



**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

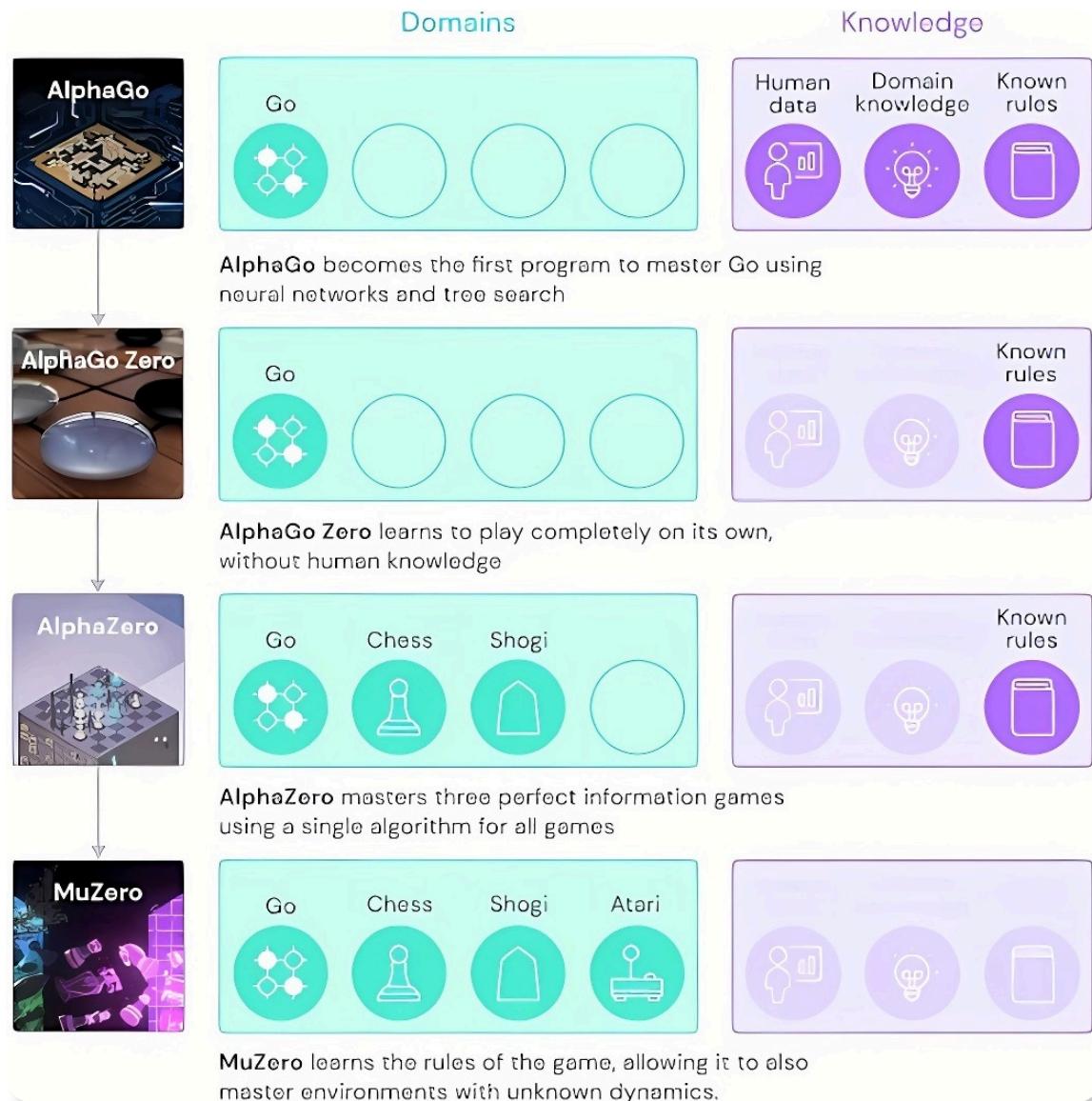
“IA é o avanço tecnológico mais significativo desde a interface gráfica. Assim como o microprocessador e a Internet, ela transformará a maneira como trabalhamos, aprendemos, viajamos e nos comunicamos.”

