



GenAI for Research

Foundation Shubin Yu





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- ❖ Msc. in Statistics, Business Economics, Cultural Studies at KU Leuven, Belgium
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- ❖ Huawei, Tencent, Country Garden, Semir

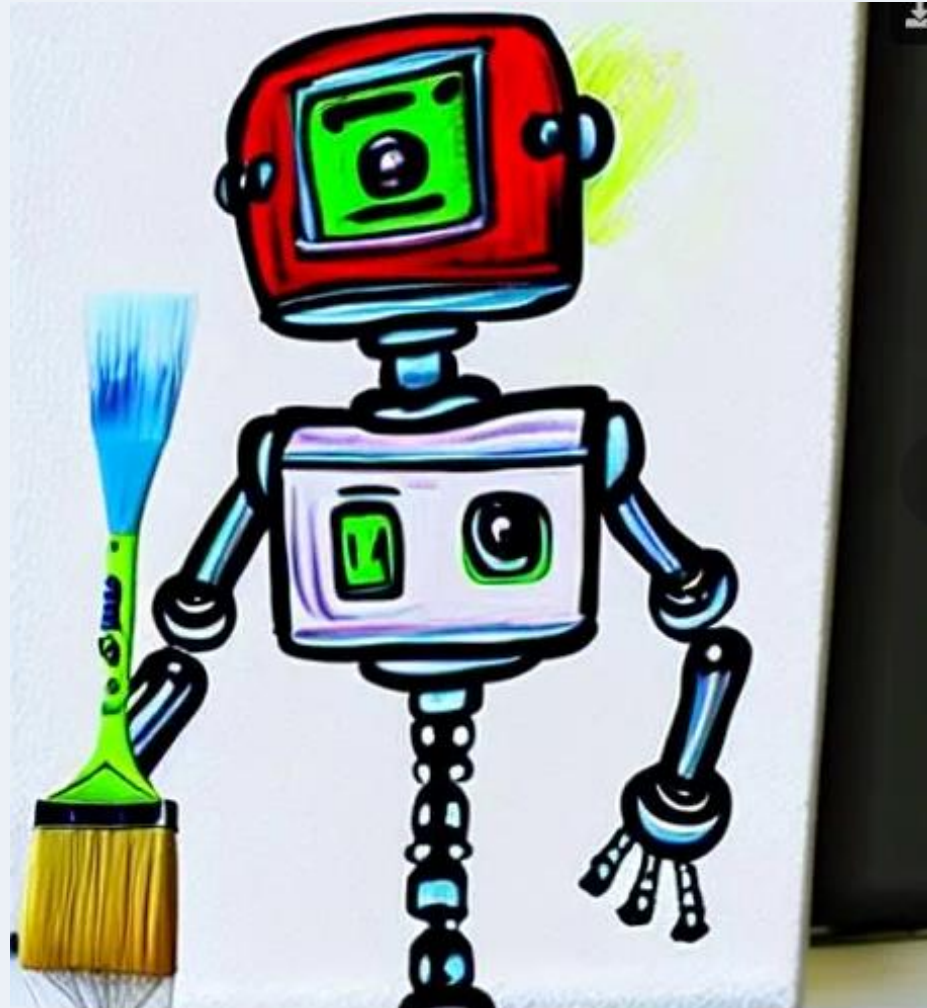


Lille My (Mimi)
Girl
2 years old
Coton de tulear
Cheese



Introduction to Generative AI

What is Generative AI (GenAI)



A robot is painting (March 2023 vs Jan 2024)



Generative AI refers to artificial intelligence systems that can create new content, such as text, images, audio, or video, based on patterns learned from existing data.

