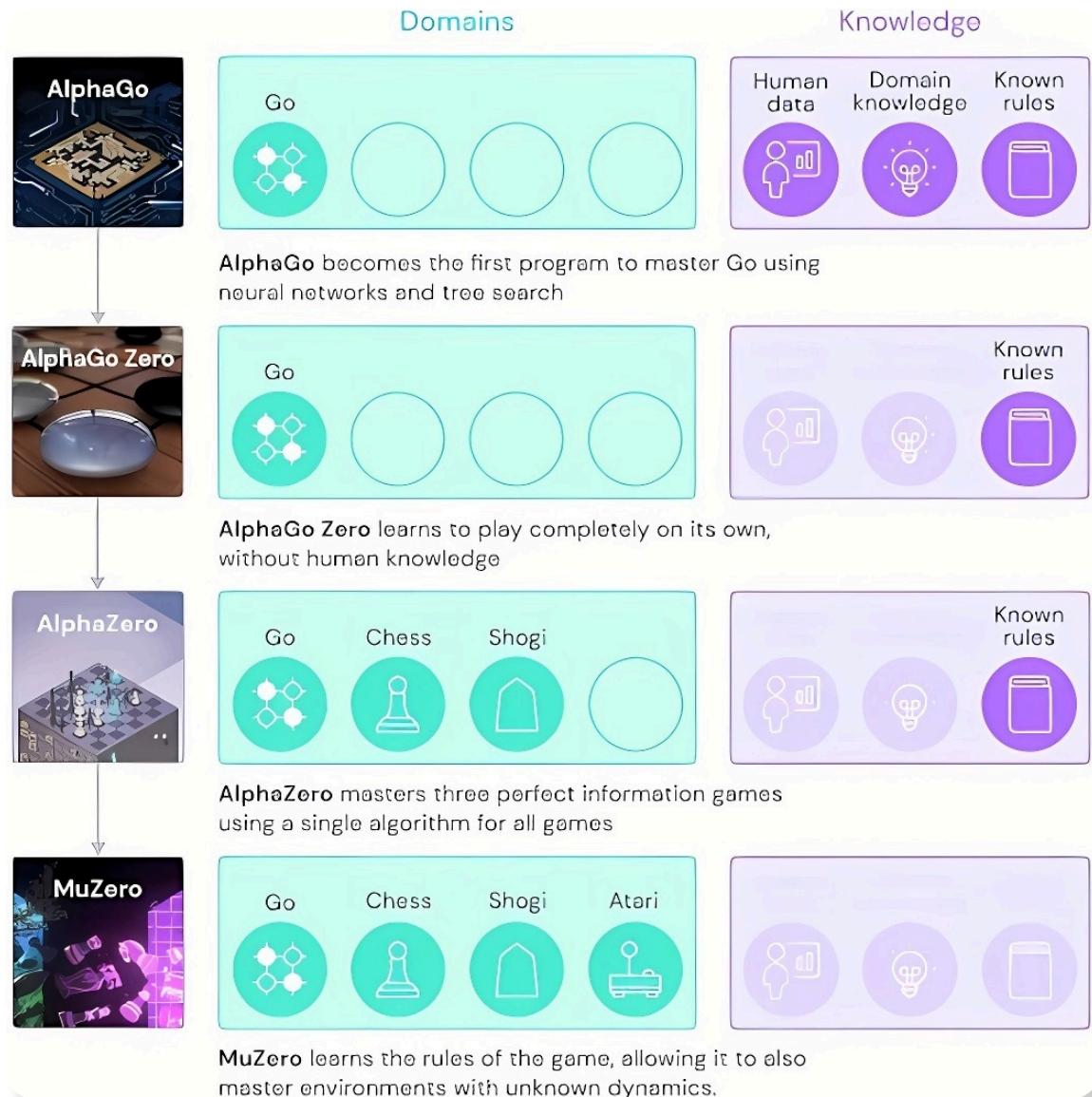
Jan, 2016



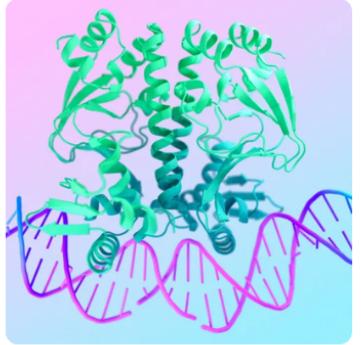
Dec, 2020

MuZero: Mastering Go, chess, shogi and Atari without rules [DeepMind, 2020]

Jan, 2016



AlphaFold



Nov, 2020

"O que nos levou meses e anos para fazer, o AlphaFold conseguiu fazer em um fim de semana."

McGeehan, Univ. Portsmouth

'It will change everything': DeepMind's AI makes gigantic leap in solving ... [Callaway, 2020]



Fev, 2022

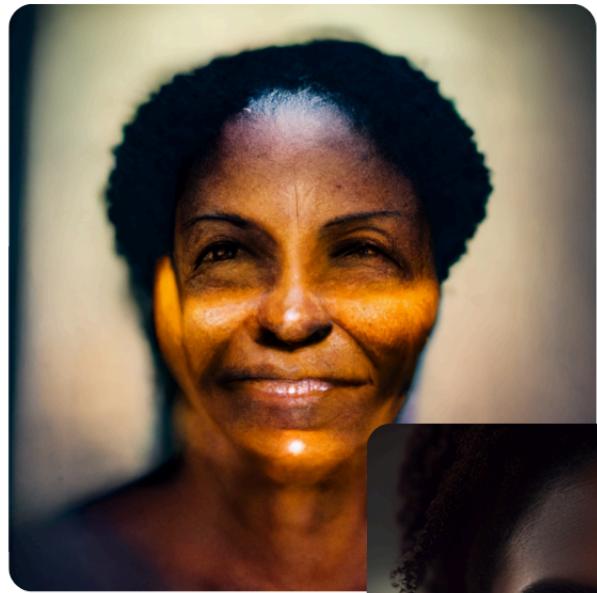


Abr, 2022

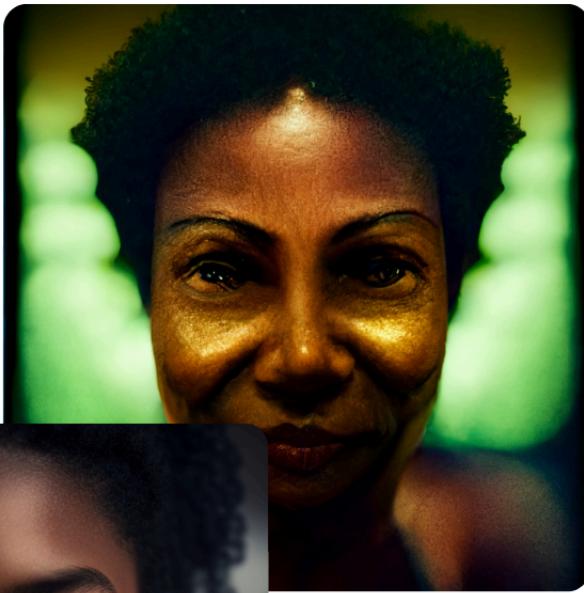


Jul, 2022

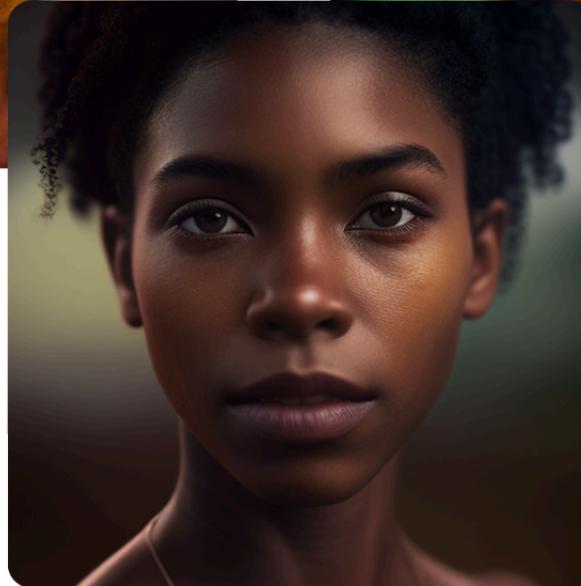
[Midjourney, 2022-2023]



Fev, 2022

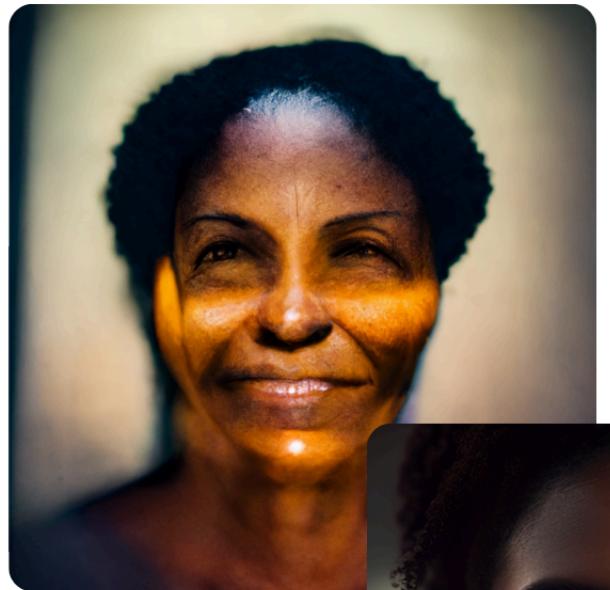


Jul, 2022



Nov, 2022

[Midjourney, 2022-2023]