Bill Gates  
Microsoft



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

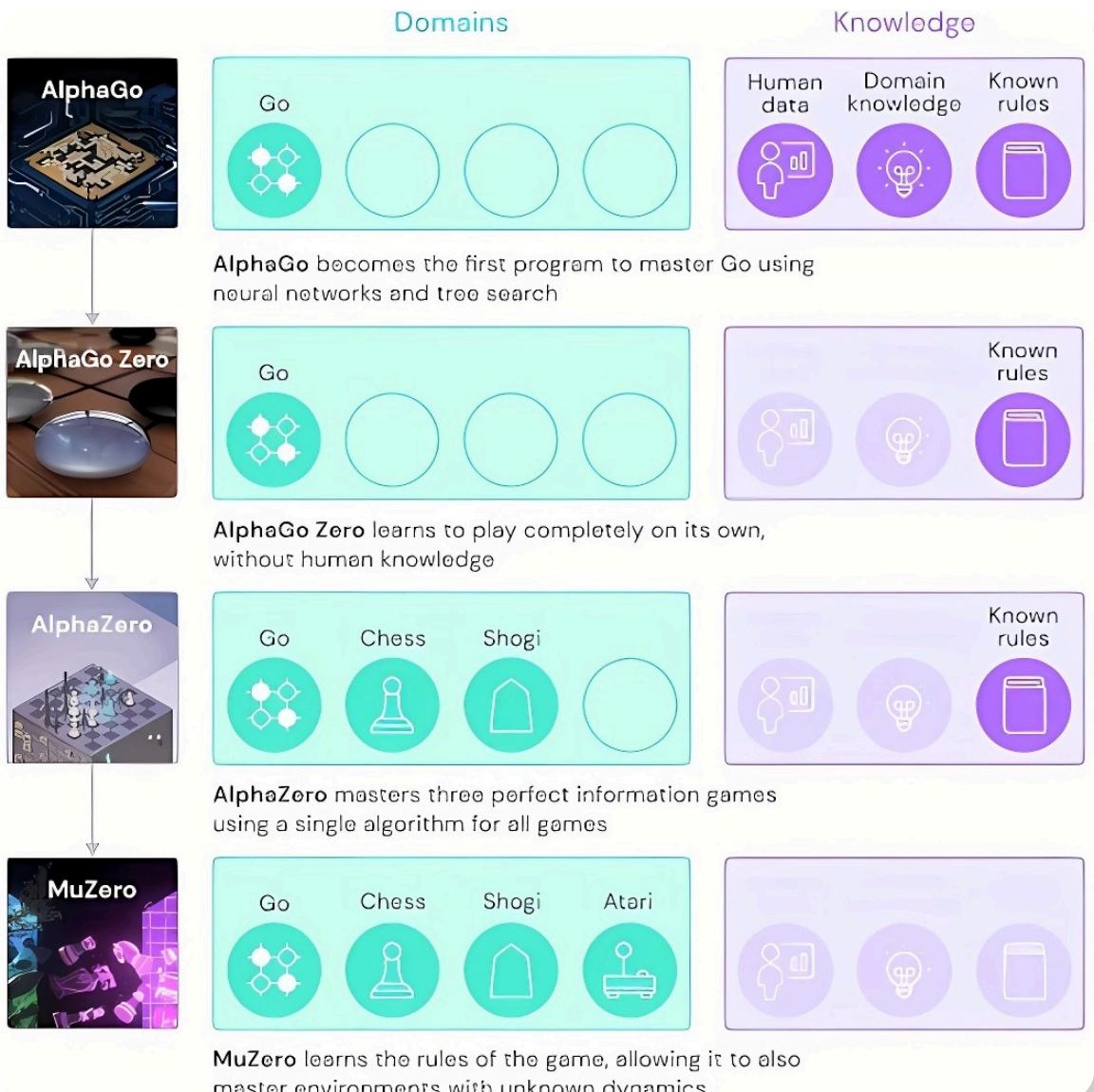
Jan, 2016



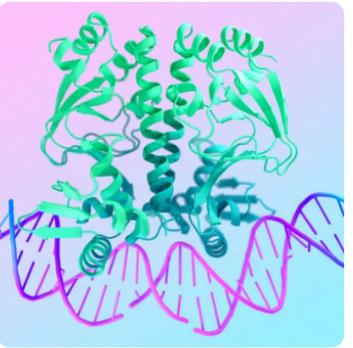
Dec, 2020

*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



Fev, 2022

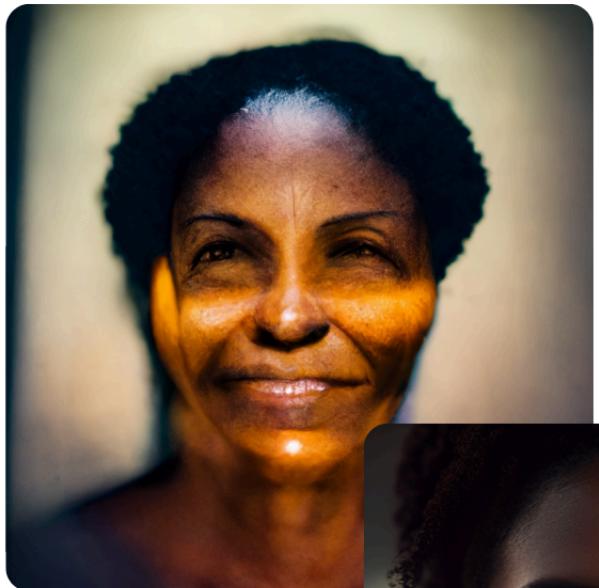


Abr, 2022

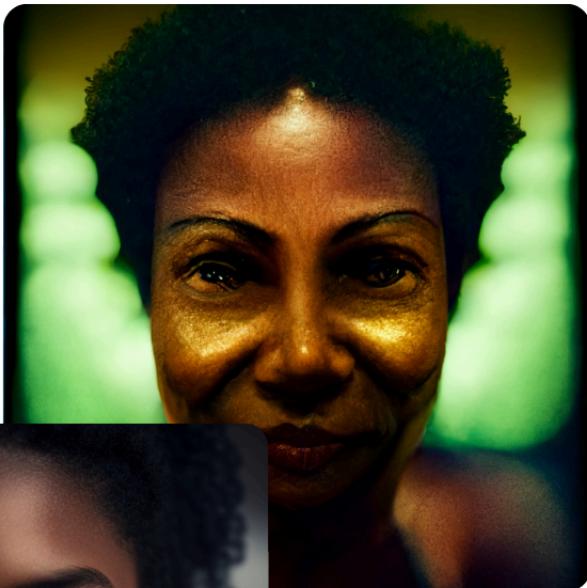


Jul, 2022

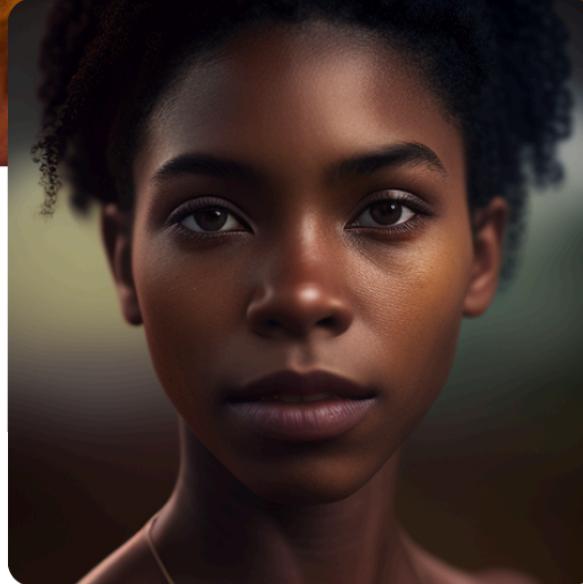
*[Midjourney, 2022-2023]*



Fev, 2022

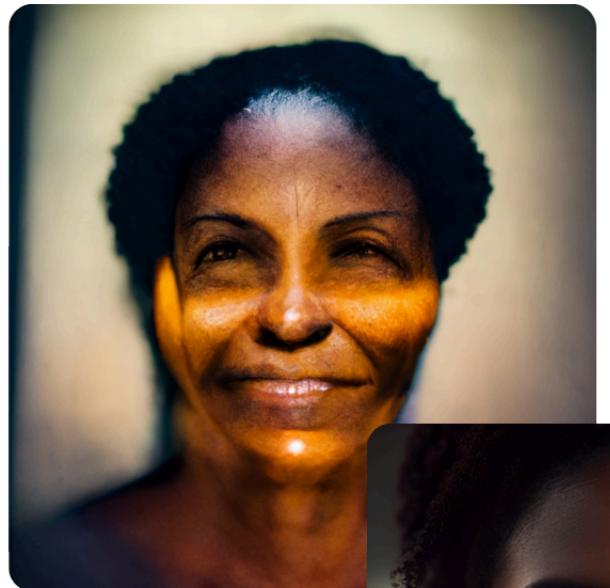


Jul, 2022



Nov, 2022

*[Midjourney, 2022-2023]*



Fev, 2022



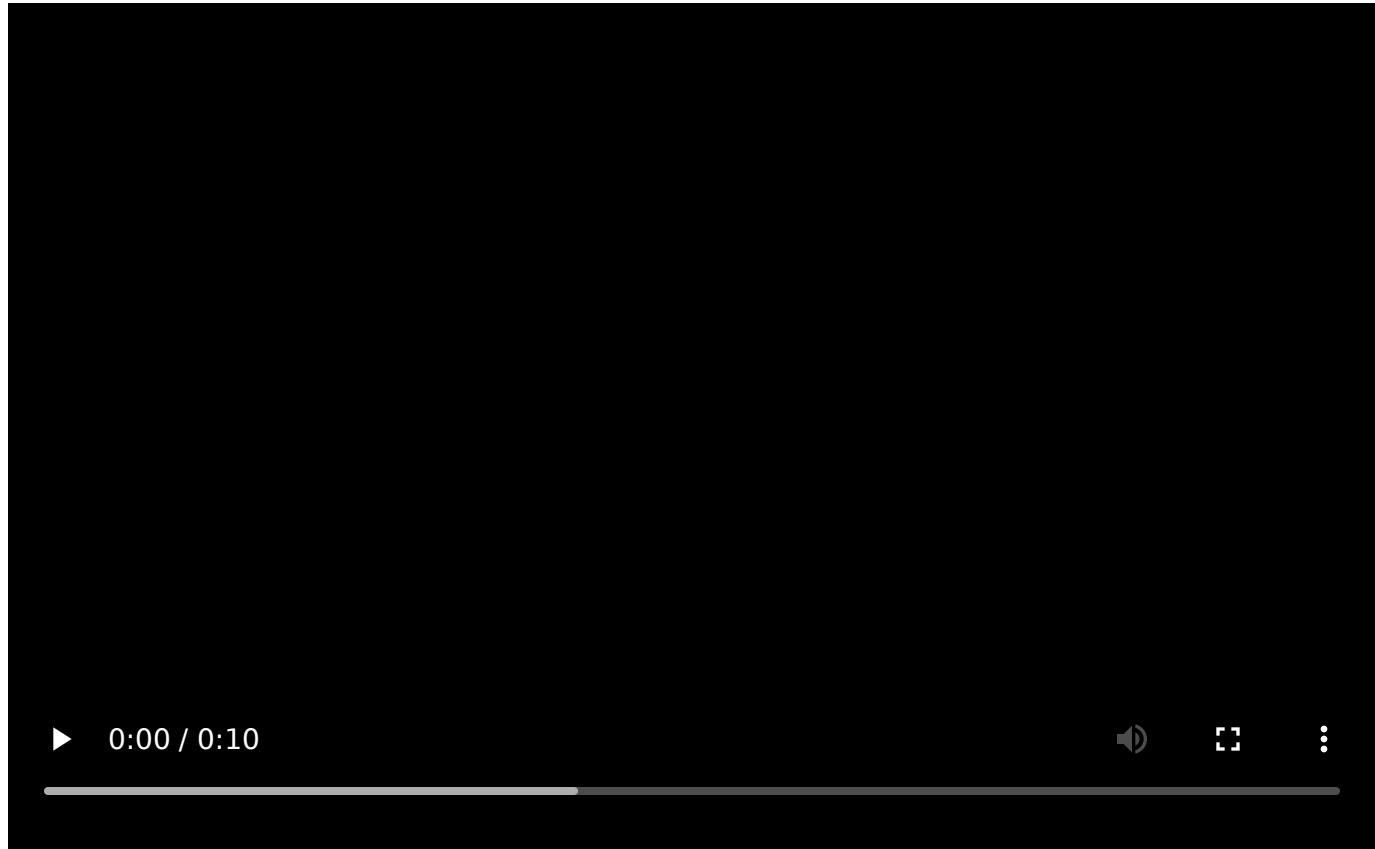
Nov, 2022



Mai, 2023

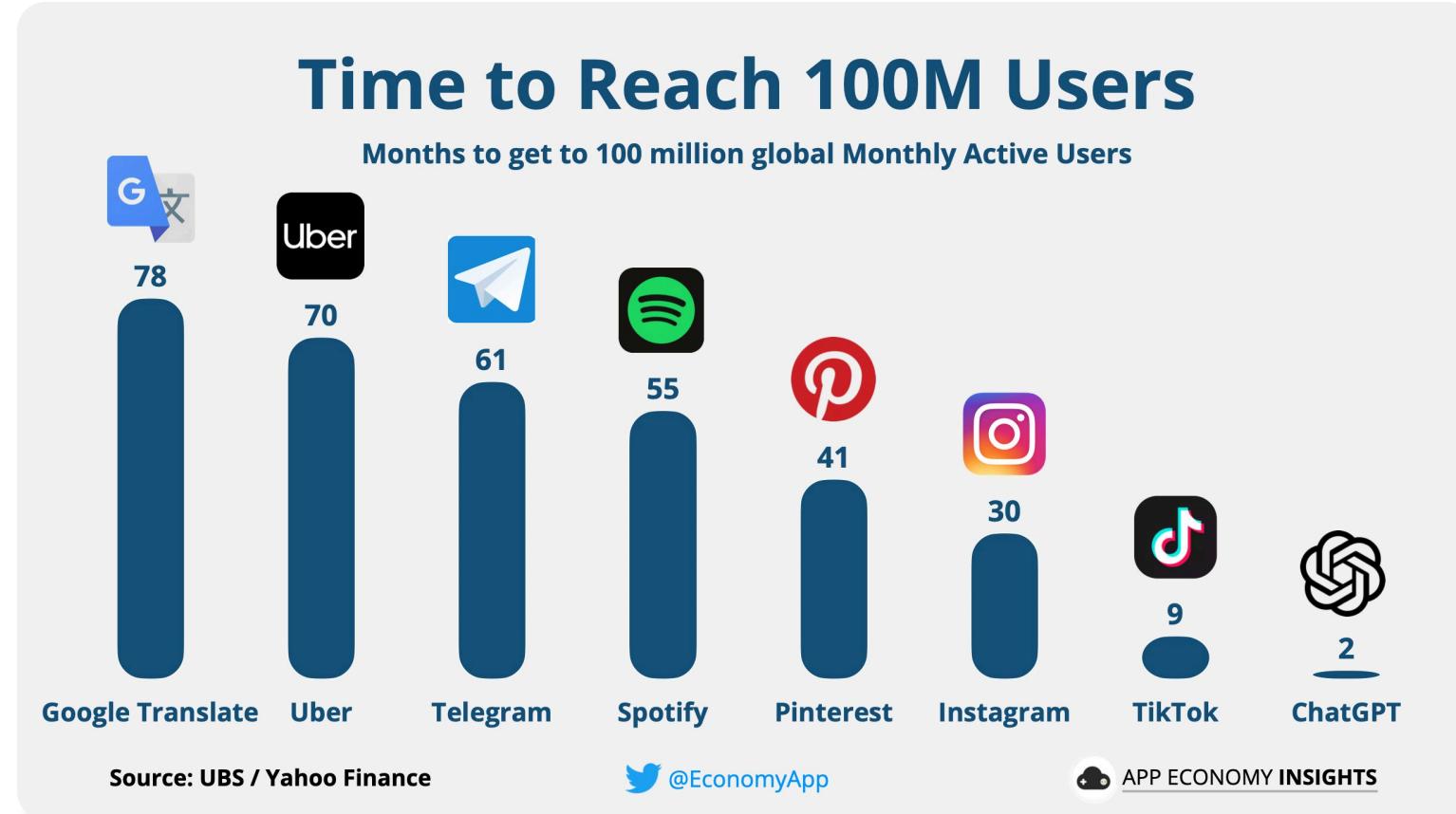
[Midjourney, 2022-2023]

2024

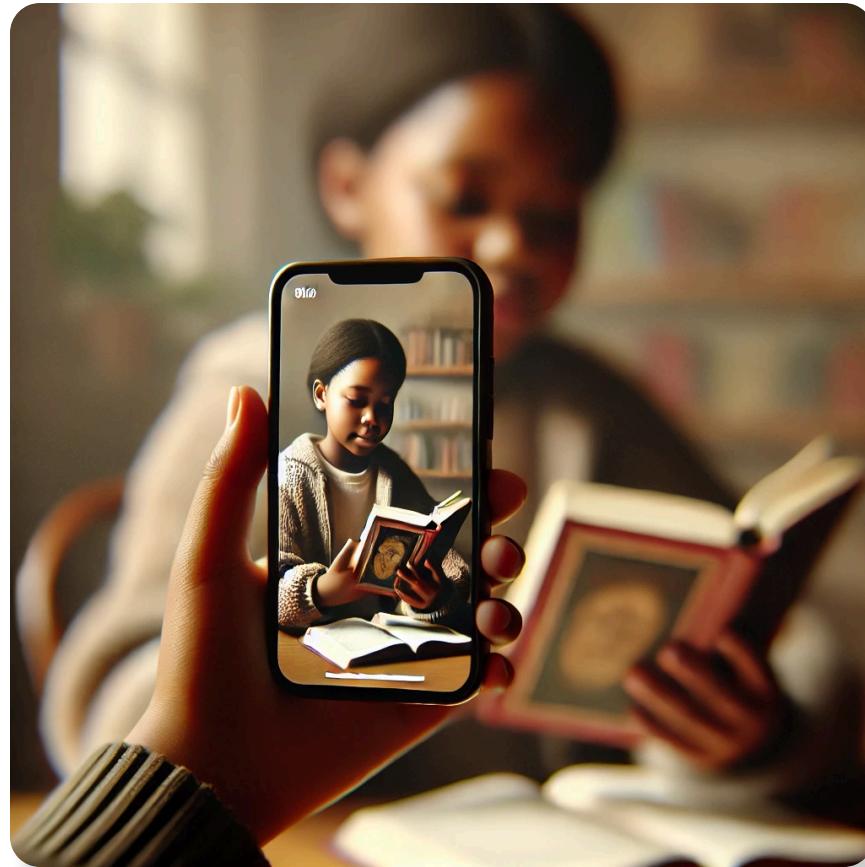


[Runway, 2024]