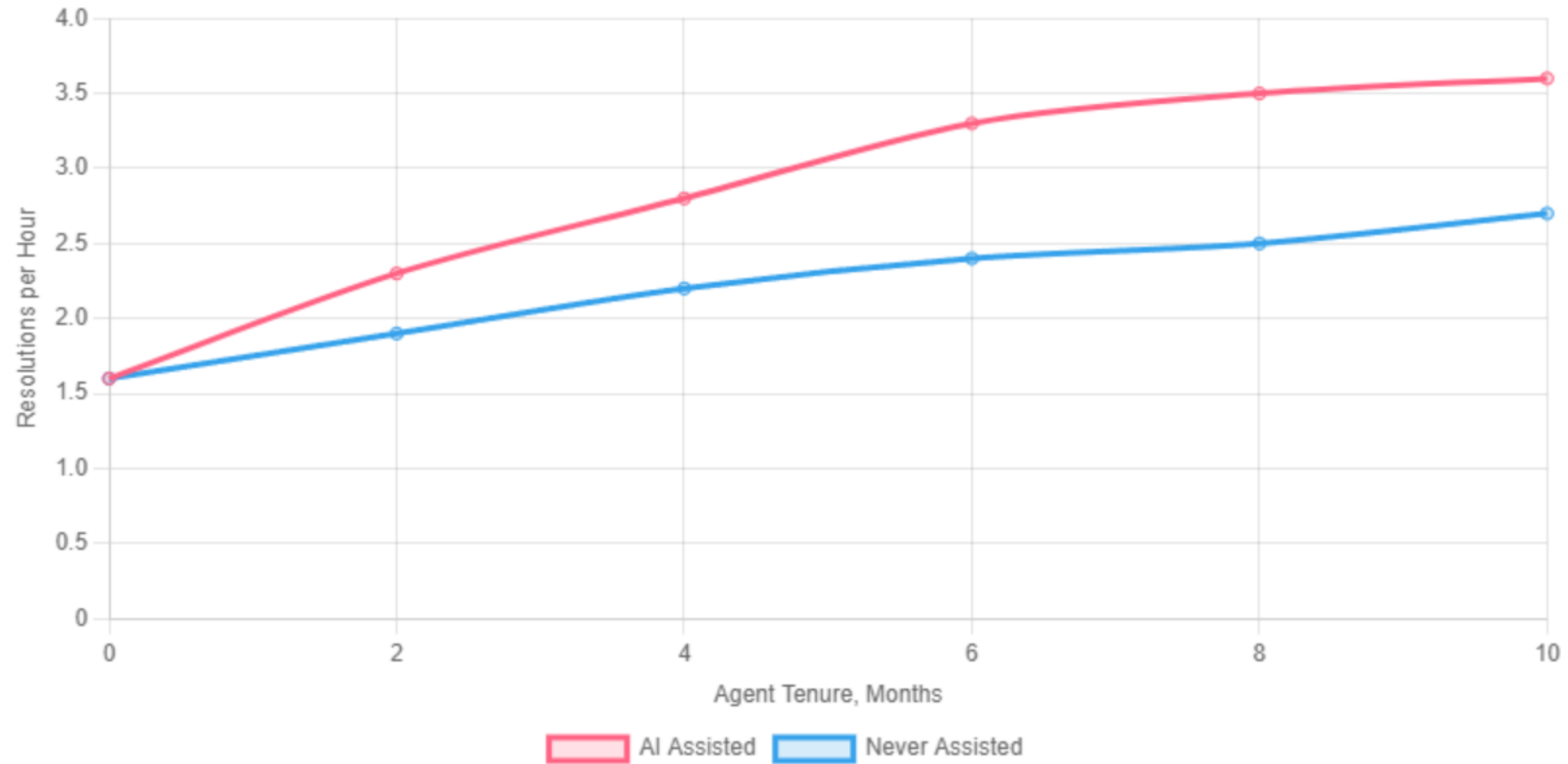
<https://openart.ai/create>

<https://hotpot.ai/art-generator>

The impact of GenAI

- OpenAI's research estimates that 80% of current work activities can integrate generative AI technologies and capabilities.
- McKinsey's research indicates that generative AI and other technologies have the potential to automate 60% to 70% of the tasks that currently occupy employees' time.
- In a study by Resume Builder involving 1,000 executives (including presidents, CEOs, and chairpersons), 91% of respondents stated that they expect job candidates to be proficient in generative AI. The demand for this skill spans various business fields: 58% of respondents work in software engineering, 33% in customer service, 32% in human resources, 31% in marketing, 28% in data entry, and 23% in sales and finance.