Fev, 2022



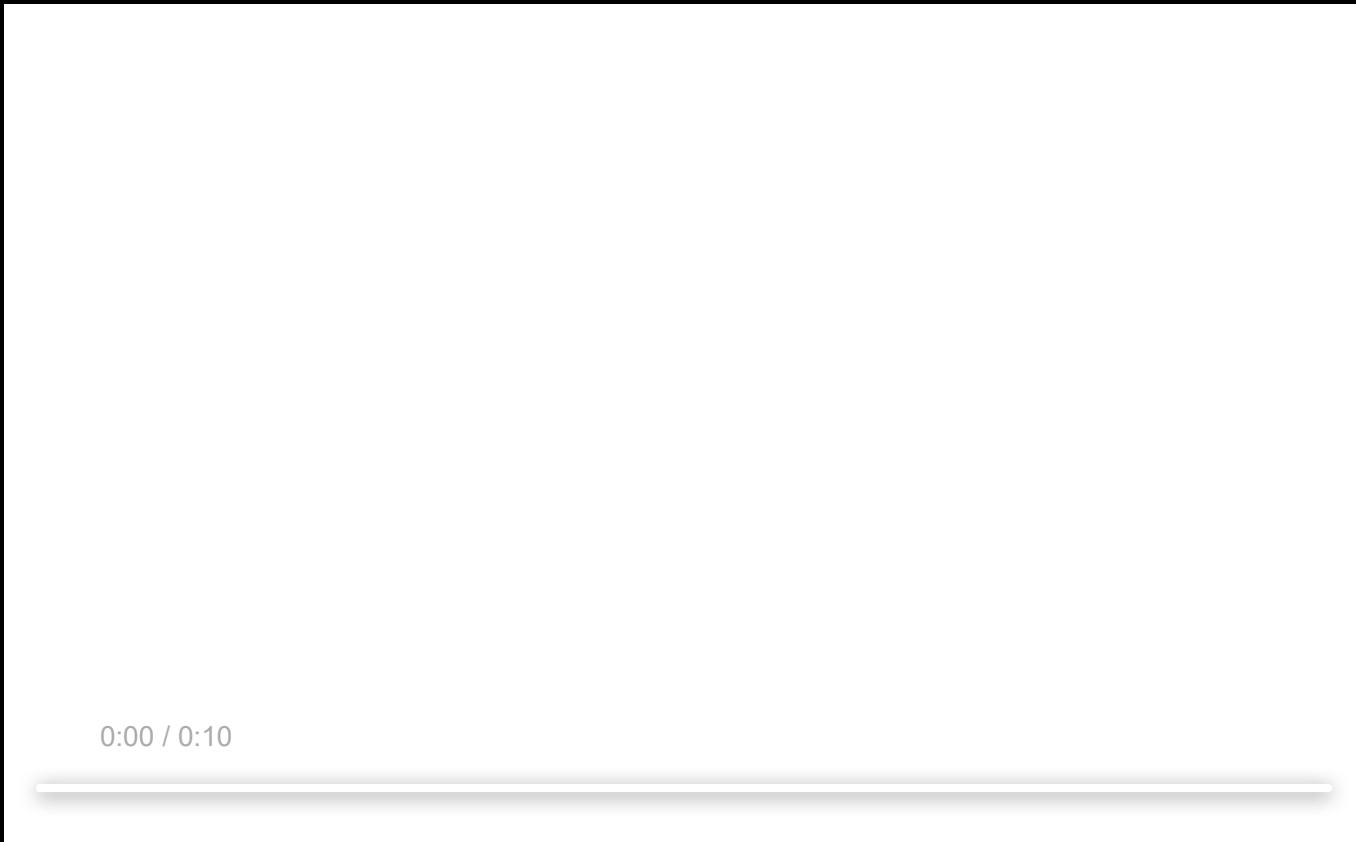
Nov, 2022



Mai, 2023

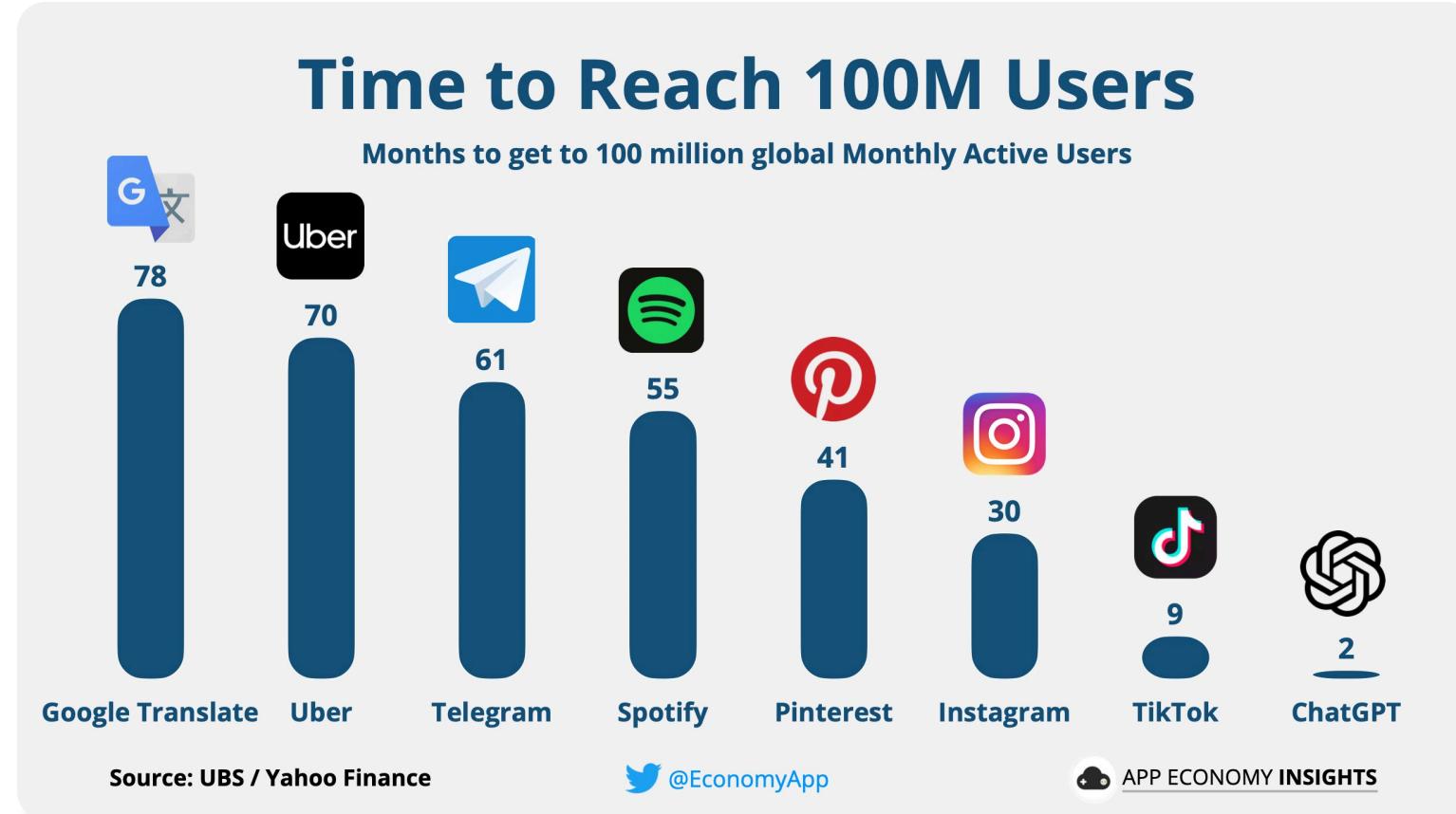
[Midjourney, 2022-2023]

2024



[Runway, 2024]

Tempo para alcançar 100 milhões de usuários



Threads becomes fastest-ever app to surge past 150 MILLION ... [Daily Mail, 2023]



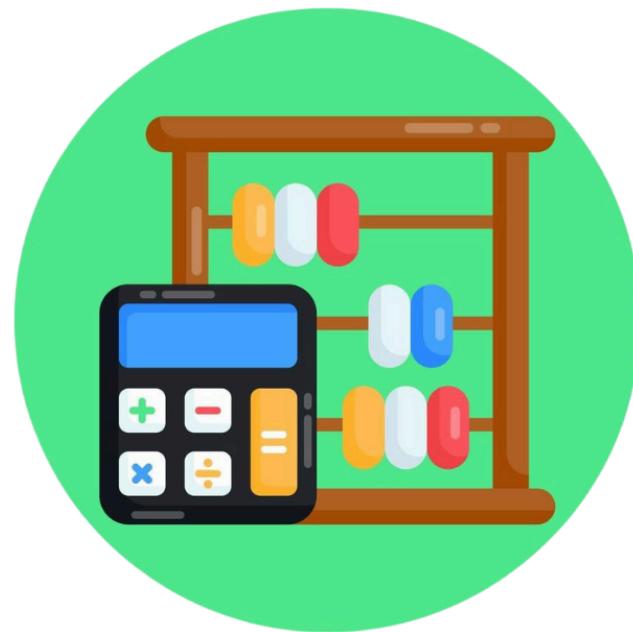
Um mundo pixelado

Os riscos da IA na educação

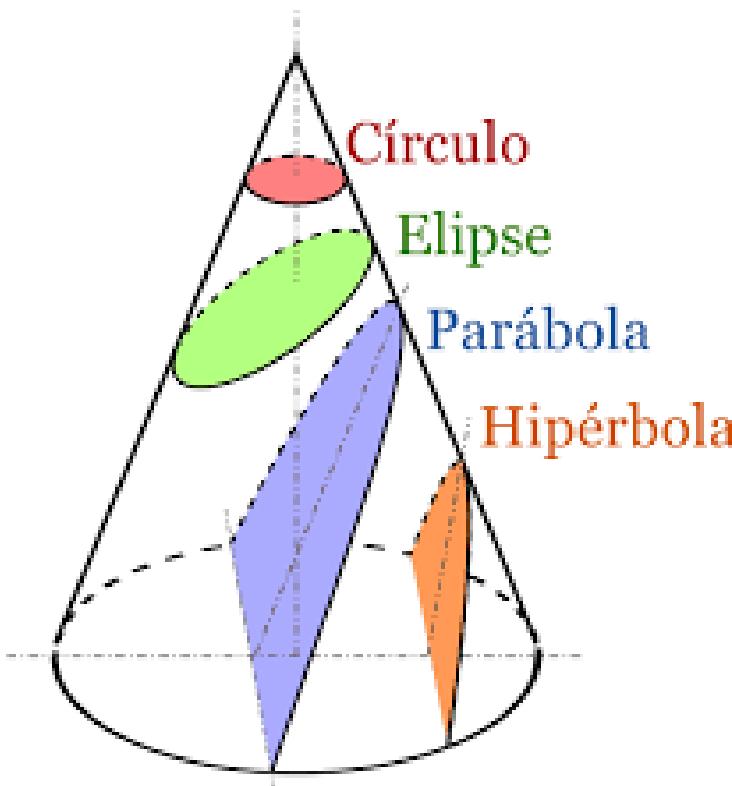
- Redução do pensamento crítico
- Dependência tecnológica
- Imprecisão e viés
- Impactos sociais e tecnológicos

Socrates on the Forgetfulness that Comes with Writing [Plato, 370 a.C.]

Melhoria vs Transformação



... What the Success of Chalkboards Tells Us About the Future of Computers ... [Krause, 2000]



Educação: Conteúdo e Forma

- Em 1825, o quadro negro foi adotado na universidade de Yale.
- Em 1830, os alunos passaram a ser obrigados a reproduzir de memória partes dos livros nos quadros.