# 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

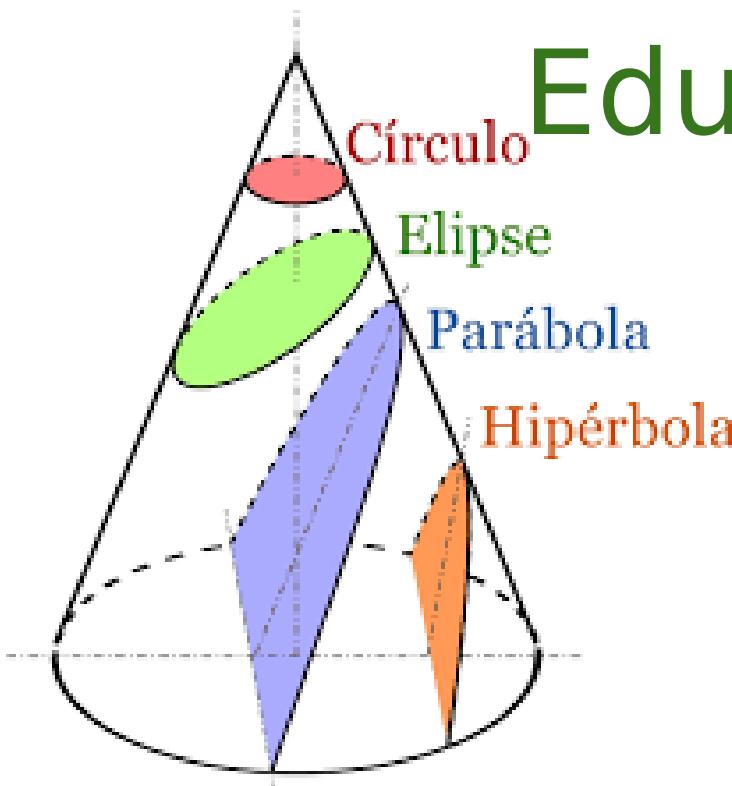
*Socrates on the Forgetfulness that Comes with Writing [Plato, 370 a.C.]*



# Melhoria vs Transformação

- A ***melhoria*** torna as práticas existentes mais eficientes sem alterá-las fundamentalmente. A tecnologia é uma ferramenta que ajuda a entregar o mesmo conteúdo de forma mais eficaz.
- A ***transformação*** ocorre quando uma nova tecnologia não apenas auxilia nas tarefas existentes, mas também

*... What the success of chalkboards tells us about the Future of Computers ... [Krause, 2000]*



# Educação: Conteúdo e Forma

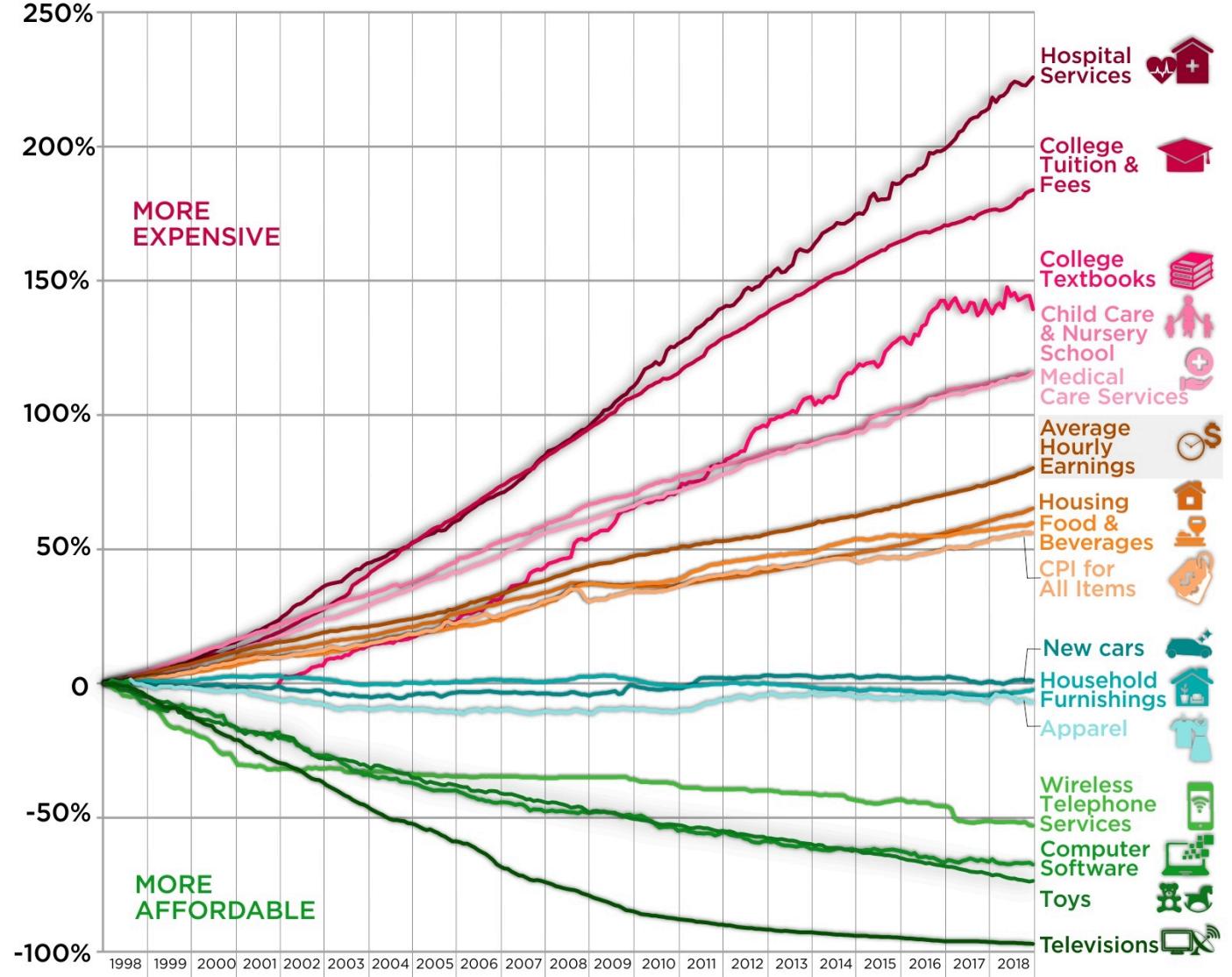
- Em 1825, o quadro negro foi adotado na universidade de Yale.
- Em 1830, os alunos passaram a ser obrigados a reproduzir de memória partes dos livros nos quadros.

# 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)



## Efeito Baumol

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

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>

howmuch William Baumol, ... has died. [Lee, 2017]

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

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



[Youtube, 2024]



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

*Bill Gates Visits First Avenue School: Commends innovative use of technology [NPS, 2024]*

**Sal Khan (CEO Khan Academy)**

"Com o Khanmigo, os educadores podem acessar (um banco de dados de) problemas recomendados para os alunos, analisar tendências da turma e simplificar tarefas administrativas, economizando tempo valioso e permitindo que a atenção seja focada nas necessidades dos alunos."

# 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

*First Avenue School Makes U.S. News Rankings for 2024 [NPS, 2024]*



# Limitações

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



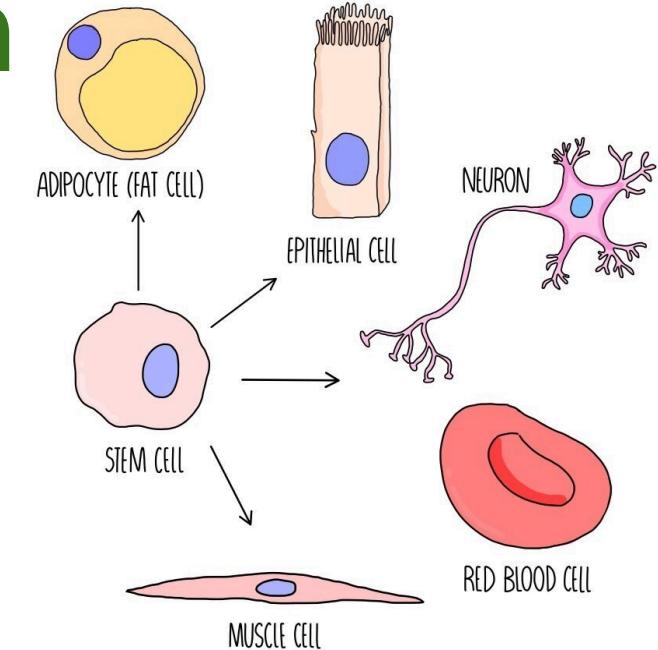
*Newark Public Schools Among 1st in US to Pilot New AI Tutor [Mosaic, 2024]*

# PNL: Problema Fundamental

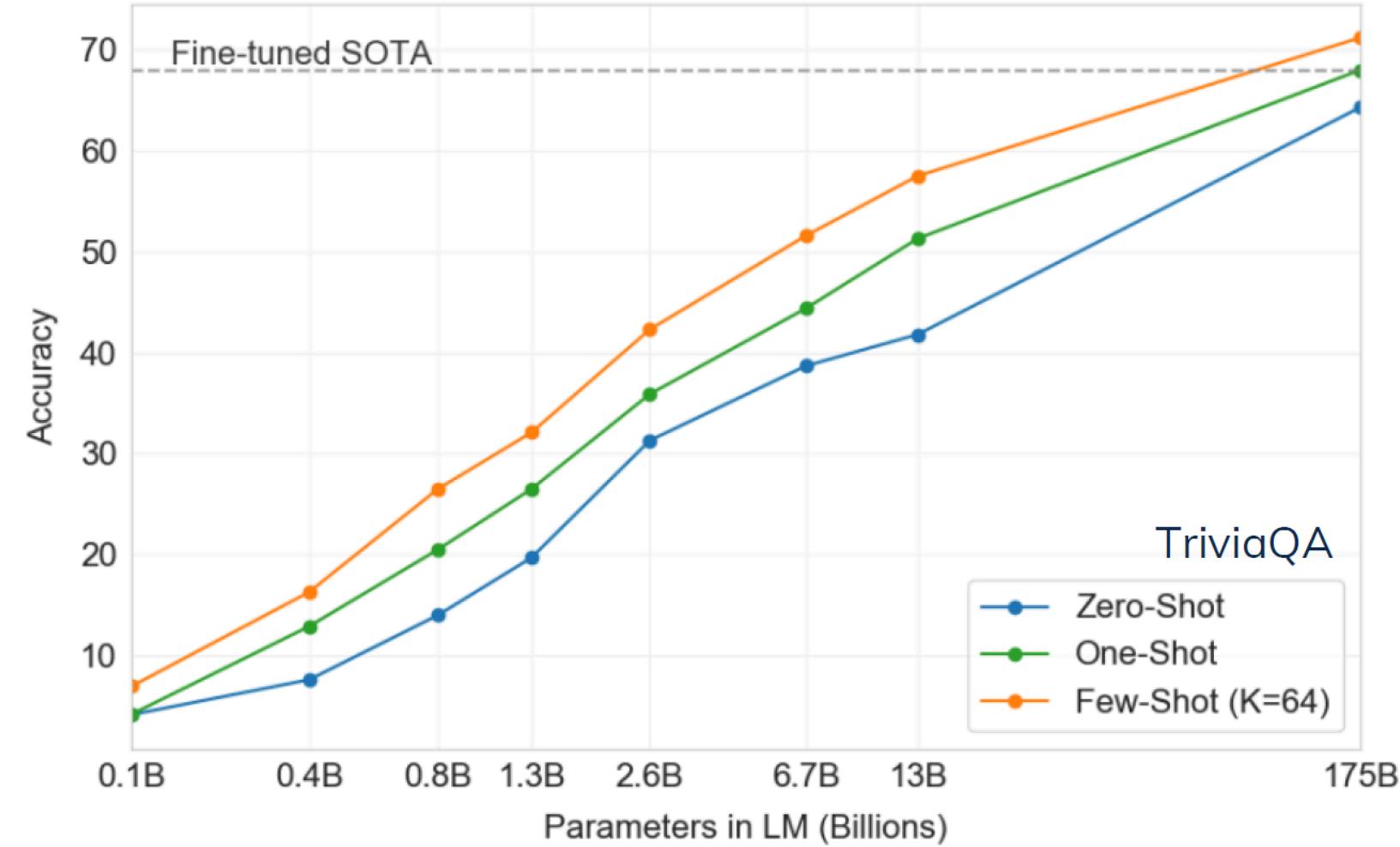
- Tradução de texto
- Correção gramatical
- Sumarização de texto
- Extração de informações