AI assistance helps newer agents "catch up"



Evidence from an increasing number of studies

Coding

- Software engineers code up to twice as fast using Codex
- Peng et al. (2023)

Management

- Consultants completed tasks 25% more quickly, and their output was 40% higher quality
- Dell'Acqua et al. (2023)

Writing

- Writing tasks completed twice as fast
- Noy and Zhang (2023)

Diagnosis

- Overall reading times shortened when radiologists used AI
- Shin et al. (2023)

- Others: productivity, creativity, job satisfaction

Jensen Huang, CEO Nvidia

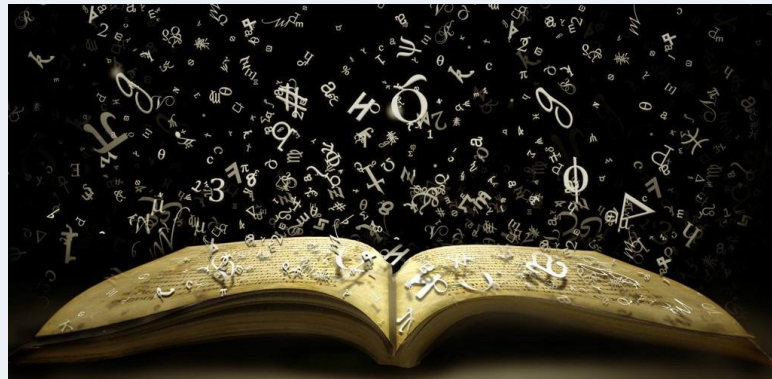
“ AI IS NOT GOING TO TAKE YOUR JOB. THE PERSON WHO USES AI WILL. USE AI AS FAST AS YOU CAN, SO THAT YOU CAN STAY GAINFULLY EMPLOYED.

”

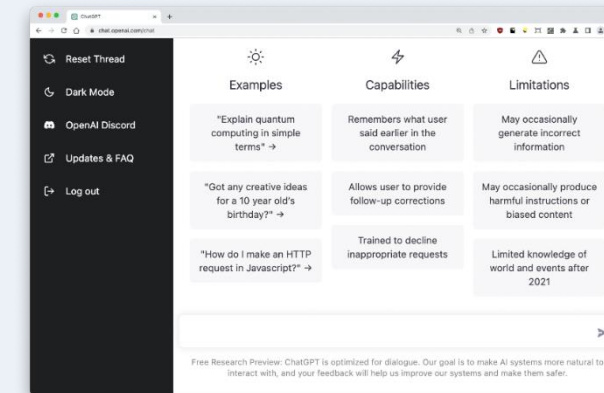
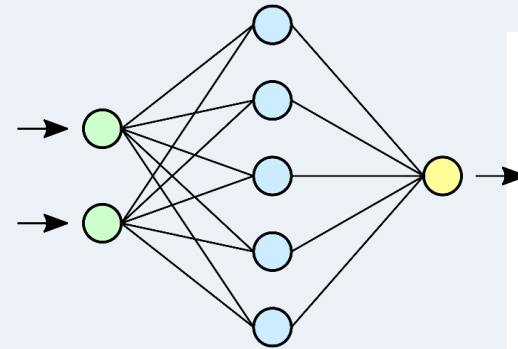


ChatGPT

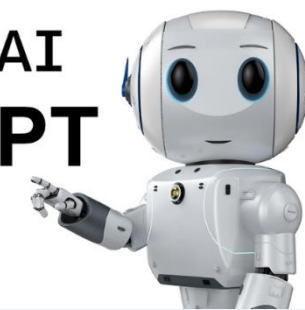
Text from web pages, books, articles,
and social gossip Unsupervised learning



GPT is a series of
language models based on
neural network
architecture.



OpenAI
ChatGPT



ChatGPT stands for "Chat Generative Pre-trained Transformer". It is an AI language model developed by OpenAI. The main purpose of ChatGPT is to generate human-like text responses in a conversational manner.

How does a large language model work?

1. Architecture:

- Based on the Transformer architecture, which uses self-attention mechanisms.
- Consists of multiple layers of neural networks with billions of parameters.

2. Pre-training:

- Trained on vast amounts of text data from the internet, books, and other sources.
- Learn patterns, relationships, and structures in language without specific tasks.