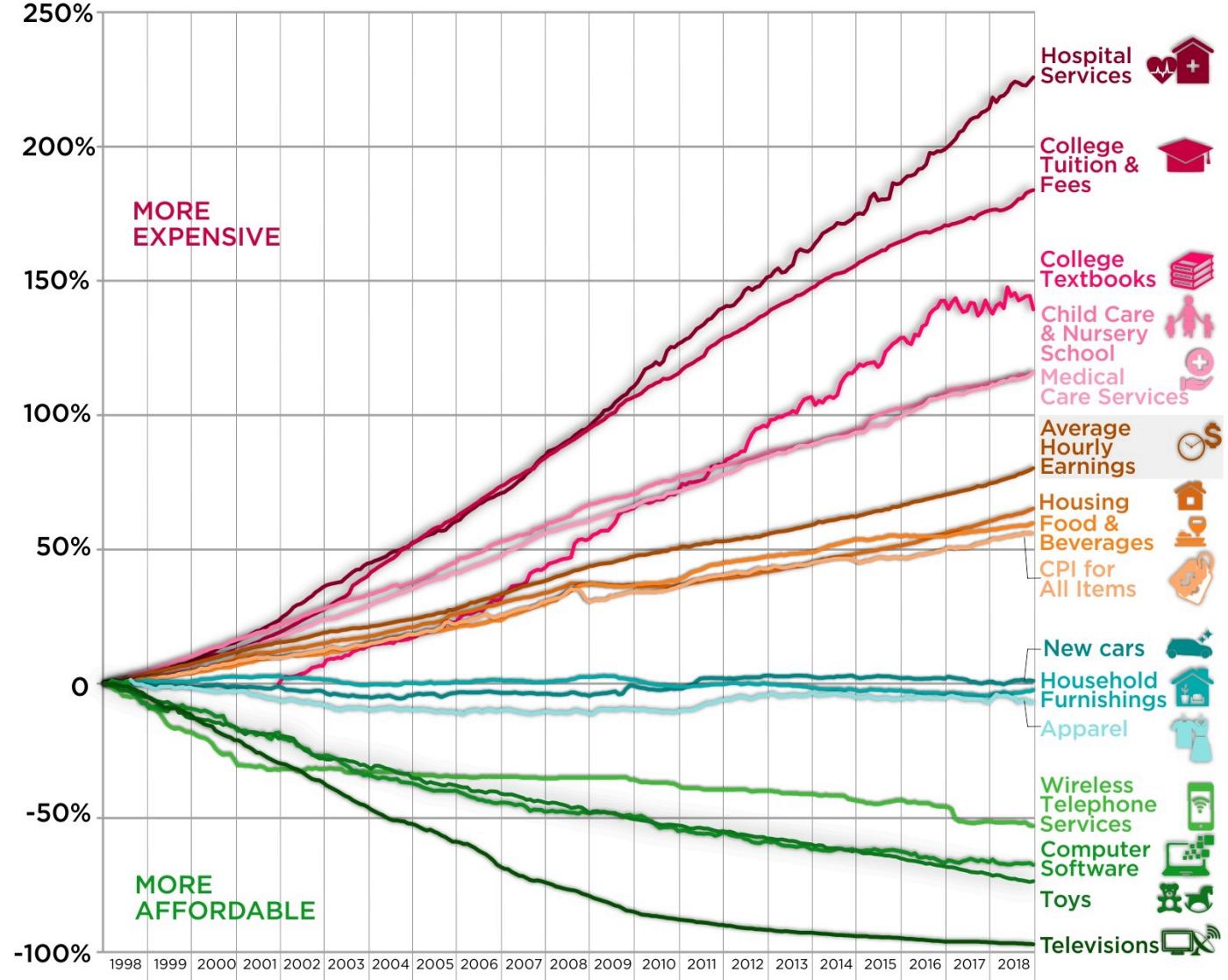


Universalizar vs. Pasteurizar

- *Descentralização Curricular*
- *Educação Inclusiva*
- *Avaliações Personalizadas*
- *Feedbacks Contínuos*

20 Years of Price Changes in The United States

Selected Consumer Goods & Services, Wages (January 1998 to December 2018)



Article & Sources:

<https://howmuch.net/articles/price-changes-in-usa-in-past-20-years>

CPI and other price indices - Bureau of Labor Statistics - <https://data.bls.gov/PDQWeb/cu>

Average hourly earnings - Bureau of Labor Statistics - <https://data.bls.gov/timeseries/CES0500000008>

Efeito Baumol

- Custos crescentes sem ganhos de produtividade
- Impacto na oferta de serviços essenciais

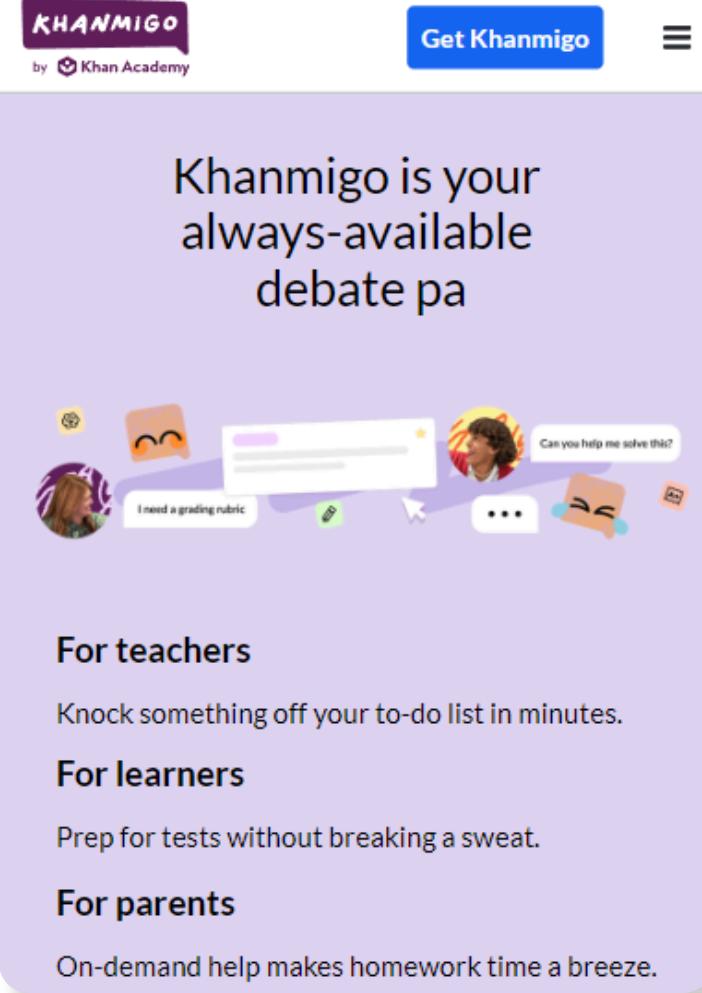
William Baumol, whose ... [Lee, 2017]



IA na Educação (GPT4-o, Sal & Imran Khan)

GPT-4o (Omni) math tutoring demo on Khan Academy





Khanmigo is your always-available debate pa

For teachers

Knock something off your to-do list in minutes.

For learners

Prep for tests without breaking a sweat.

For parents

On-demand help makes homework time a breeze.

Get Khanmigo

≡

The screenshot shows the Khanmigo mobile application interface. At the top, there's a purple header with the text "Khanmigo is your always-available debate pa". Below this, there's a decorative illustration of various educational icons like a graduation cap, a book, and a lightbulb. The main content area has three sections: "For teachers", "For learners", and "For parents", each with a brief description and a call-to-action button. At the bottom, there's a blue button labeled "Get Khanmigo" and a menu icon represented by three horizontal lines.

"Os educadores podem acessar um *banco de dados de exercícios* recomendados para os alunos, *analisar tendências* da turma e *simplificar tarefas* administrativas."

Sal Khan (CEO Khan Academy)

First Avenue School

- 1.081 alunos
- 98% minorias, 86% econ. desfavorecidos
- Relação aluno-professor: 15:1
- Atende do PK (4 anos) ao 8º ano
- Proficiência
21% matemática, 36% leitura



Limitações

- Erros na resolução de problemas
- Ajuda excessiva durante as avaliações
- Alinhamento pedagógico
- Mais treinamento para professores

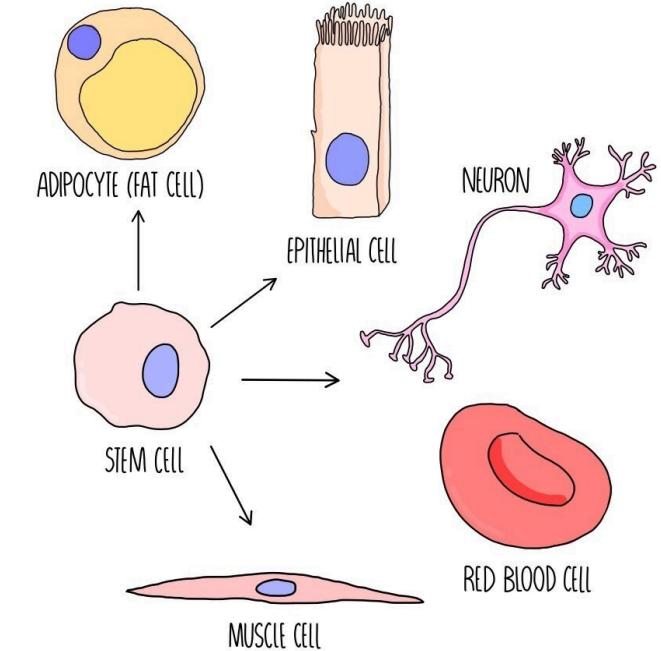


Newark Public Schools Among 1st in US to Pilot New AI Tutor [Mosaic, 2024]