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

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



## PNL: QA



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

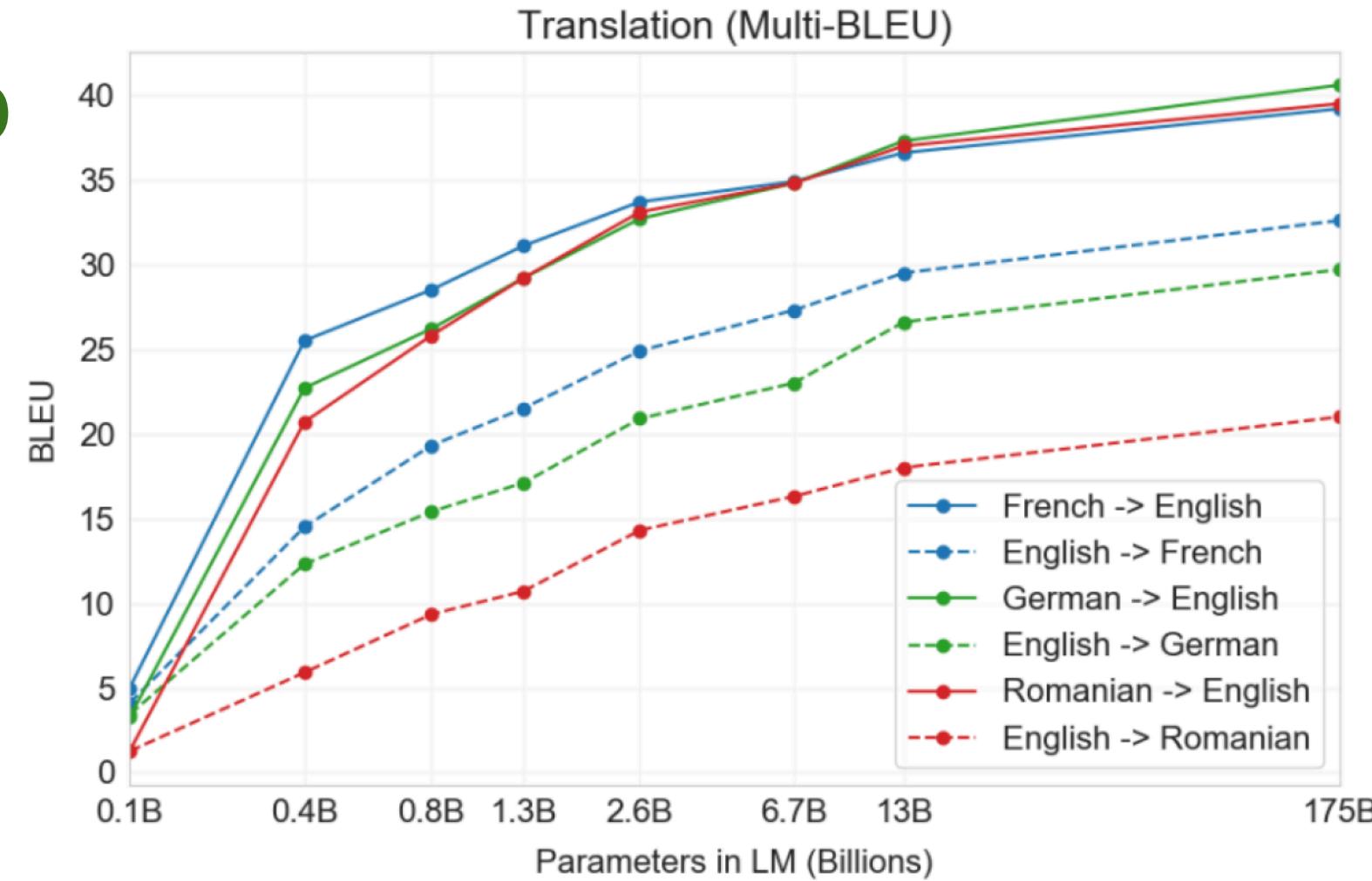


# PNL: Tradução

Setting	En→Fr	Fr→En	En→De	De→En	En→Ro	Ro→En
SOTA (Supervised)	<b>45.6<sup>a</sup></b>	35.0 <sup>b</sup>	<b>41.2<sup>c</sup></b>	40.2 <sup>d</sup>	<b>38.5<sup>e</sup></b>	<b>39.9<sup>e</sup></b>
XLM [LC19]	33.4	33.3	26.4	34.3	33.3	31.8
MASS [STQ <sup>+</sup> 19]	<u>37.5</u>	34.9	28.3	35.2	<u>35.2</u>	33.1
mBART [LGG <sup>+</sup> 20]	-	-	<u>29.8</u>	34.0	<u>35.0</u>	30.5
GPT-3 Zero-Shot	25.2	21.2	24.6	27.2	14.1	19.9
GPT-3 One-Shot	28.3	<u>33.7</u>	26.2	30.4	20.6	38.6
GPT-3 Few-Shot	32.6	<u>39.2</u>	29.7	<u>40.6</u>	21.0	<u>39.5</u>

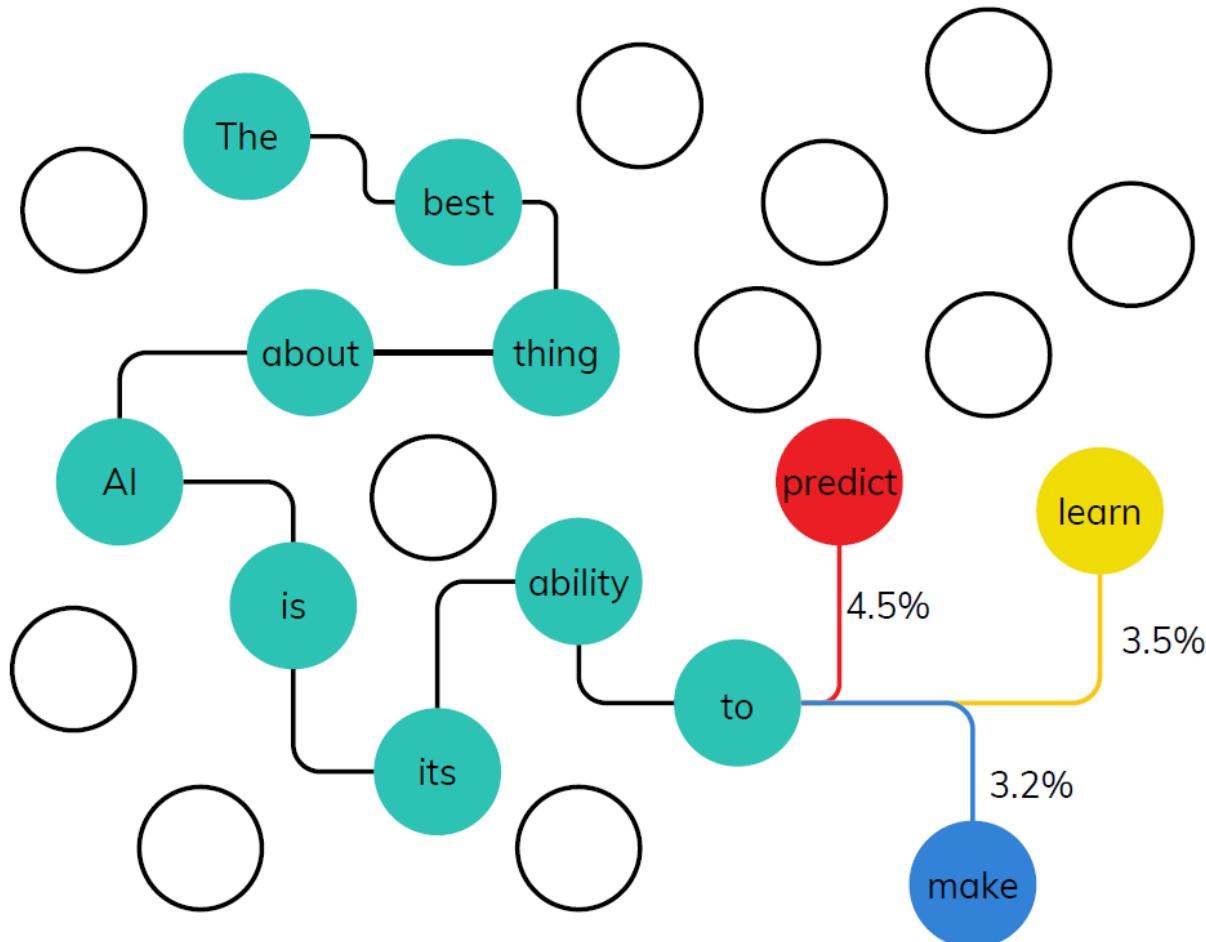
*Language Models are Few-Shot Learners [Brown et al., 2020]*

# PNL: Tradução



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

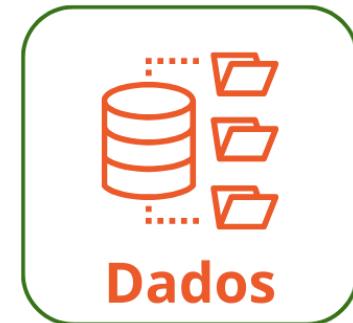
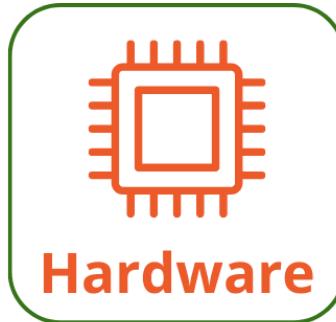
*The best thing about AI is its ability to \_\_\_\_\_*



## A próxima palavra é?

O problema de determinar a próxima palavra é um problema de trajetória.