3. Unsupervised Learning:

- During pre-training, the model predicts the next word given the previous words.
- This allows it to learn grammar, facts, reasoning, and even some level of common sense.

4. Tokenization:

- Text is broken down into tokens (words or subwords).
- The model processes and generates text token by token.

5. Contextual Understanding:

- Uses attention mechanisms to weigh the importance of different parts of the input.
- Can understand context over long sequences of text.

6. Fine-tuning:

- Can be further trained on specific tasks or domains for better performance.

7. Inference:

- When given a prompt, the model generates text by predicting the most likely next token repeatedly.

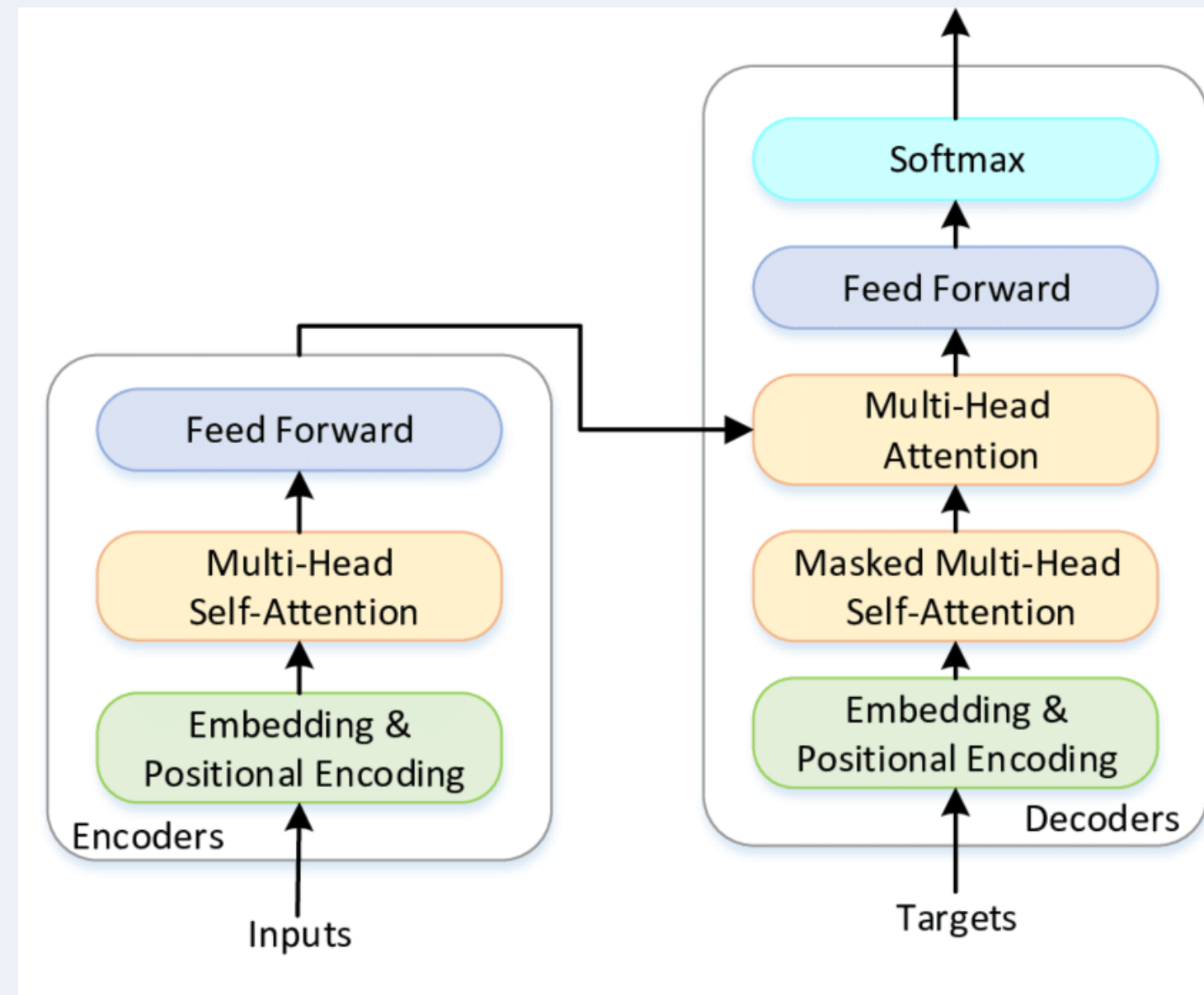
8. Zero-shot and Few-shot Learning:

- Can perform tasks without specific training, using learned patterns and instructions in the prompt.