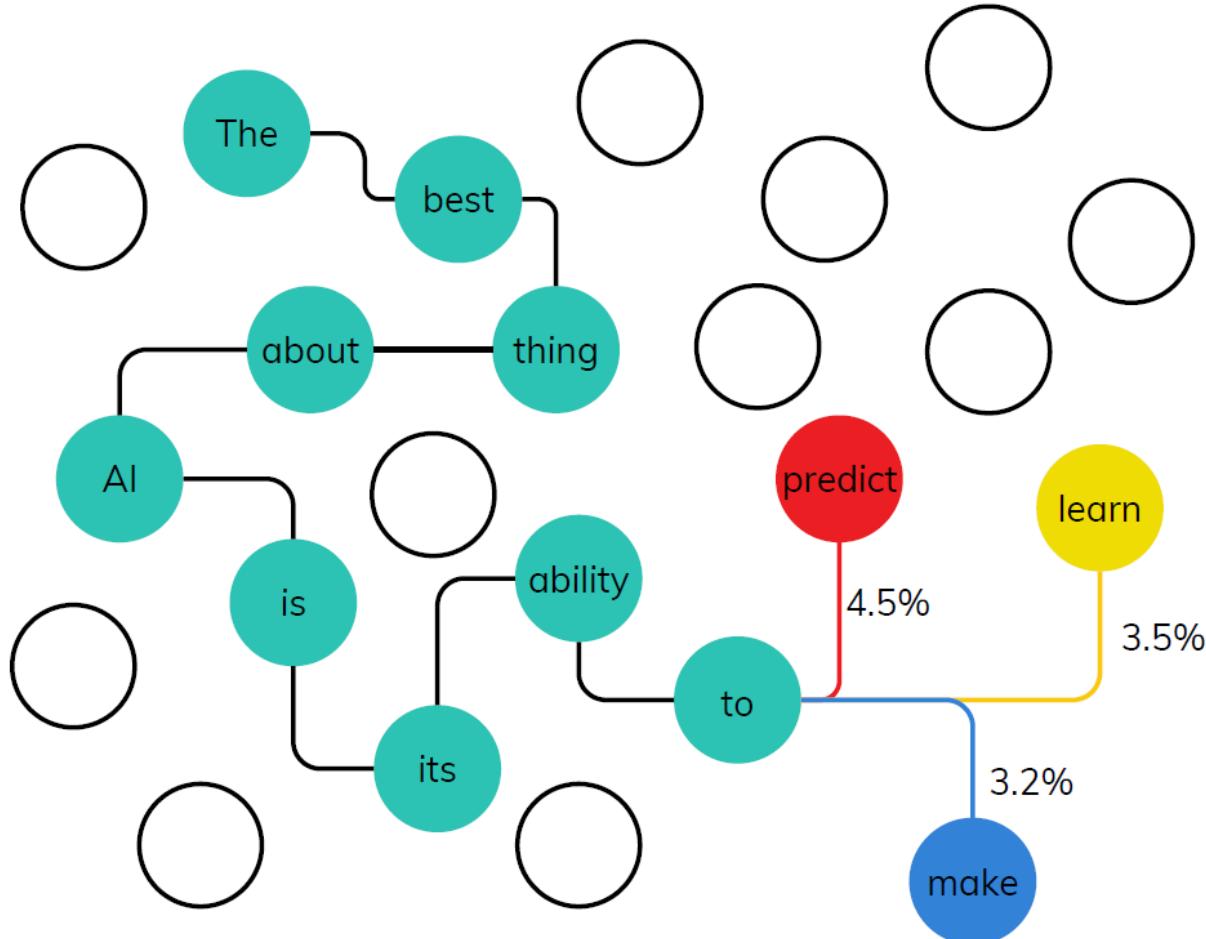
PNL: Problema Fundamental

- Tradução de texto
- Correção gramatical
- Sumarização de texto
- Extração de informações

A abordagem tradicional é treinar uma rede neural para cada tarefa específica, utilizando grandes bancos de dados.



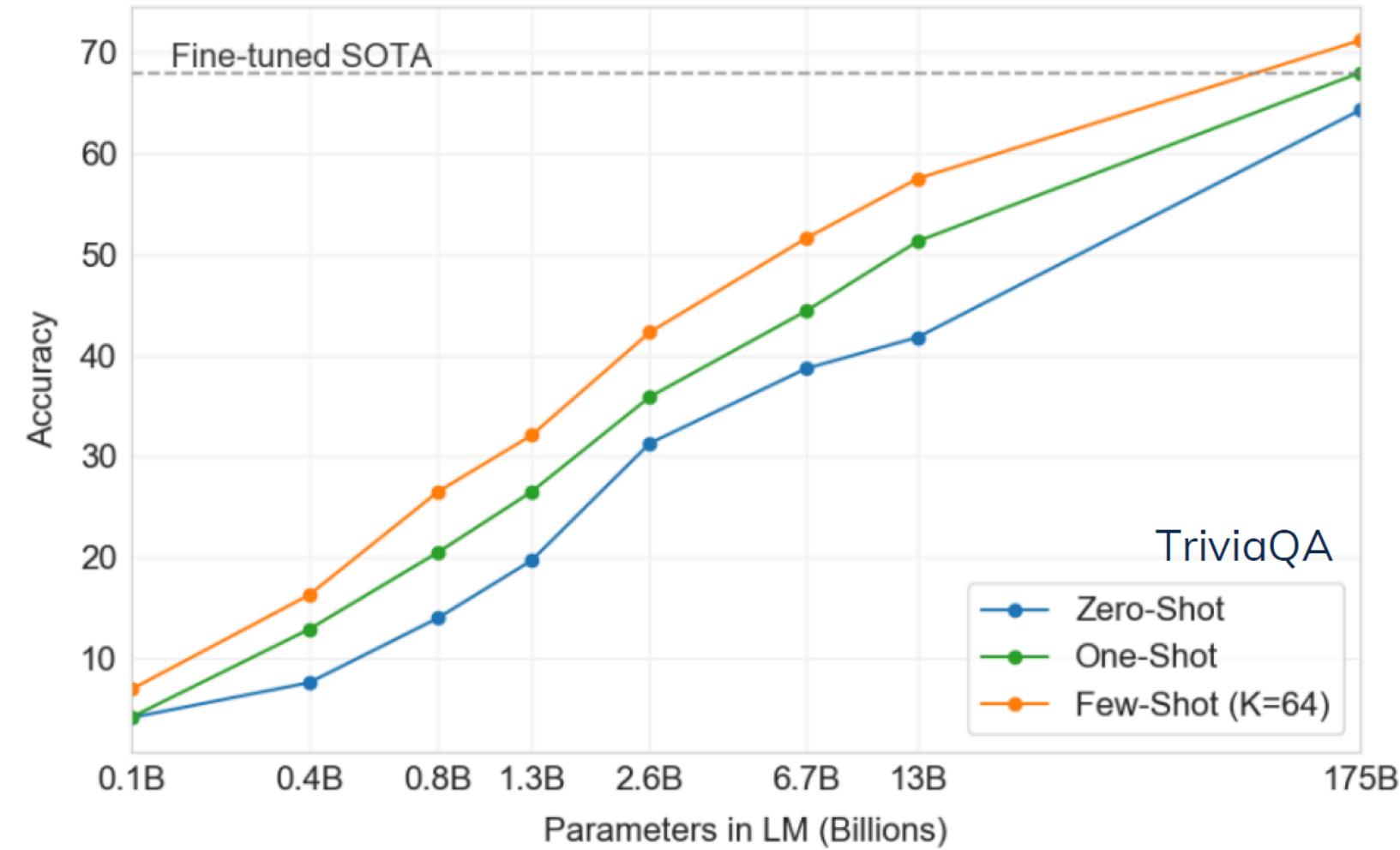
The best thing about AI is its ability to _____



A próxima
palavra é?

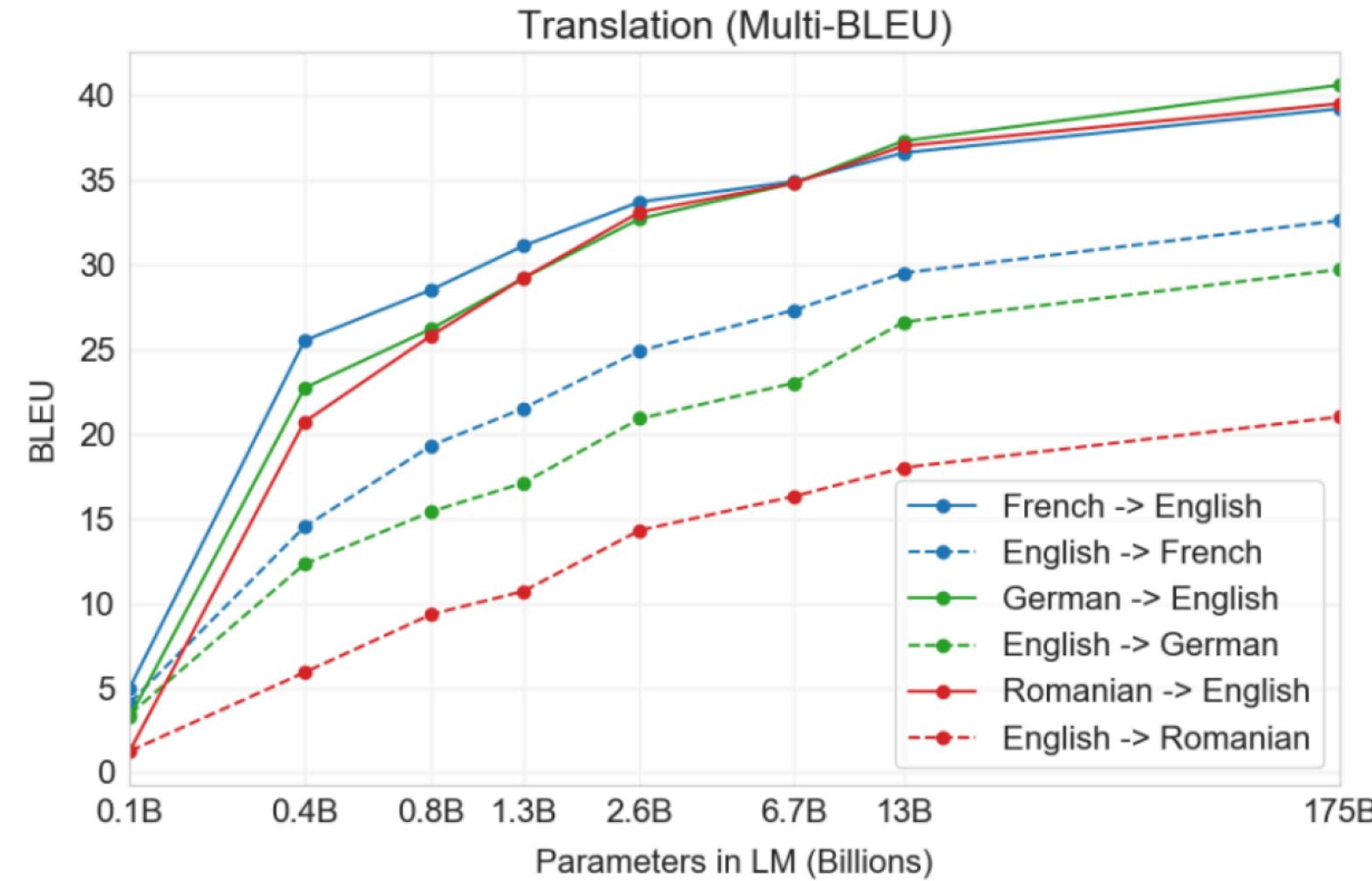
What Is ChatGPT Doing ... and Why Does It Work? [Stephen Wolfram, 2023]

PNL: QA



Language Models are Few-Shot Learners [Brown et al., 2020]

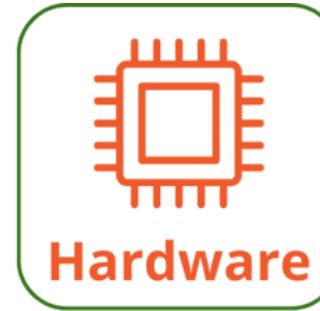
PNL: Tradução



Language Models are Few-Shot Learners [Brown et al., 2020]