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

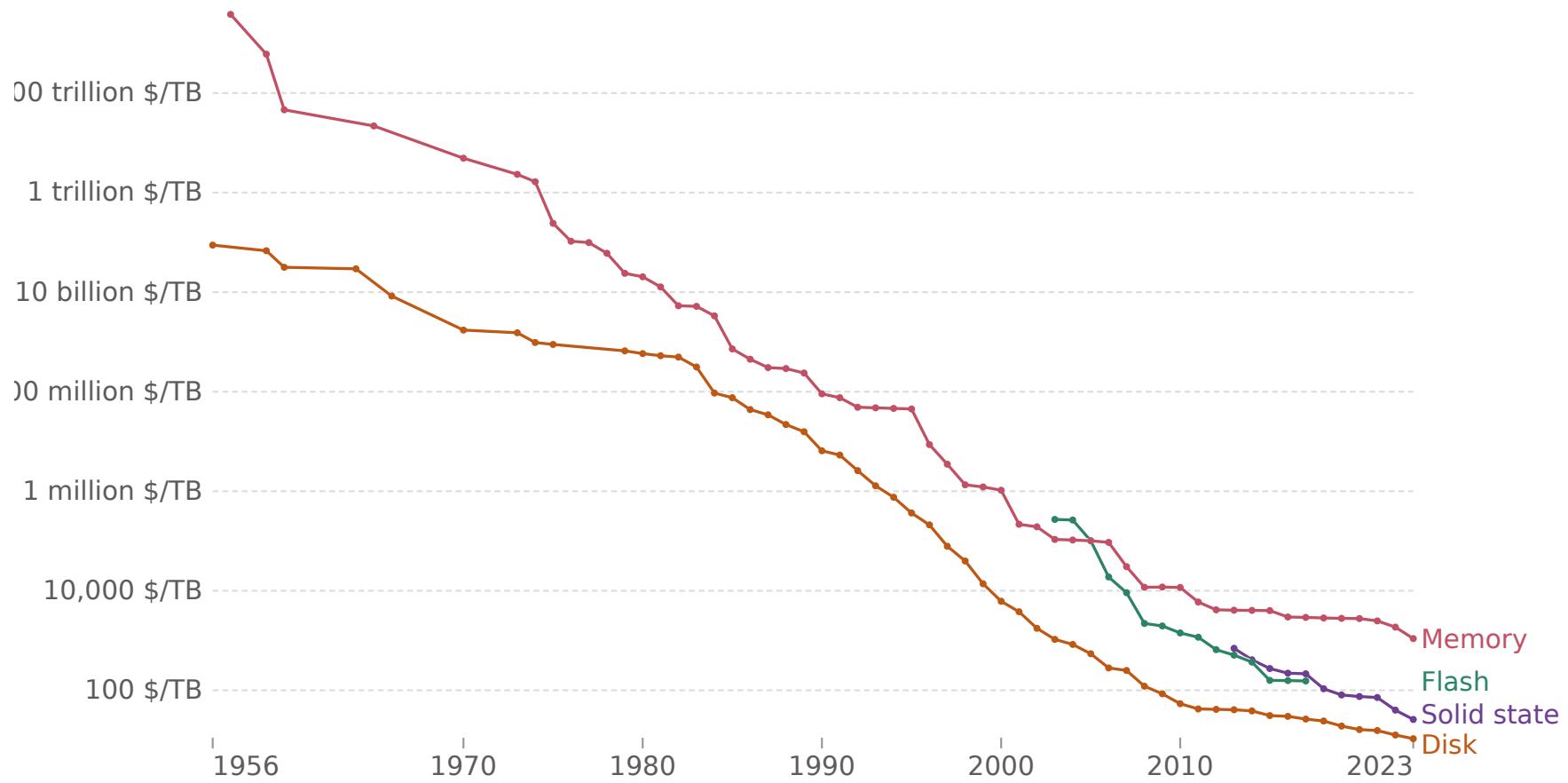


# Por que agora?

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

# 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).

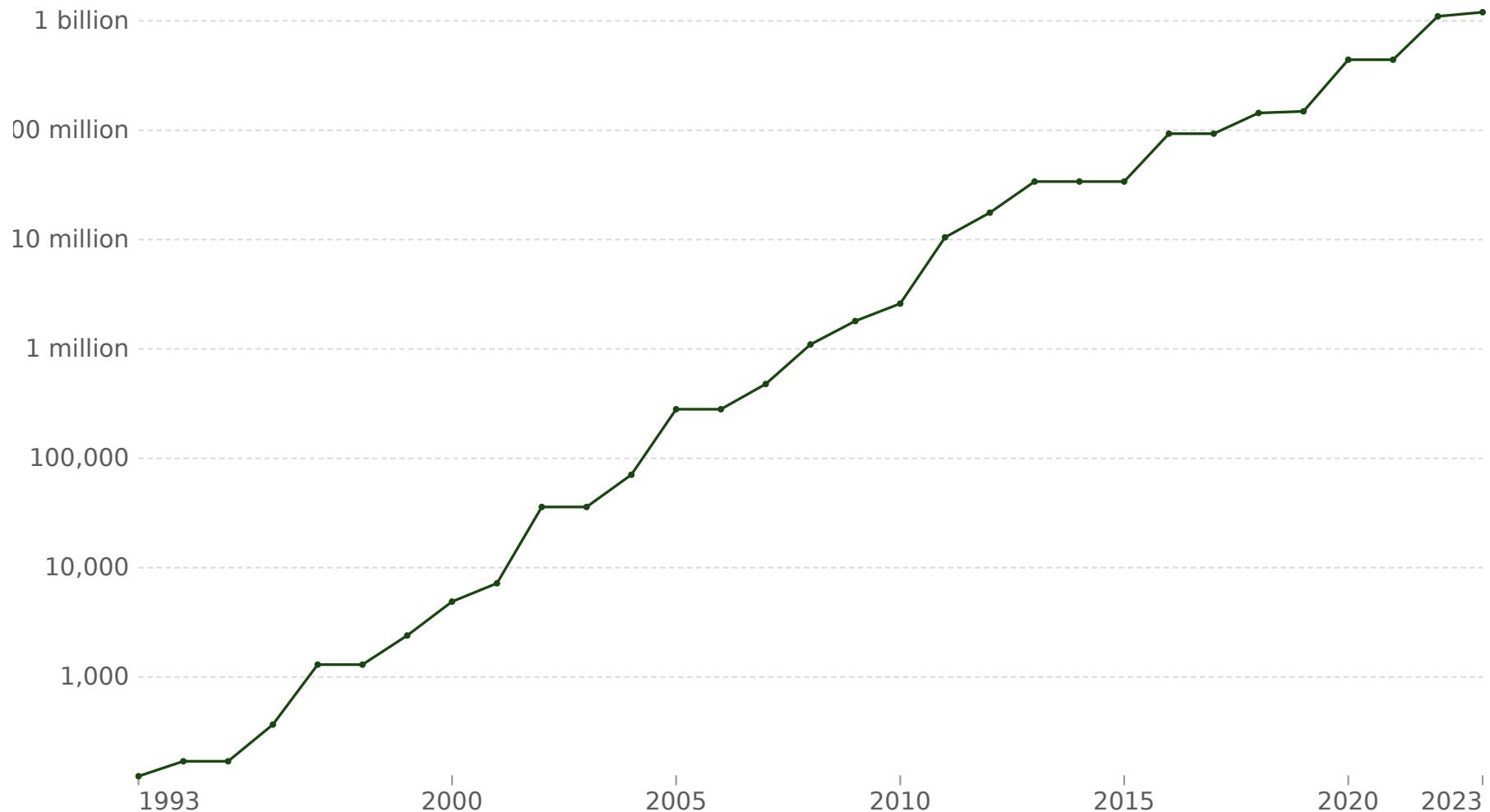


Moore's Law [Roser et. al, 2023]

# Computational capacity of the fastest supercomputers

Our World  
in Data

The number of floating-point operations<sup>1</sup> 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.

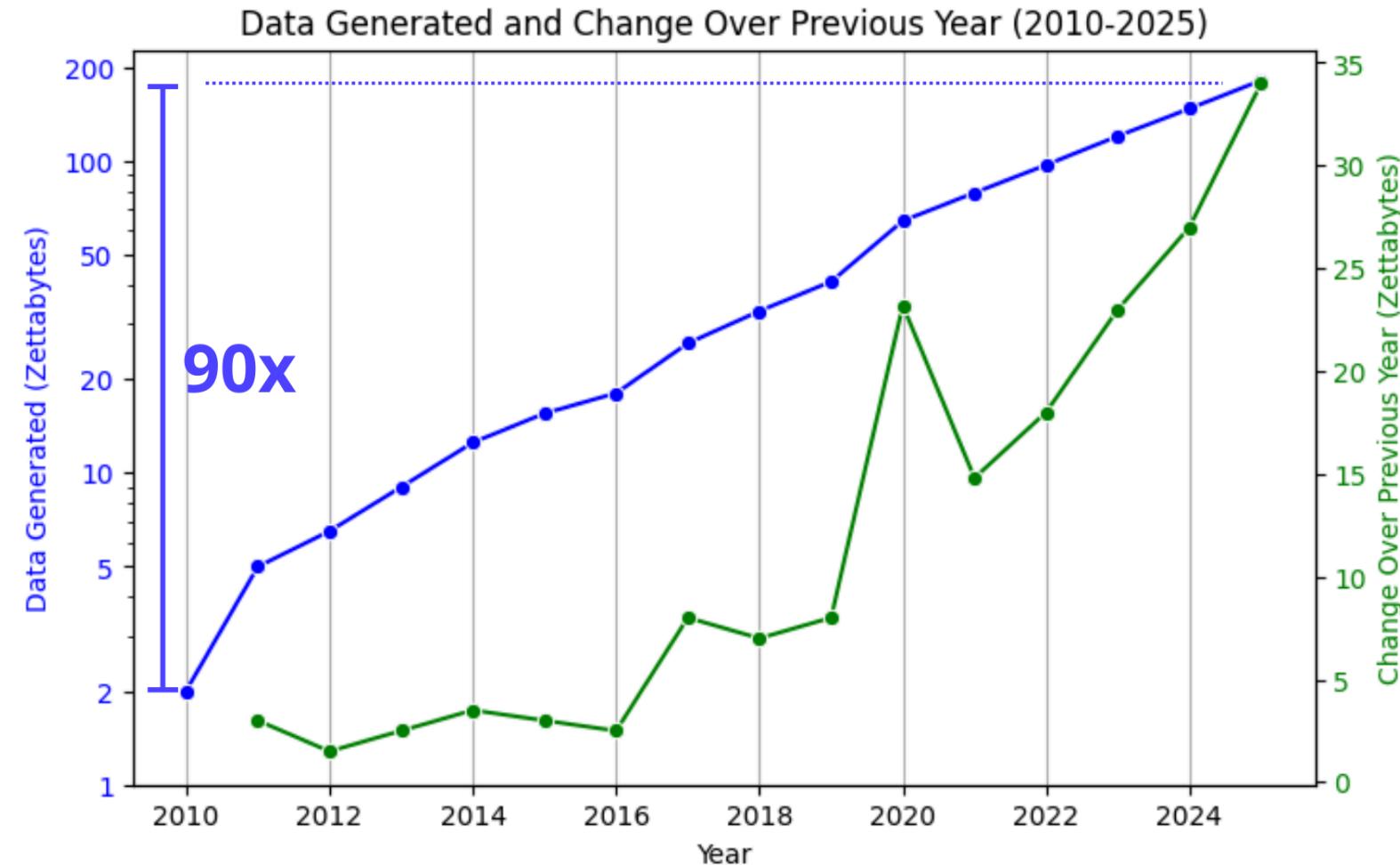


Data source: Dongarra et al. (2023)

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

[OurWorldInData.org/technological-change](https://OurWorldInData.org/technological-change) | C

# Explosão de Dados



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

# Explosão de Dados

## *Dados por minuto*

 **41,666,667**

messages shared  
by WhatsApp users

 **1,388,889**

video / voice calls made  
by people worldwide

 **404,444**

hours of video streamed  
by Netflix users

 **347,222**

stories posted by Instagram users

 **150,000**

messages shared by Facebook users

 **147,000**

photos shared by Facebook users

*53 Important Statistics About How Much Data Is Created Every Day in 2024 [Finances Online, 2024]*

# Palavras vs. Números

Redes neurais lidam com números, não com palavras.