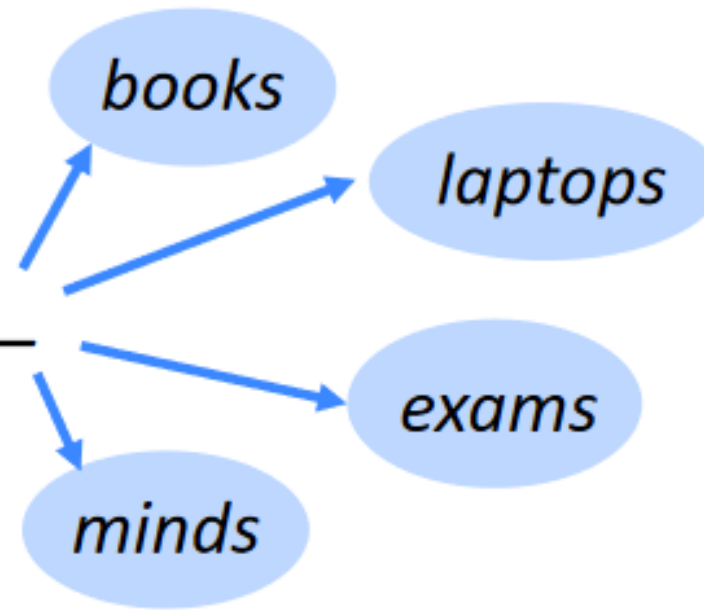
Understanding Transformer Models: The Orchestra Analogy

Transformer Models explained:

- **The Orchestra (Input):** Each word is like a musician
 - **The Conductor (Attention Mechanism):**
 - Decides which musicians (words) to focus on
 - Coordinates how they interact with each other
 - **The Performance (Processing):**
 - Each musician plays in context of others
 - Creates a harmonious output (understanding)
 - **Multiple Conductors (Multi-Head Attention):**
 - Different conductors focus on various aspects
 - Combines multiple perspectives for rich understanding
- **Result:** Ability to understand complex language contexts and generate coherent responses
This allows for powerful language understanding and generation capabilities.



the students opened their _____



- What about images and sounds? How do multimodal LLMs work?