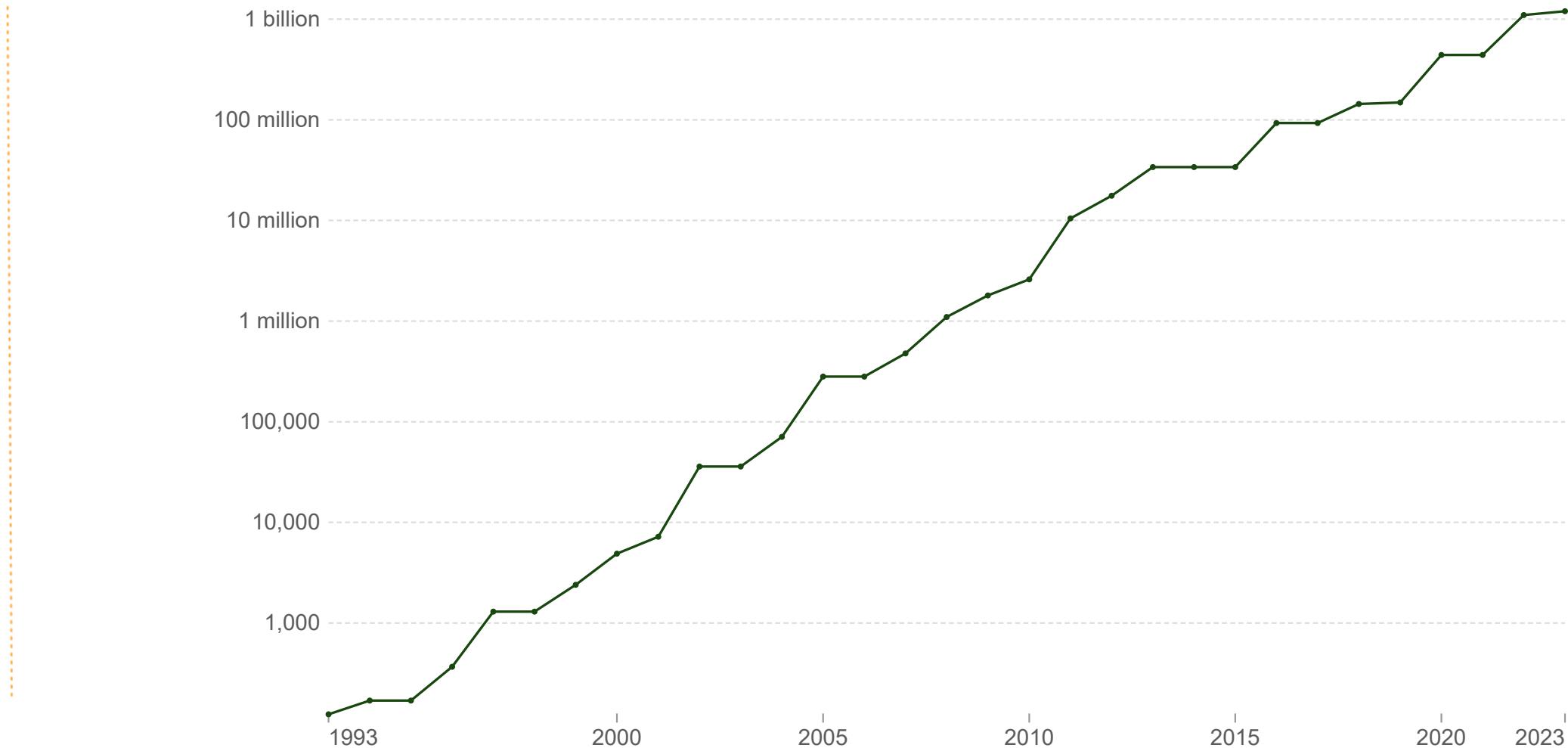
Por que agora?

- Algoritmos aprimorados
- Poder de computação acessível
- Grandes quantidades de dados



Computational capacity of the fastest supercomputers

The number of floating-point operations¹ carried out per second by the fastest supercomputer in any given year. This is expressed in gigaFLOPS, equivalent to 10^9 floating-point operations per second.



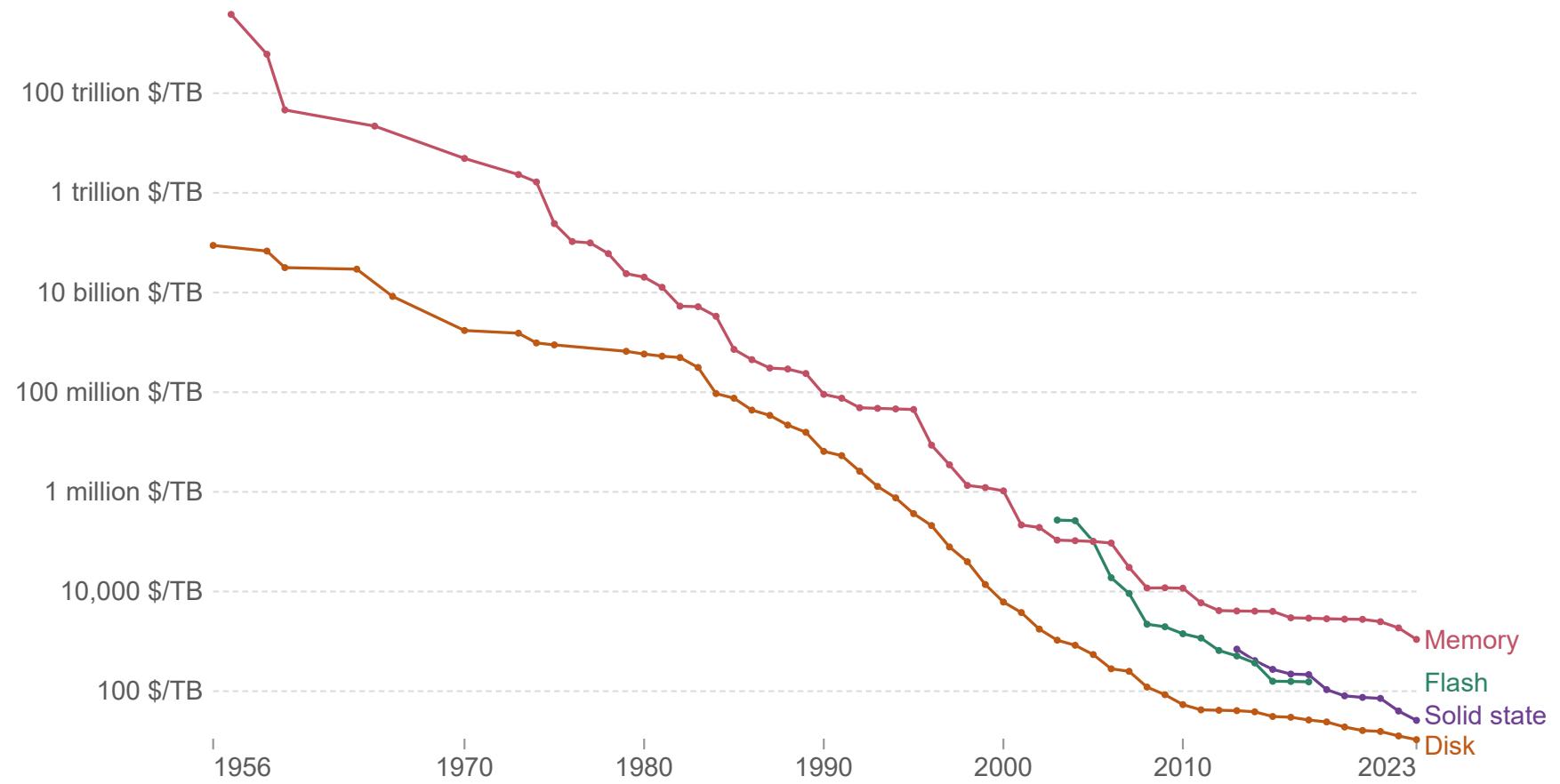
Data source: Dongarra et al. (2023)

Moore's Law [Roser et al. 2023]

OurWorldInData.org/technological-change | CC BY

Historical price of computer memory and storage

This data is expressed in US dollars per terabyte (TB), adjusted for inflation. "Memory" refers to random access memory (RAM), "disk" to magnetic storage, "flash" to special memory used for rapid data access and rewriting, and "solid state" to solid-state drives (SSDs).



Moore's Law [Roser et. al, 2023]

Explosão de Dados

Dados por minuto

 **41,666,667**

messages shared
by WhatsApp users

 **347,222**

stories posted by Instagram users

 **1,388,889**

video / voice calls made
by people worldwide

 **150,000**

messages shared by Facebook users

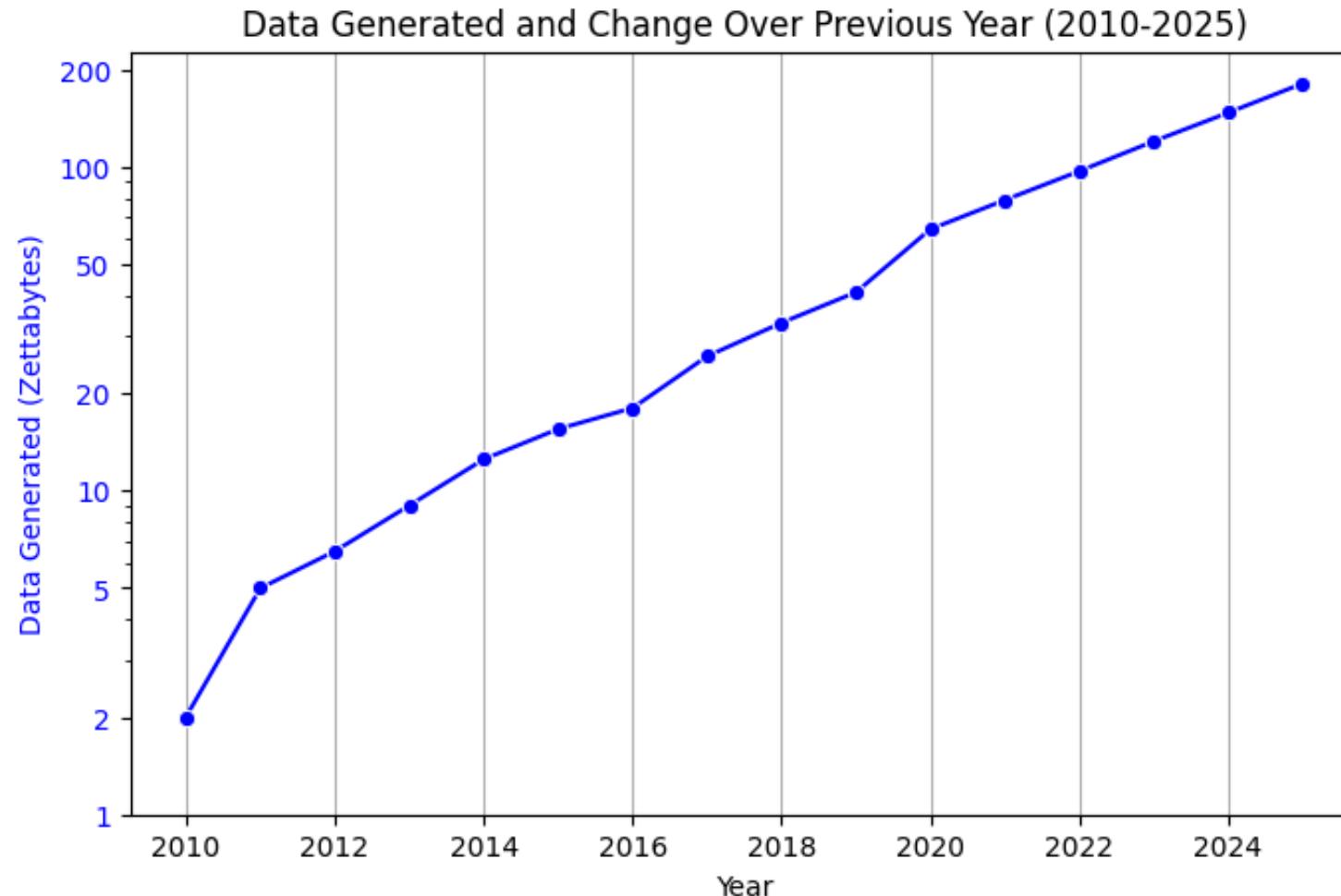
 **404,444**

hours of video streamed
by Netflix users

 **147,000**

photos shared by Facebook users

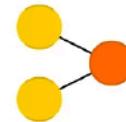
Explosão de Dados



Volume of data/information created, captured, copied, and consumed ... [Statista, 2024]