Desejamos uma representação que seja

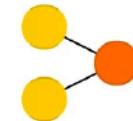
***útil = semântica +***

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



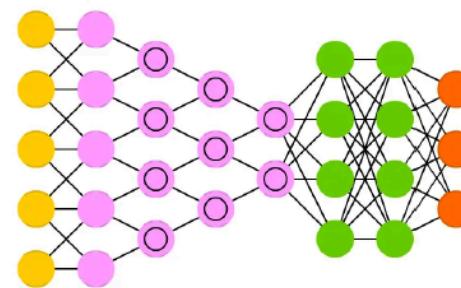
McCulloch '43

Perceptron (P)



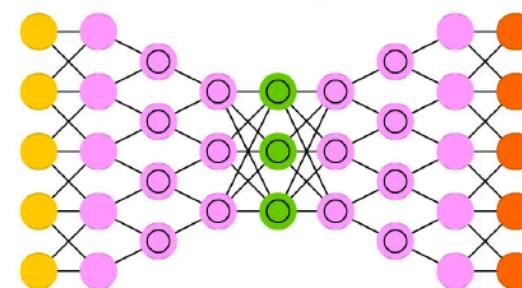
Cun'80

Deep Convolutional Network (DCN)



Kulkarni'15

Deep Convolutional Inverse Graphics Network (DCIGN)

*The Neural Network Zoo [Fjodor Van Veen, 2016]*

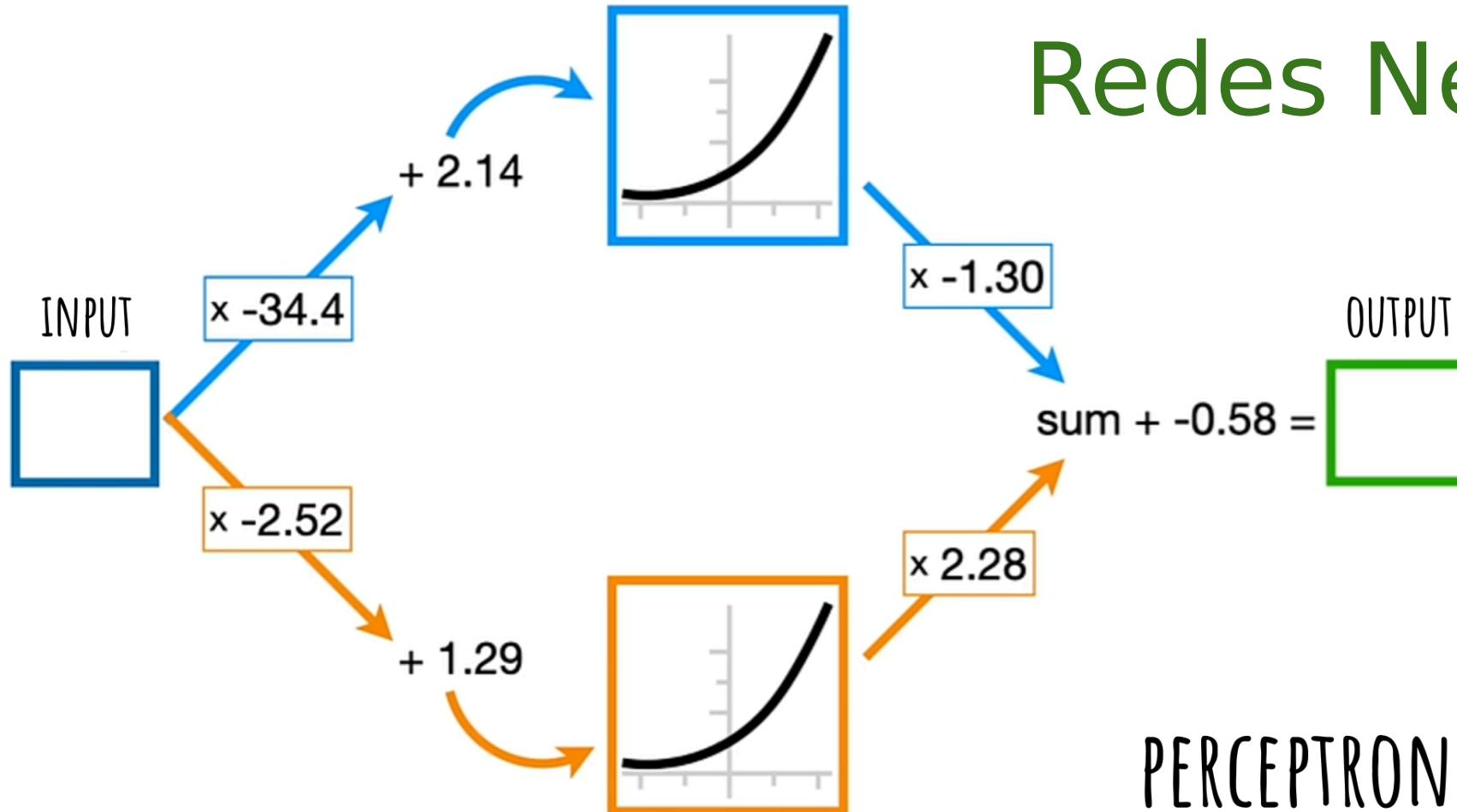
# Redes Neurais

Existem diferentes arquiteturas (forma e tamanho) de redes neurais.

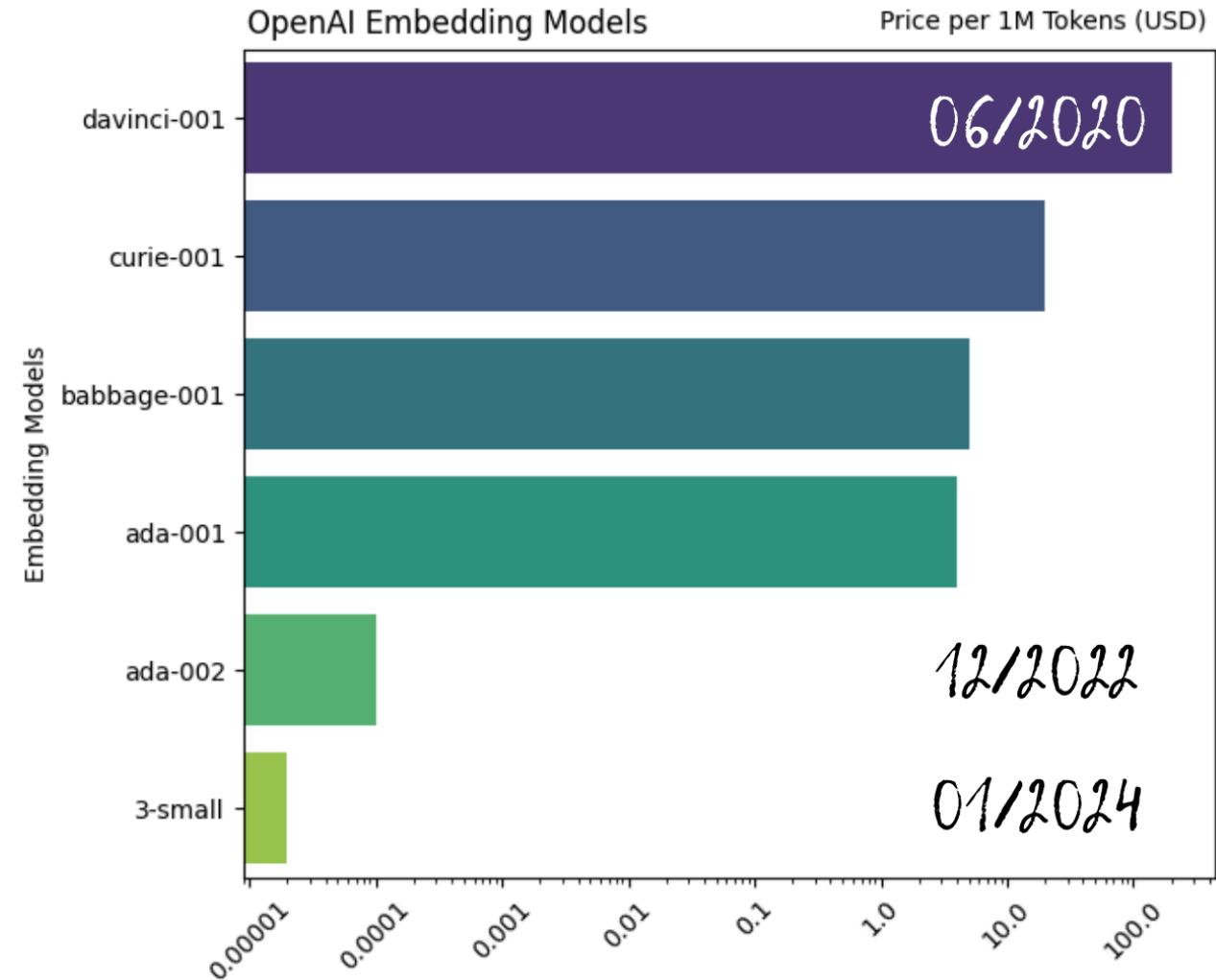
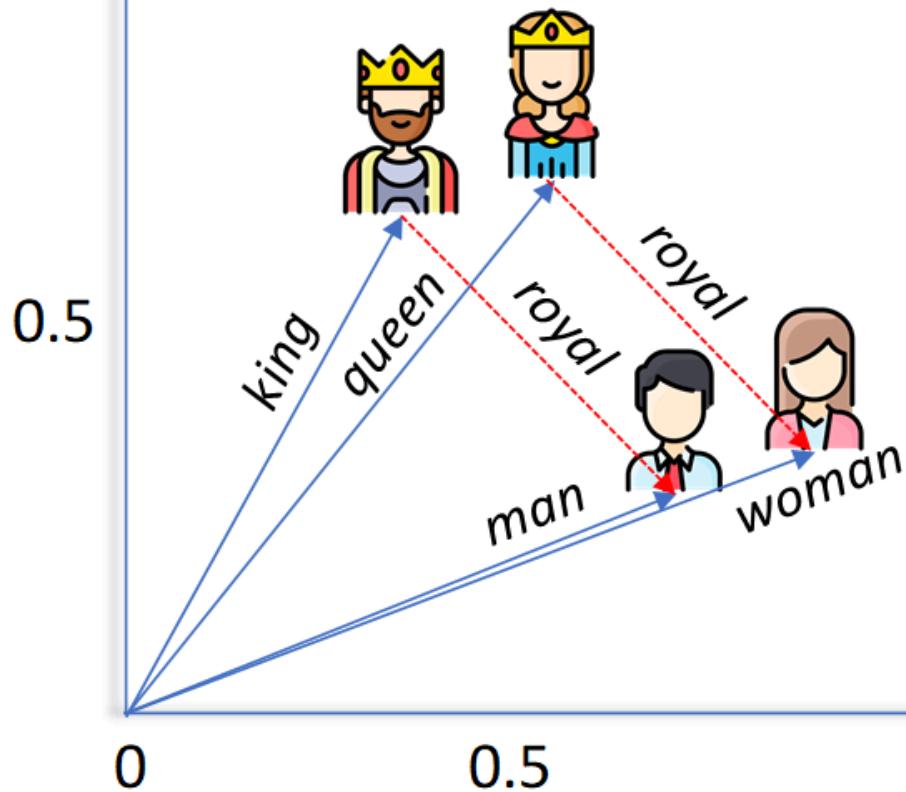
Cada uma é mais adequada para um tipo de problema (regressão, classificação, etc).