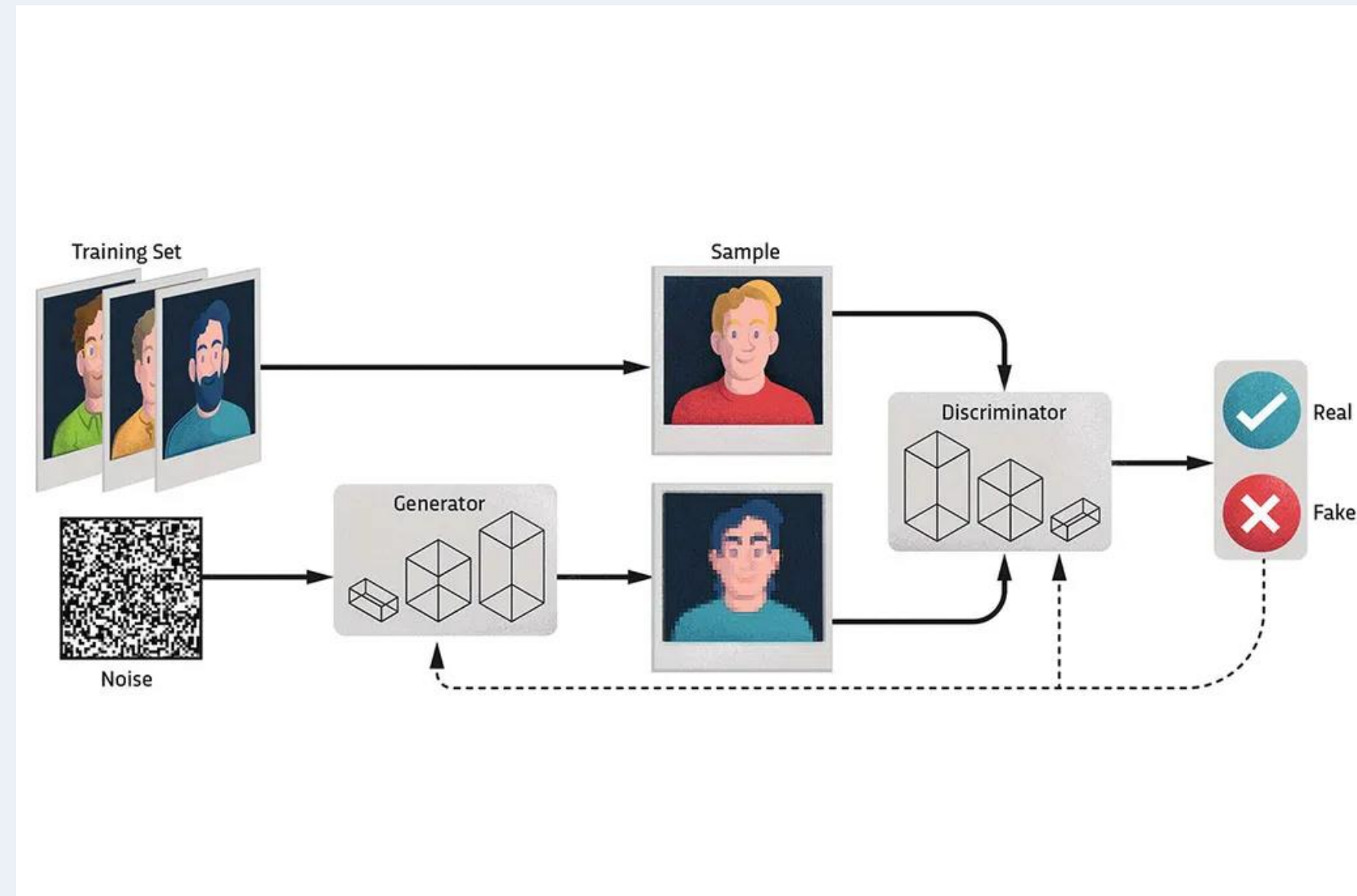
Understanding GANs: The Art Forgery Analogy

Generative Adversarial Networks (GANs) explained:

- **The Forger (Generator):** Creates fake artwork
- **The Detective (Discriminator):** Tries to spot fakes
- **The Process:**
 - Forger creates fake art
 - Detective examines both real and fake art
 - Forger learns from feedback to improve fakes
 - Detective gets better at spotting fakes

• **Result:** Forger becomes so good that fakes are indistinguishable from real art

This competitive process leads to the creation of highly realistic artificial data or images.



Understanding Diffusion Models: The Dust Cloud Analogy

Diffusion Models explained:

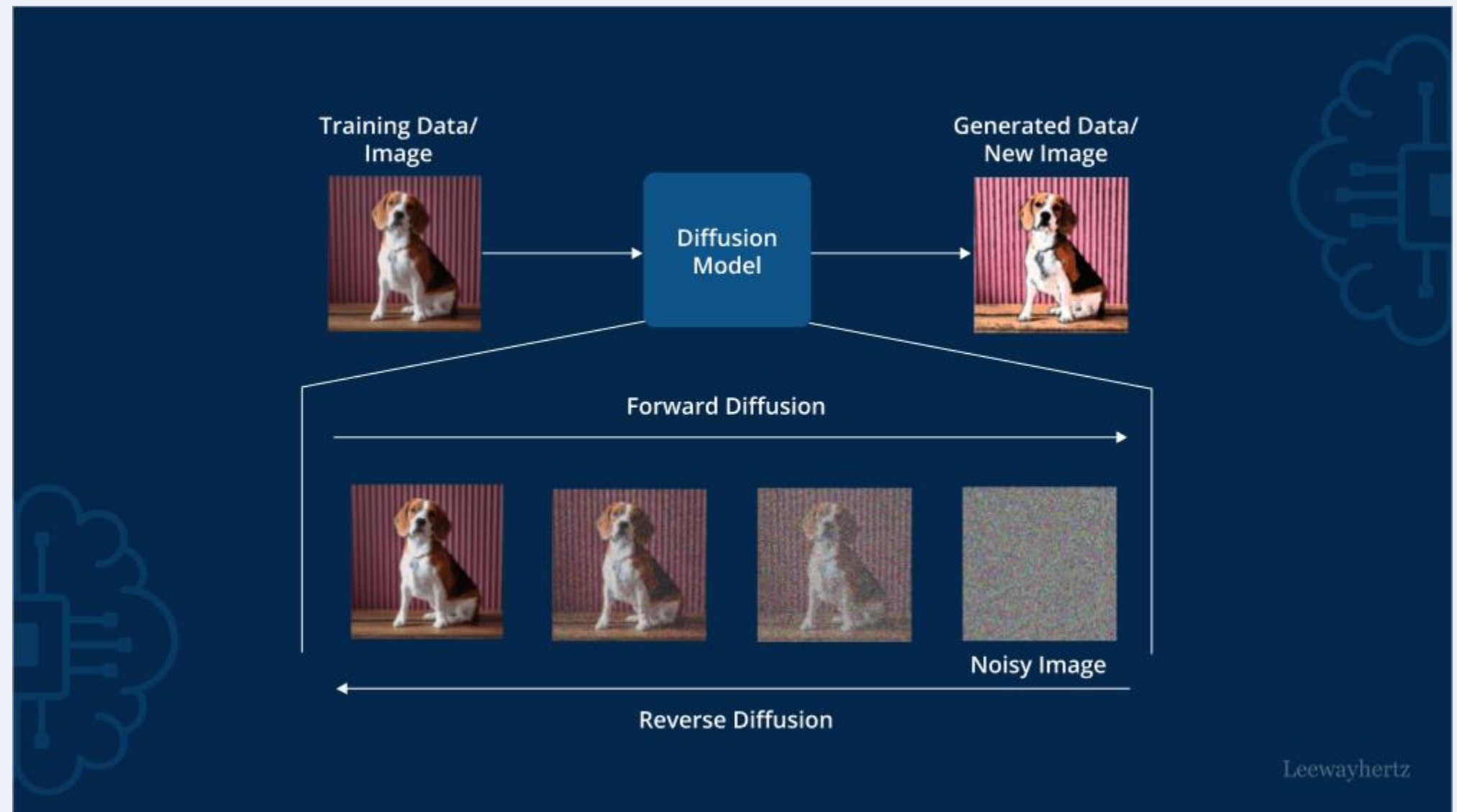
•The Process:

- Start with a clear image
- Gradually add "noise" (like dust)
- Image becomes increasingly blurry
- AI learns to reverse this process

•Generation:

- Begin with pure noise (dust cloud)
- AI gradually removes "dust"
- A clear image emerges step-by-step

•**Result:** AI can create new, realistic images by "de-noising" random noise
This process allows for controlled, high-quality image generation.



LEARN MORE 

<https://www.leewayhertz.com/diffusion-models/>

Leewayhertz

Models and techniques

Generative Adversarial Networks (GANs)

Diffusion models

Transformer

Variational Autoencoders (VAEs)

Retrieval-Augmented Generation (RAG)

Recurrent Neural Networks (RNNs)

Autoregressive Models

Convolutional neural networks (CNNs)

Memory Neural Networks (MNNs)

...