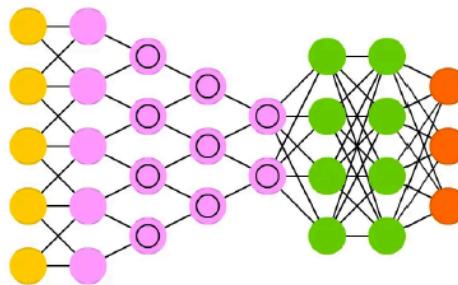
McCulloch '43

Perceptron (P)



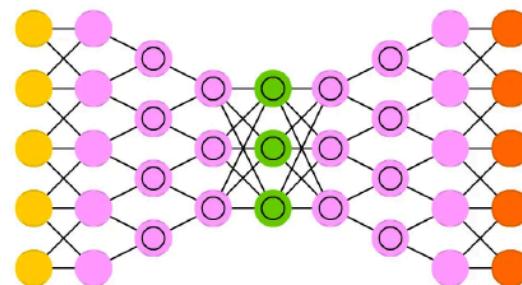
Cun'80

Deep Convolutional Network (DCN)



Kulkarni'15

Deep Convolutional Inverse Graphics Network (DCIGN)

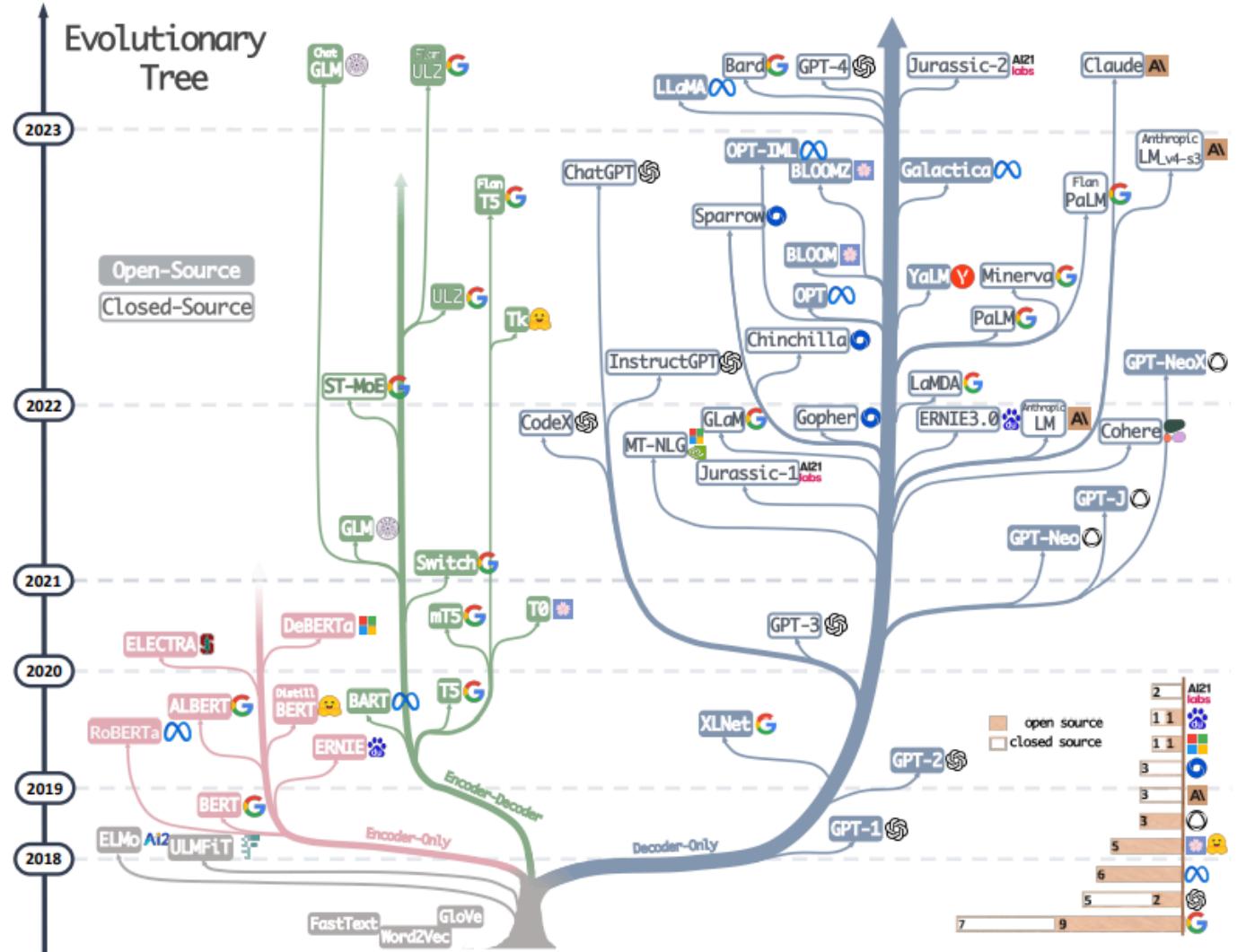


Redes Neurais

Rank	Citations	Title	Year
1	305,148	Protein measurement with the folin phenol reagent	1951
2	213,005	Cleavage of structural proteins during the assembly of the head of bacteriophage T4	1970
3	155,530	A rapid and sensitive method for the quantitation of microgram quantities of protein utilizing the principle of protein-dye binding	1976
4	130,441	Attention is all you need	2017

Attention is All You Need [Vaswani et al., 2017]

Explosão de Modelos de Linguagem



Harnessing the Power of LLMs in Practice: A Survey on ChatGPT and Beyond [Yang et. al, 2023]

Palavras vs. Números

Redes neurais lidam com números, não com palavras.

Desejamos uma representação que seja

útil = semântica + aritmética



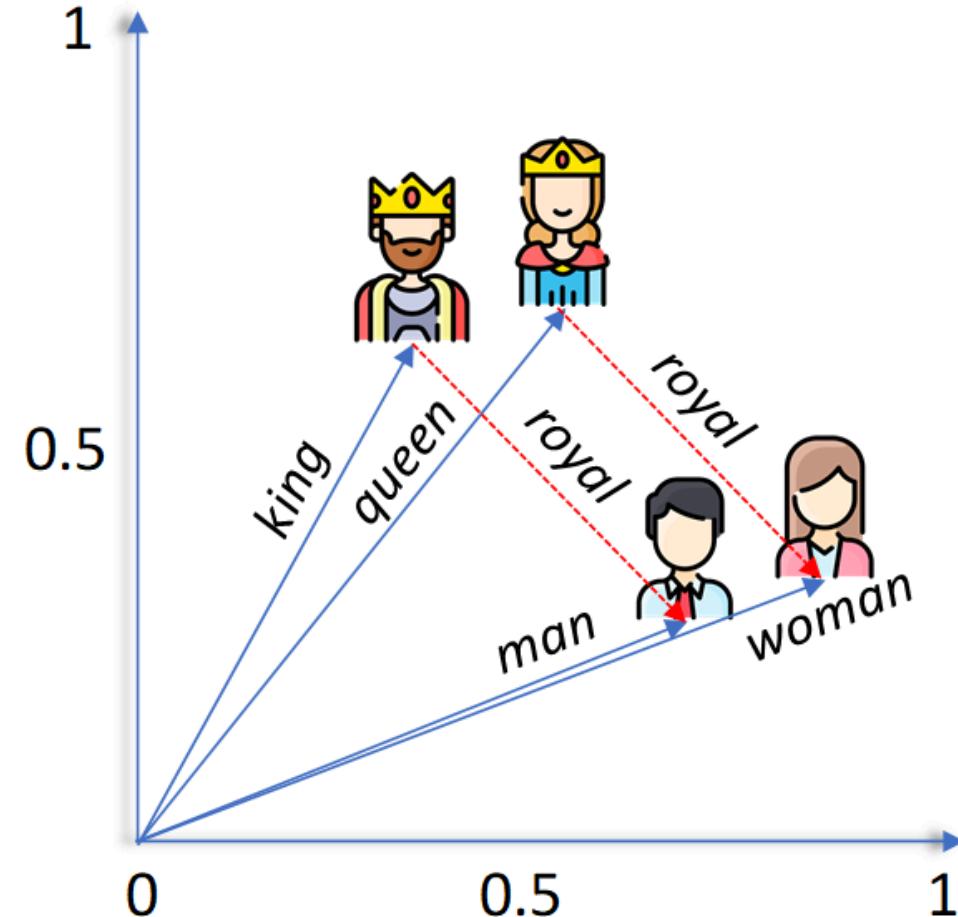
Über formal unentscheidbare Sätze der Principia Mathematica und verwandter .. [Kurt Gödel, 1931]

Word Embedding

Redes neurais lidam com números, não com palavras.