# Redes Neurais

## PERCEPTRON



## Word Embeddings



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

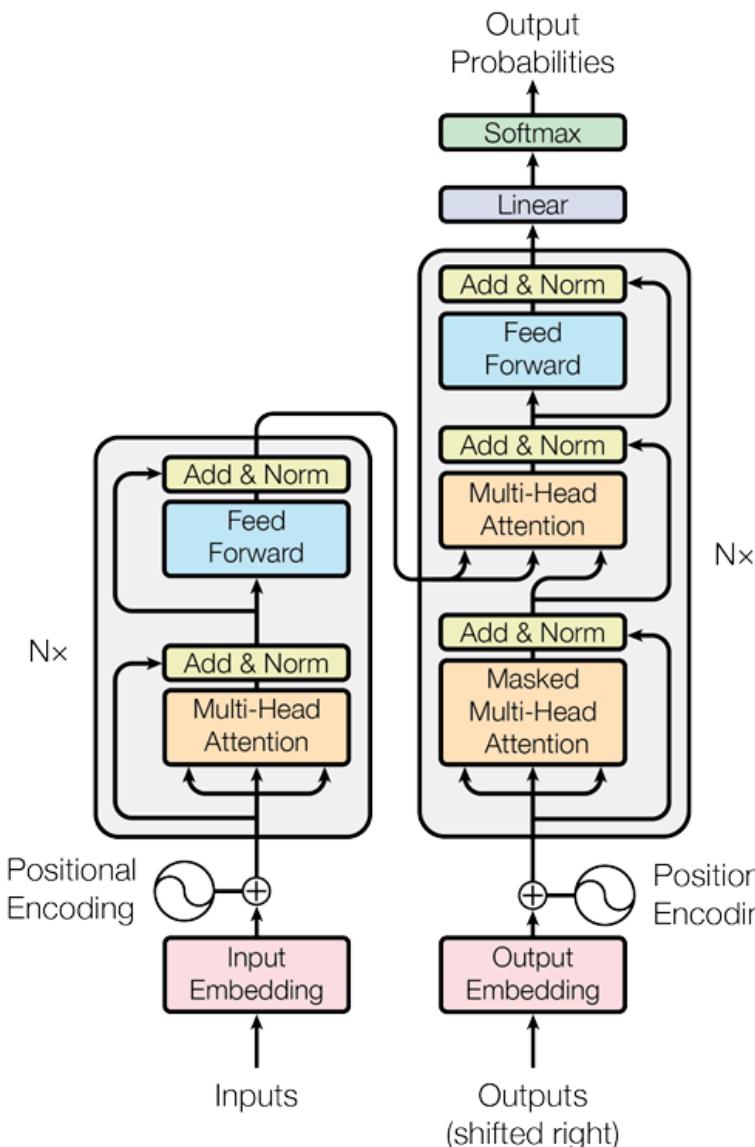
# Word Embeddings

## Tokenização



# Attention is all you need

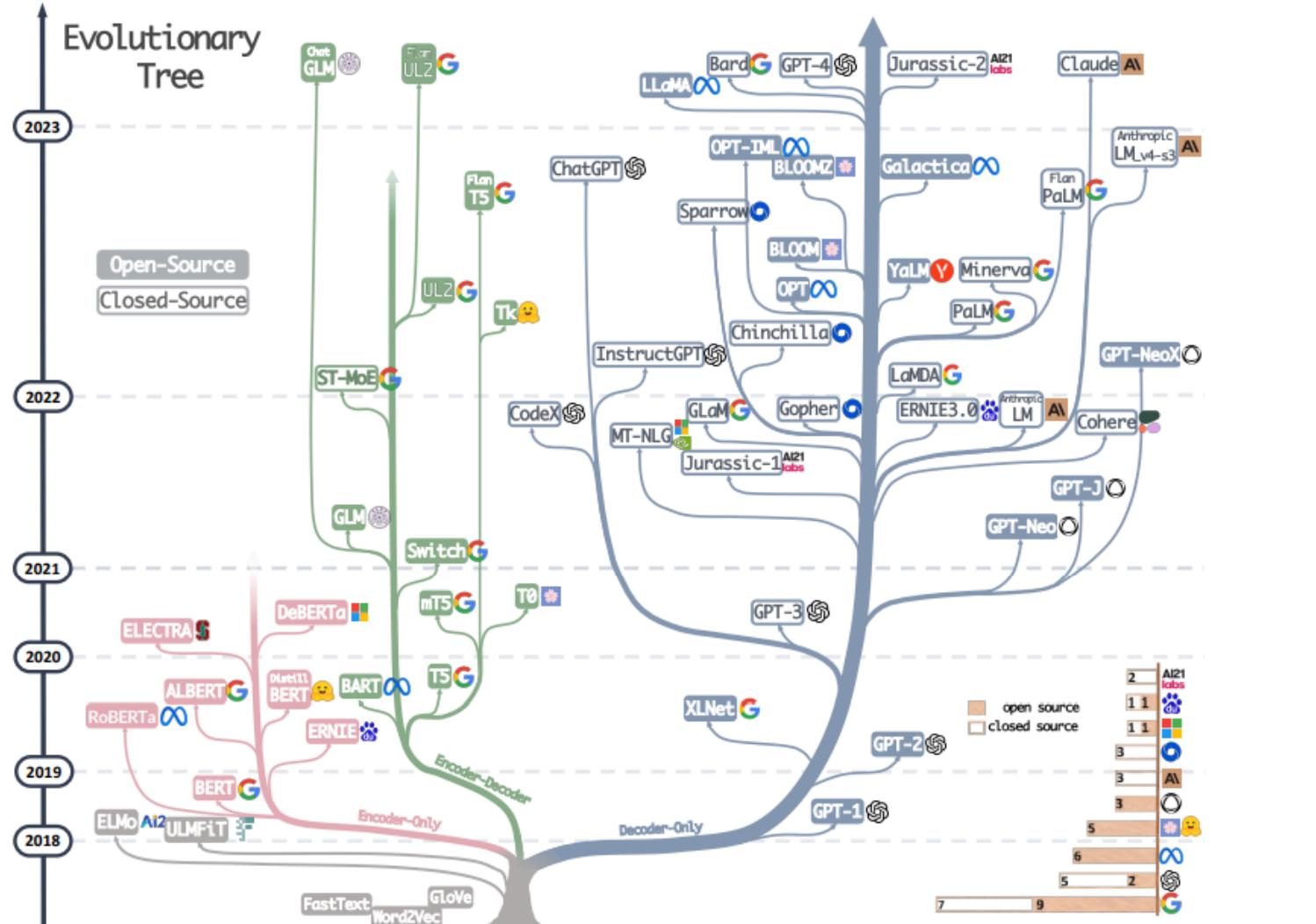
- Rede neural com atenção
- Massivamente paralela



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

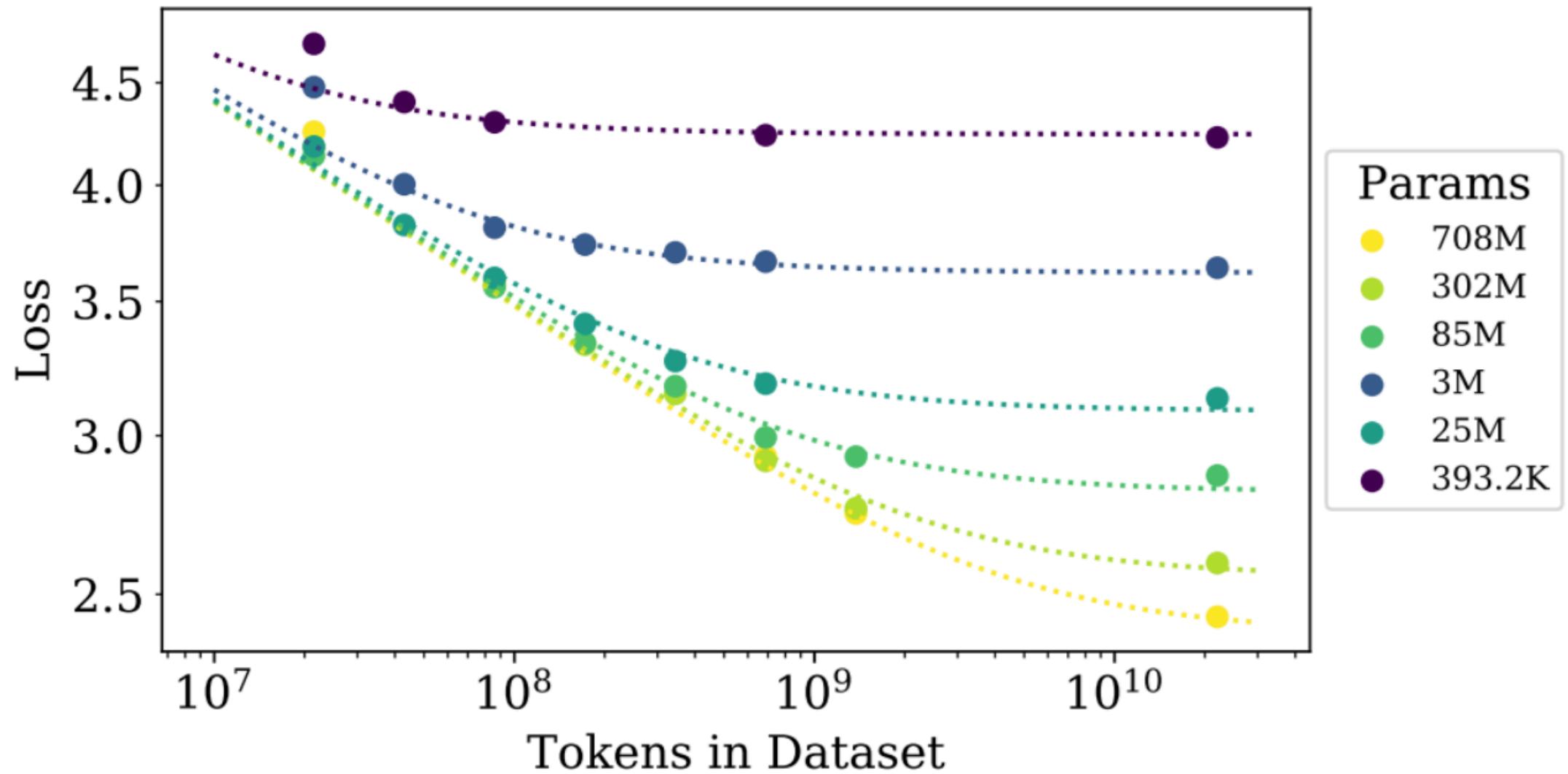
*Attention is All You Need [Vaswani et al., 2017]*