Desejamos uma representação que seja

útil = semântica + aritmética



A Neural Probabilistic Language Model [Bengio et al., 2003]

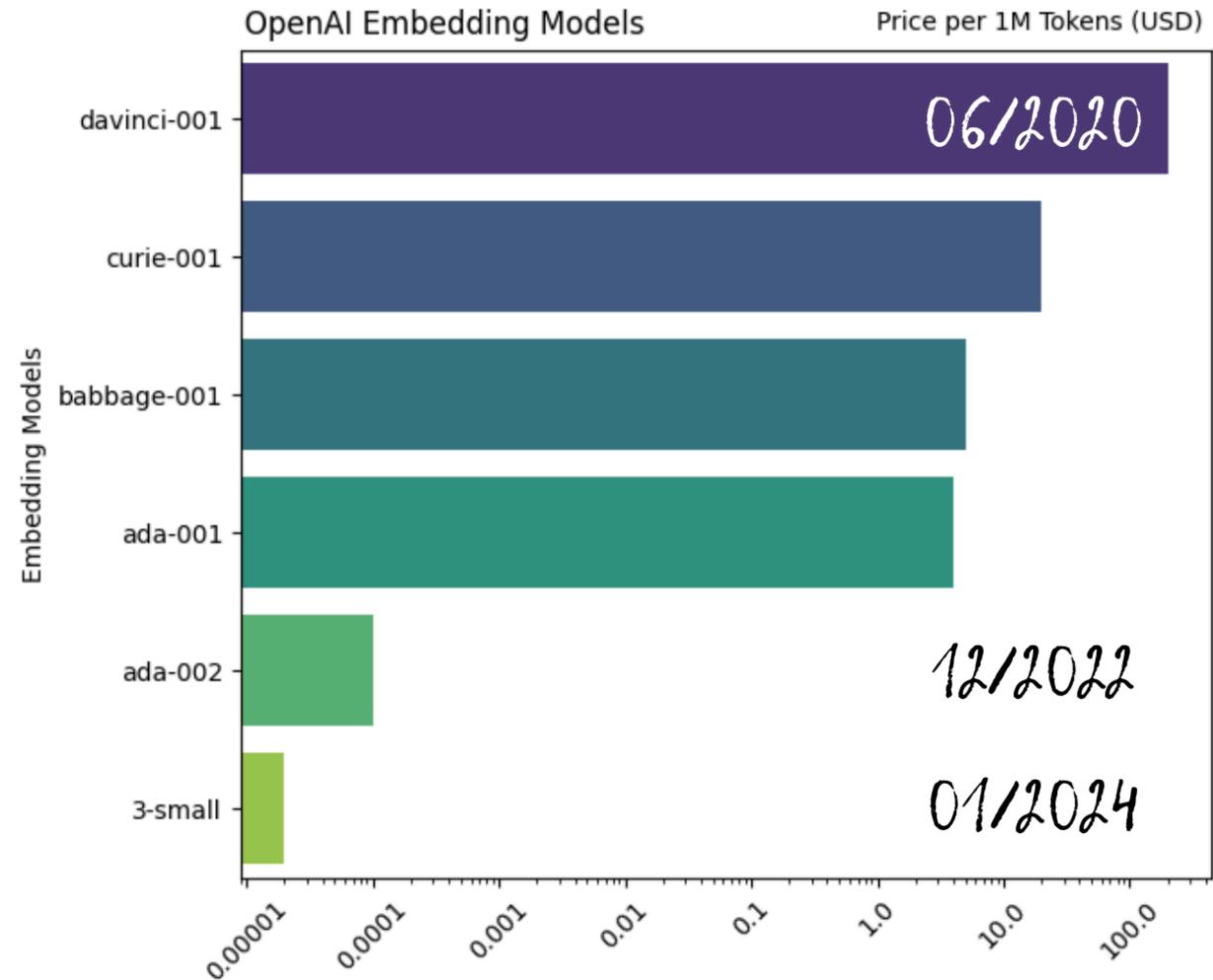
Word Embedding

Redes neurais lidam com
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que seja

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<https://openai.com/research/>



Word Embeddings

Tokenização

gpt-4 / gpt-3.5-turbo / text-embedding-ada-002

Um triângulo retângulo, em geometria, é um triângulo em que um dos ângulos é reto (ou seja, um ângulo de 90 graus). A relação entre os lados e os ângulos de um triângulo retângulo é a base da trigonometria.|

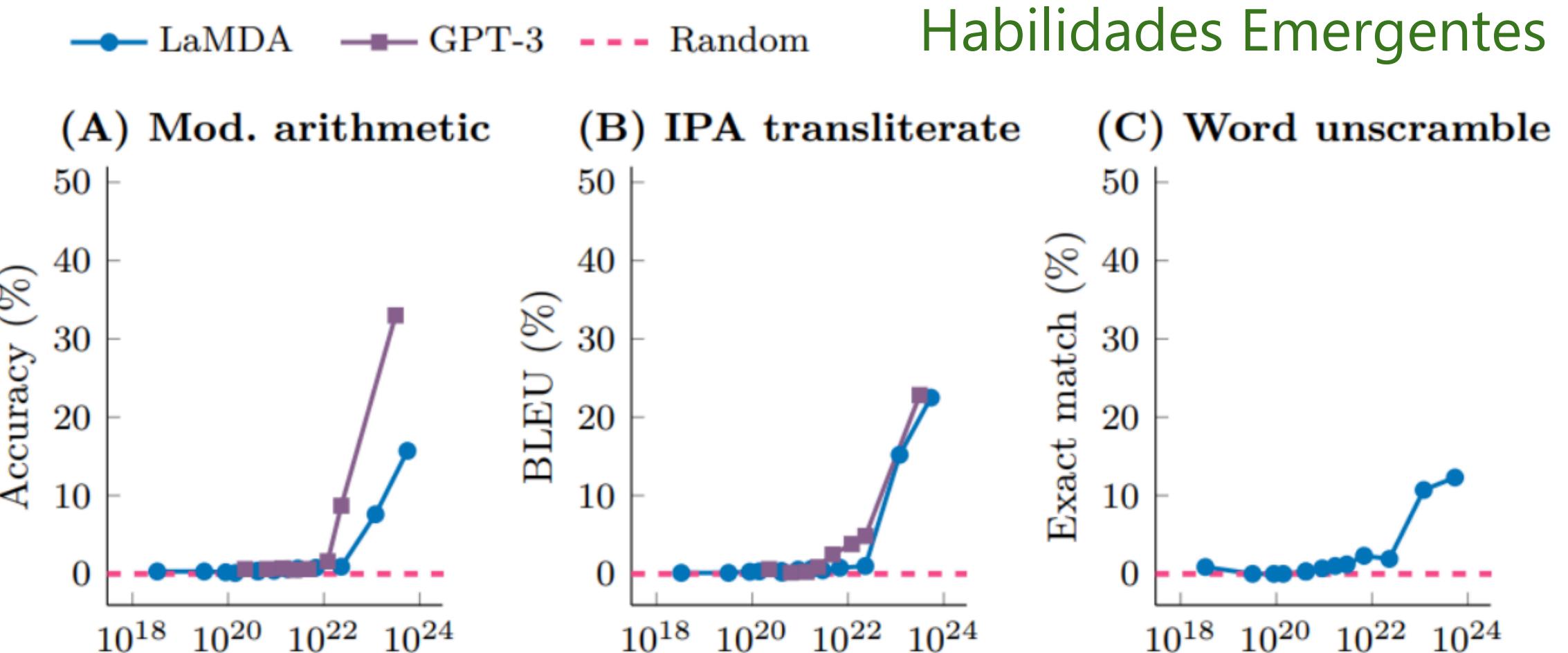
TOKENS CHARACTERS
74 206

Um triângulo retângulo, em geometria, é um triângulo em que um dos ângulos é reto (ou seja, um ângulo de 90 graus). A relação entre os lados e os ângulos de um triângulo retângulo é a base da trigonometria.

A right triangle, in geometry, is a triangle in which one of the angles is right (i.e., a 90-degree angle). The relationship between the sides and angles of a right triangle is the basis of trigonometry.

TOKENS CHARACTERS
47 203

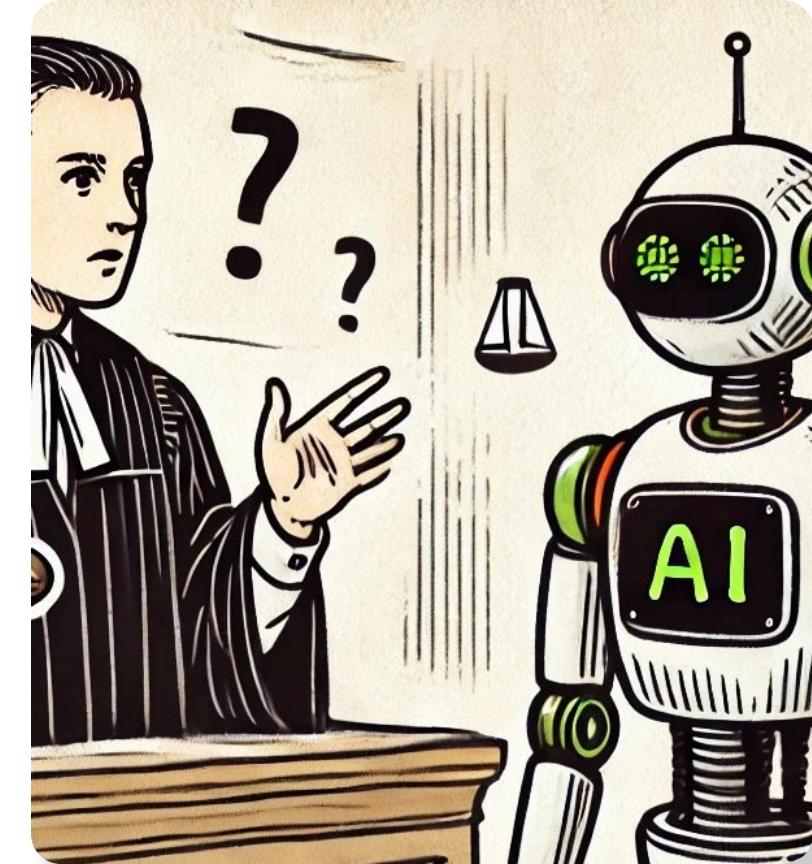
A right triangle, in geometry, is a triangle in which one of the angles is right (i.e., a 90-degree angle). The relationship between the sides and angles of a right triangle is the basis of trigonometry.



Emergent Abilities in Large Language Models [Wei et. al, 2022]

Regulação Jurídica

- Qual é o limite de uso de uma obra?
- Dados abertos e democratização
- Modelos compensatórios
- O que é a autoria?