# Explosão de Modelos de Linguagem



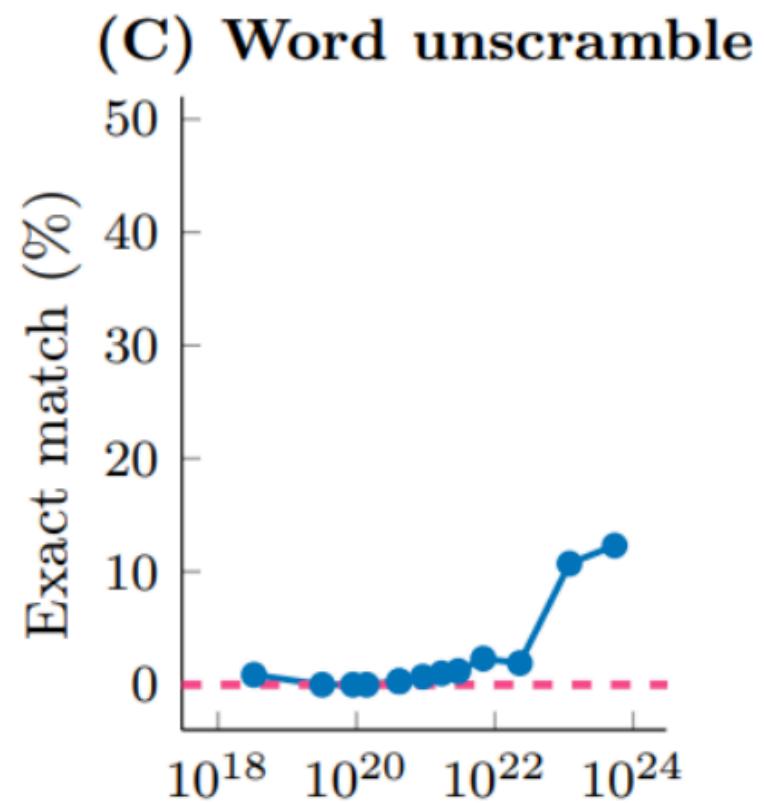
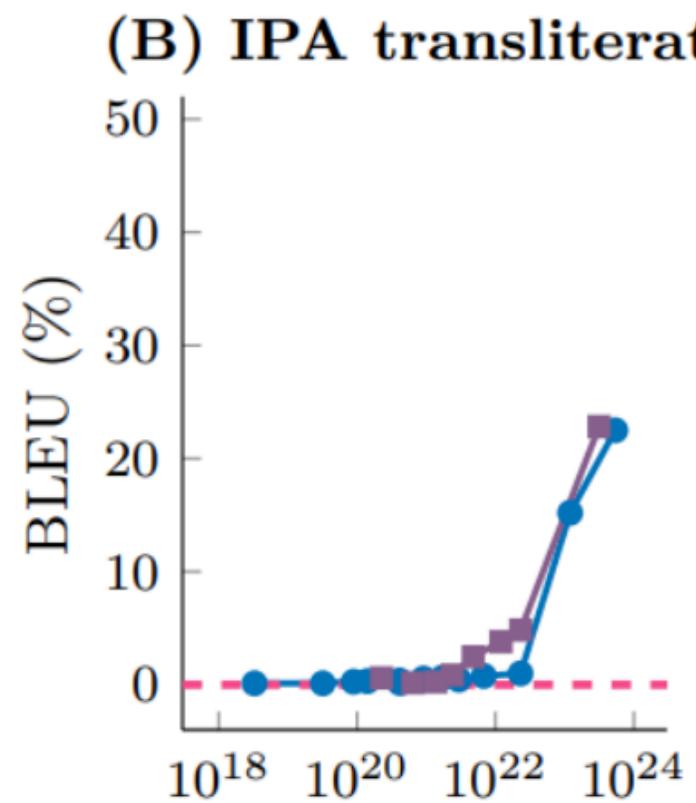
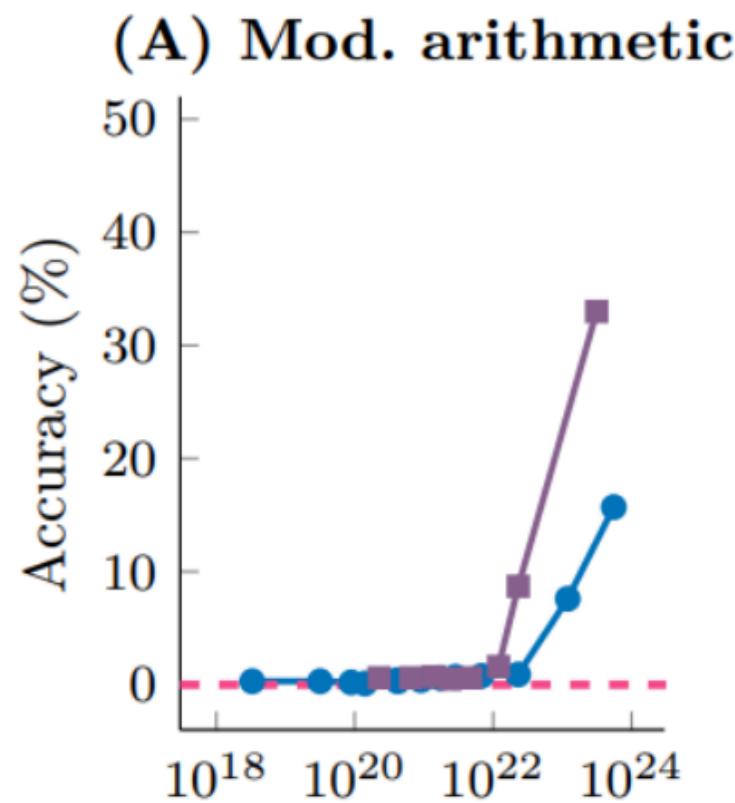
*Harnessing the Power of LLMs in Practice: A Survey on ChatGPT and Beyond [Yang et. al, 2023]*

# Loss vs Model and Dataset Size



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

## Habilidades Emergentes

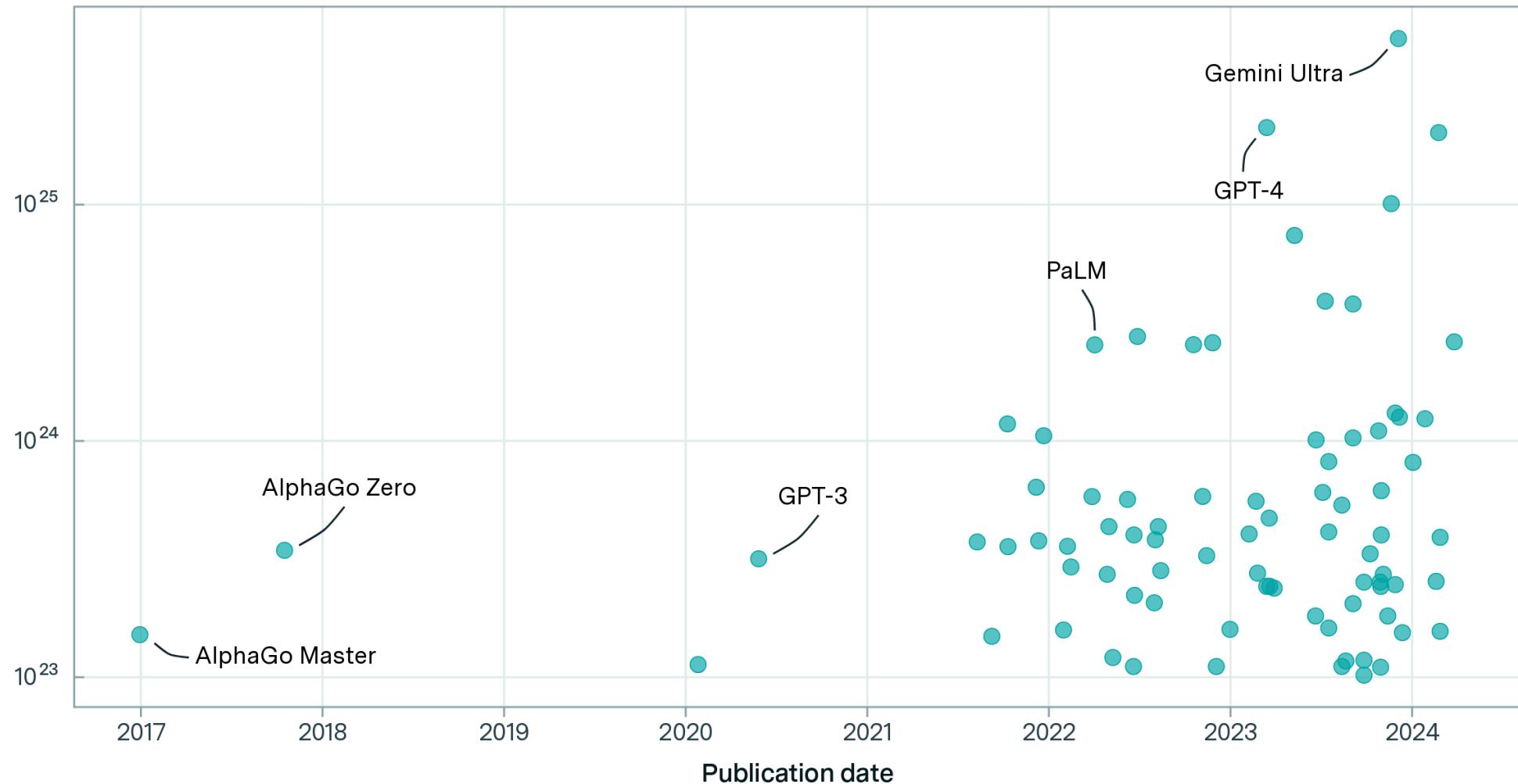


*Emergent Abilities in Large Language Models [Wei et. al, 2022]*

## Large-scale models

EPOCH AI

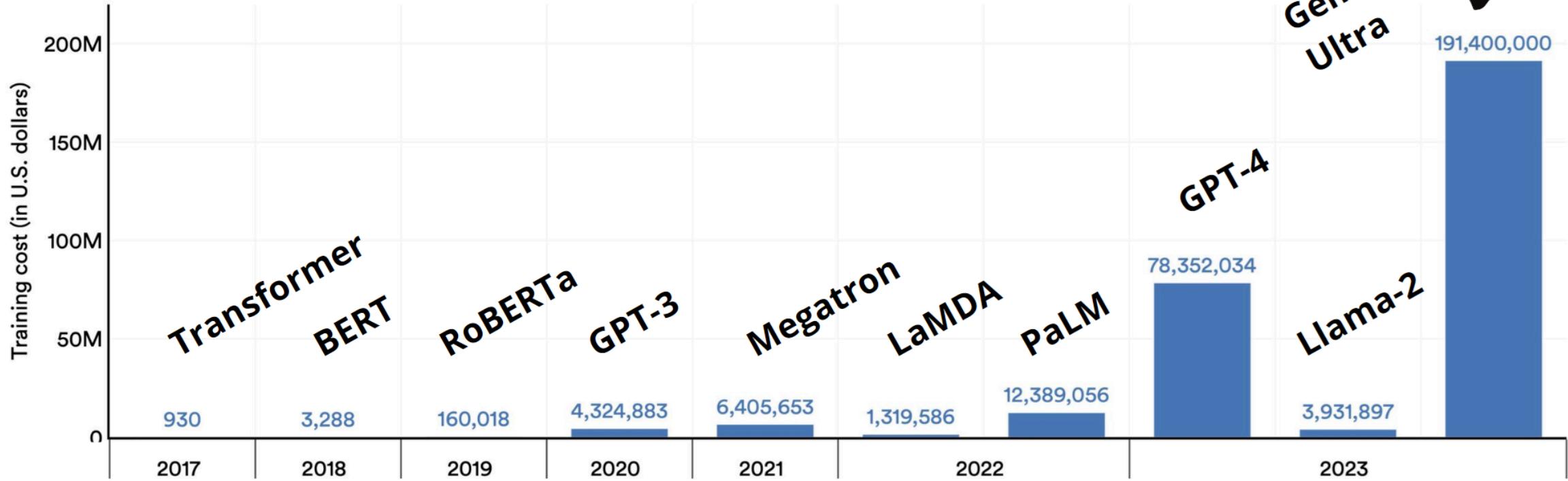
Training compute (FLOP)



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



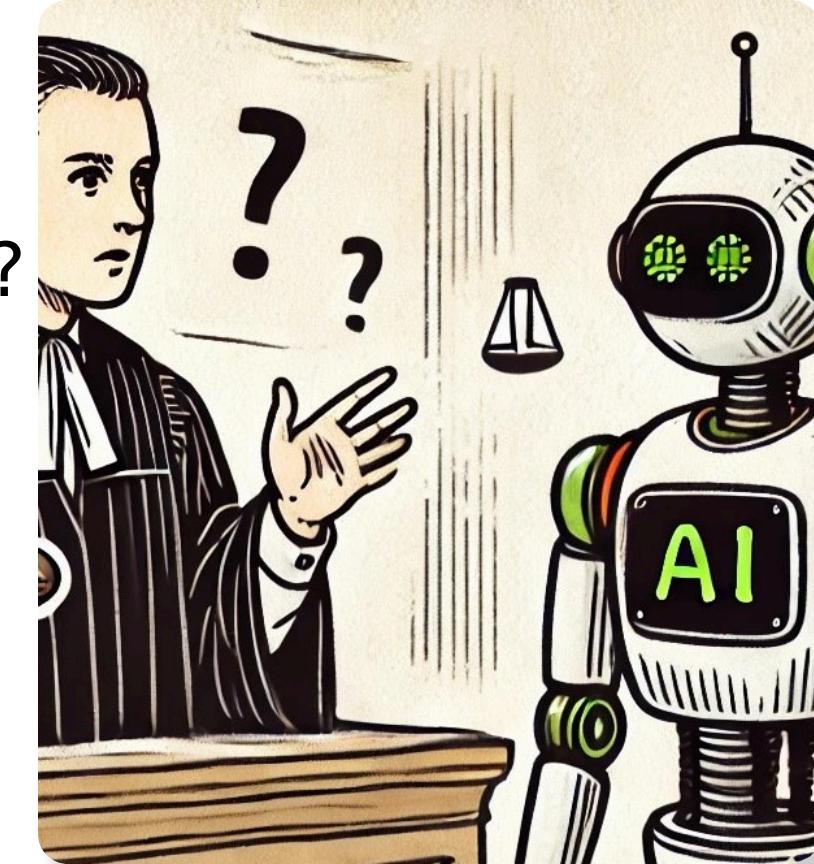
Artificial Intelligence Index Report 2024 [Stanford, 2024]

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

LLM Arena # Leaderboard, 27/08/2024

# 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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