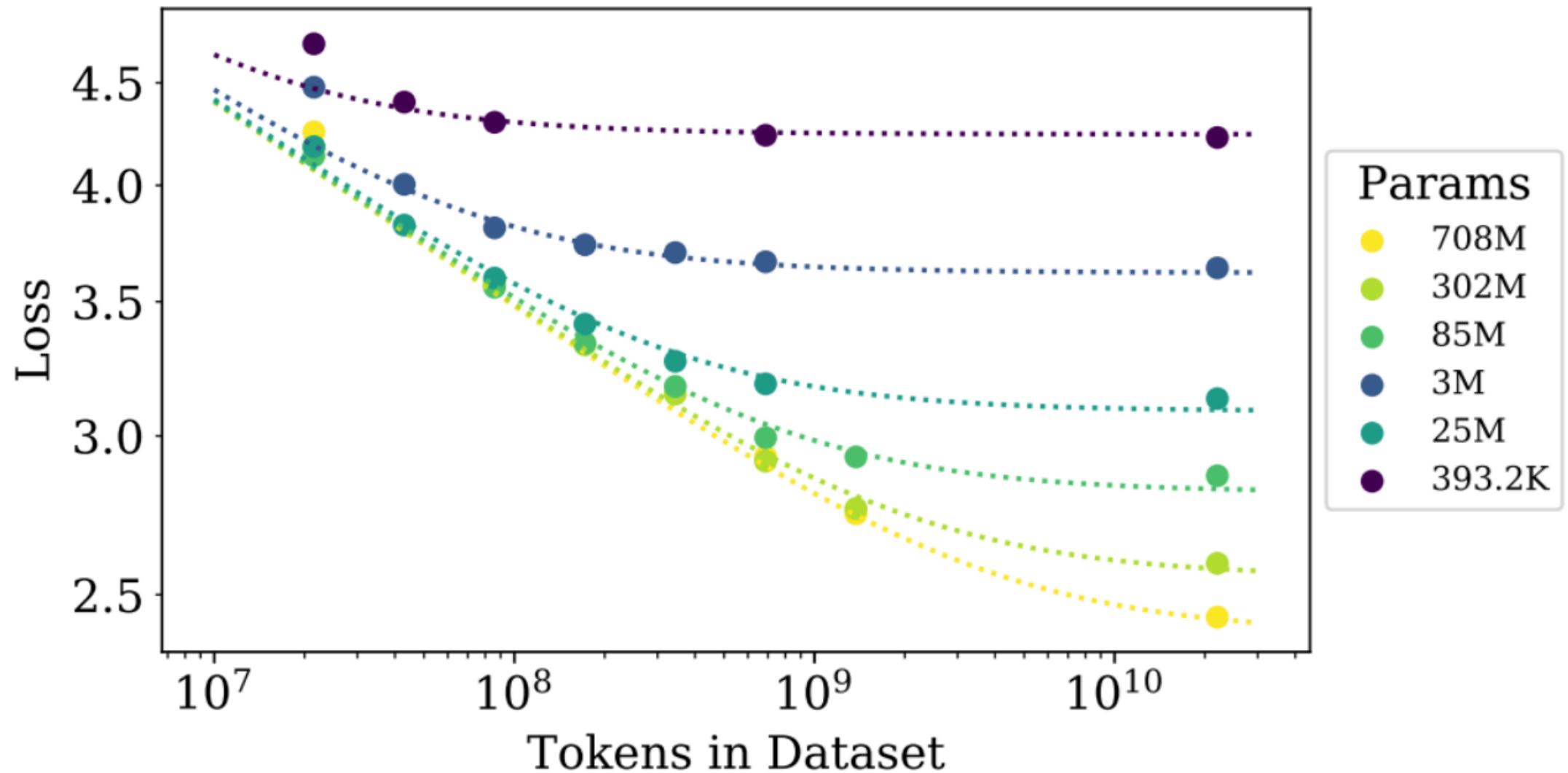


ChatGPT: A Case Study on Copyright Challenges for Generative Artificial Intelligence ... [Lucchi, 2023]



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Loss vs Model and Dataset Size

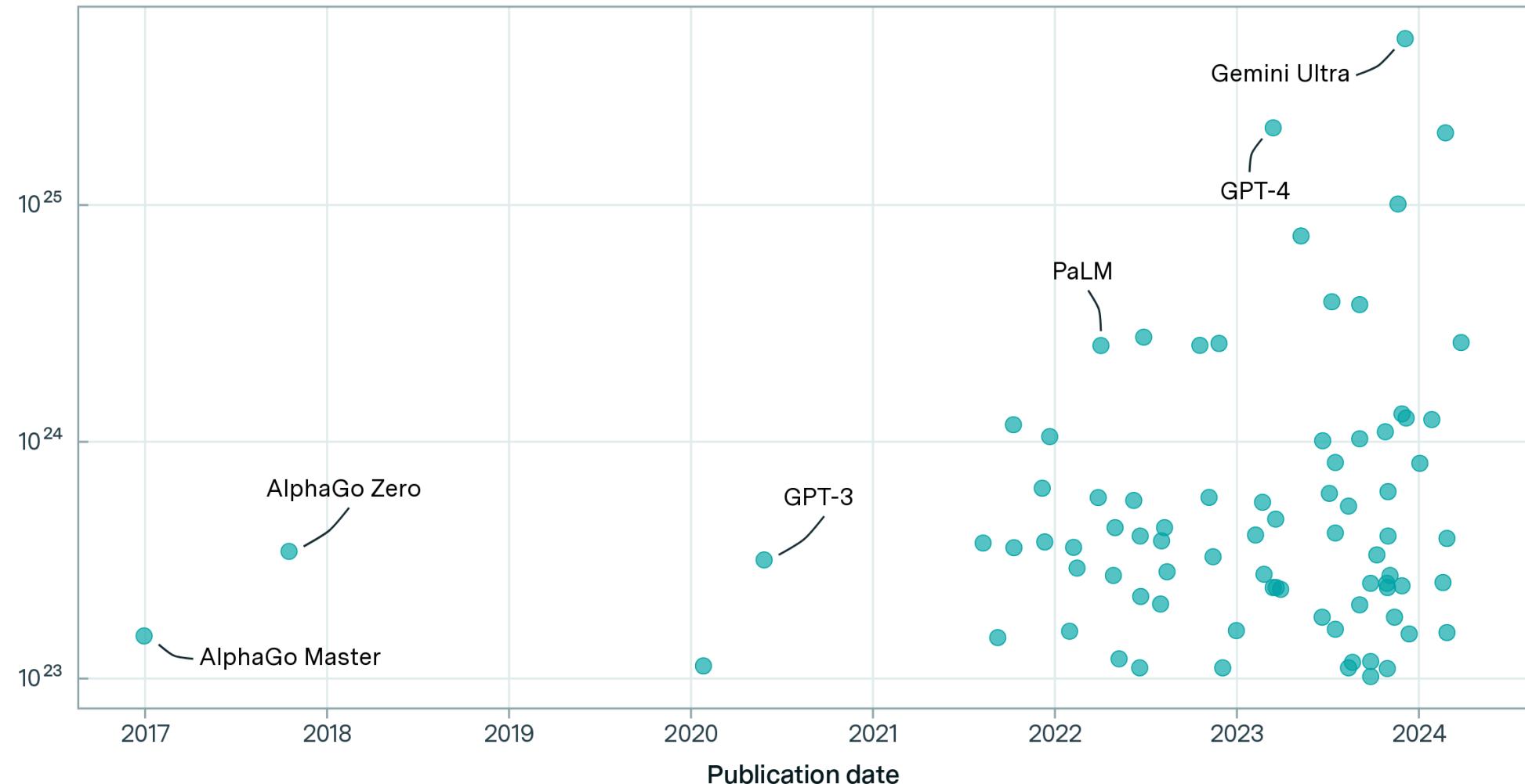


Emergent Abilities in Large Language Models [Wei et. al, 2022]

Large-scale models

EPOCH AI

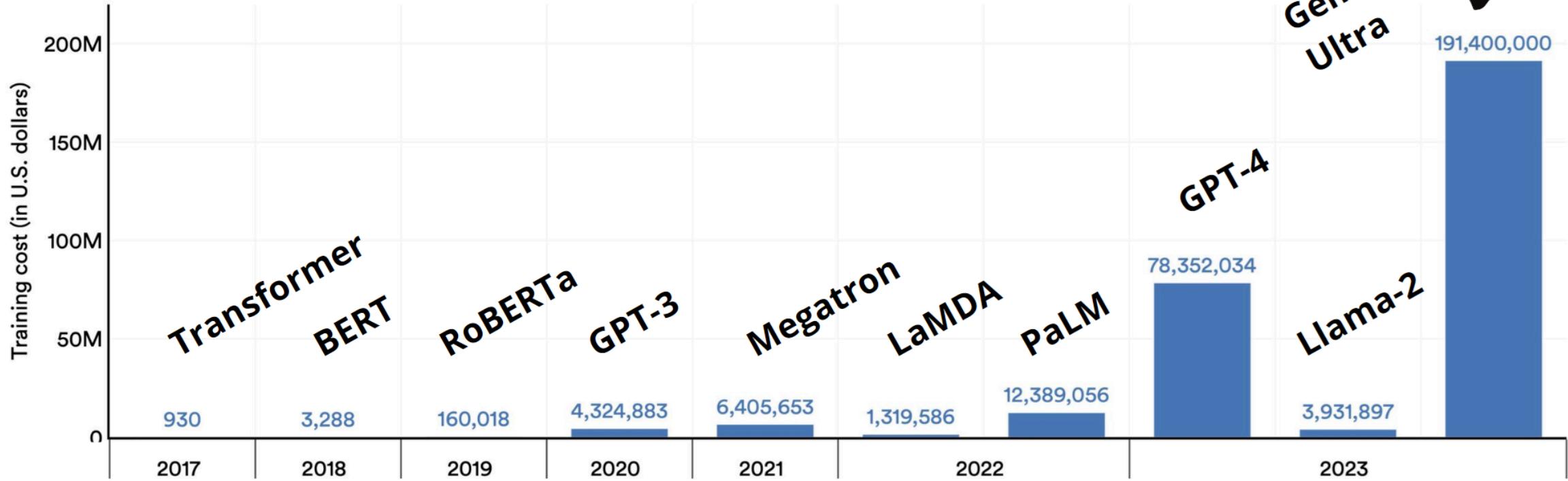
Training compute (FLOP)



Tracking Large-Scale AI Models [Raman et al., 2024]

Estimated training cost of select AI models, 2017–23

Source: Epoch, 2023 | Chart: 2024 AI Index report



Artificial Intelligence Index Report 2024 [Stanford, 2024]

Rank*	Model	Arena Score	Organization	License
Rank*	Model	Arena Score	Organization	License
1	ChatGPT-4o-latest...(2024-08-08)	1317	OpenAI	Proprietary
2	Gemini-1.5-Pro-Exp-0801	1298	Google	Proprietary
2	Grok-2-08-13	1293	xAI	Proprietary
3	GPT-4o-2024-05-13	1286	OpenAI	Proprietary
5	GPT-4o-mini-2024-07-18	1275	OpenAI	Proprietary
5	Claude_3.5_Sonnet	1271	Anthropic	Proprietary
5	Grok-2-Mini-08-13	1268	xAI	Proprietary
6	Gemini_Advanced_App...(2024-05-14)	1267	Google	Proprietary
6	Meta-Llama-3.1-405b-Instruct	1266	Meta	Llama 3.1 Community
7	GPT-4o-2024-08-06	1262	OpenAI	Proprietary
8	Gemini-1.5-Pro-001	1260	Google	Proprietary
10	Gemini-1.5-Pro-Preview-0409	1257	Google	Proprietary
10	GPT-4-Turbo-2024-04-09	1257	OpenAI	Proprietary