The history of Generative AI

The history of GenAI

1960s: ELIZA chatbot

1980-1990s: Development of neural networks

2000s: Rise of deep learning

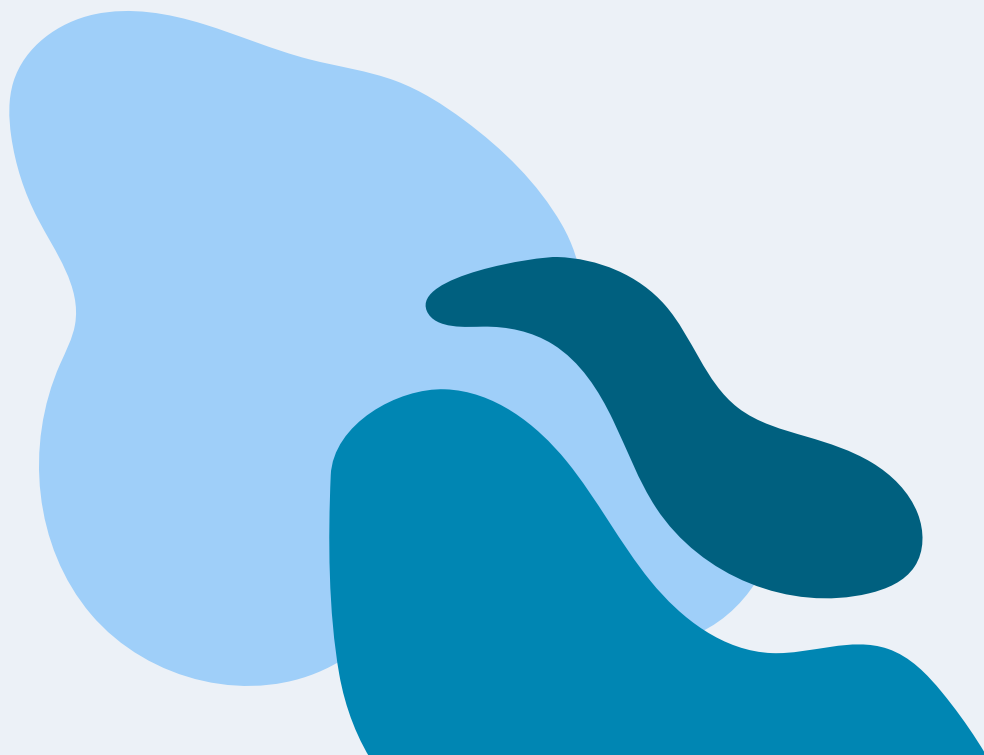
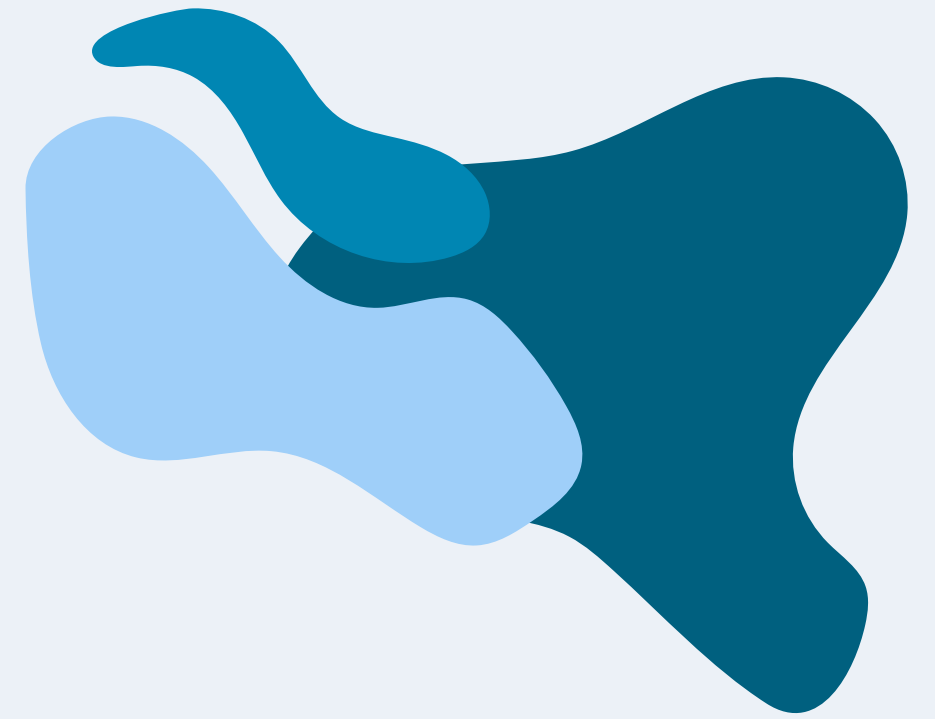
2014: Introduction of Generative Adversarial Networks (GANs)

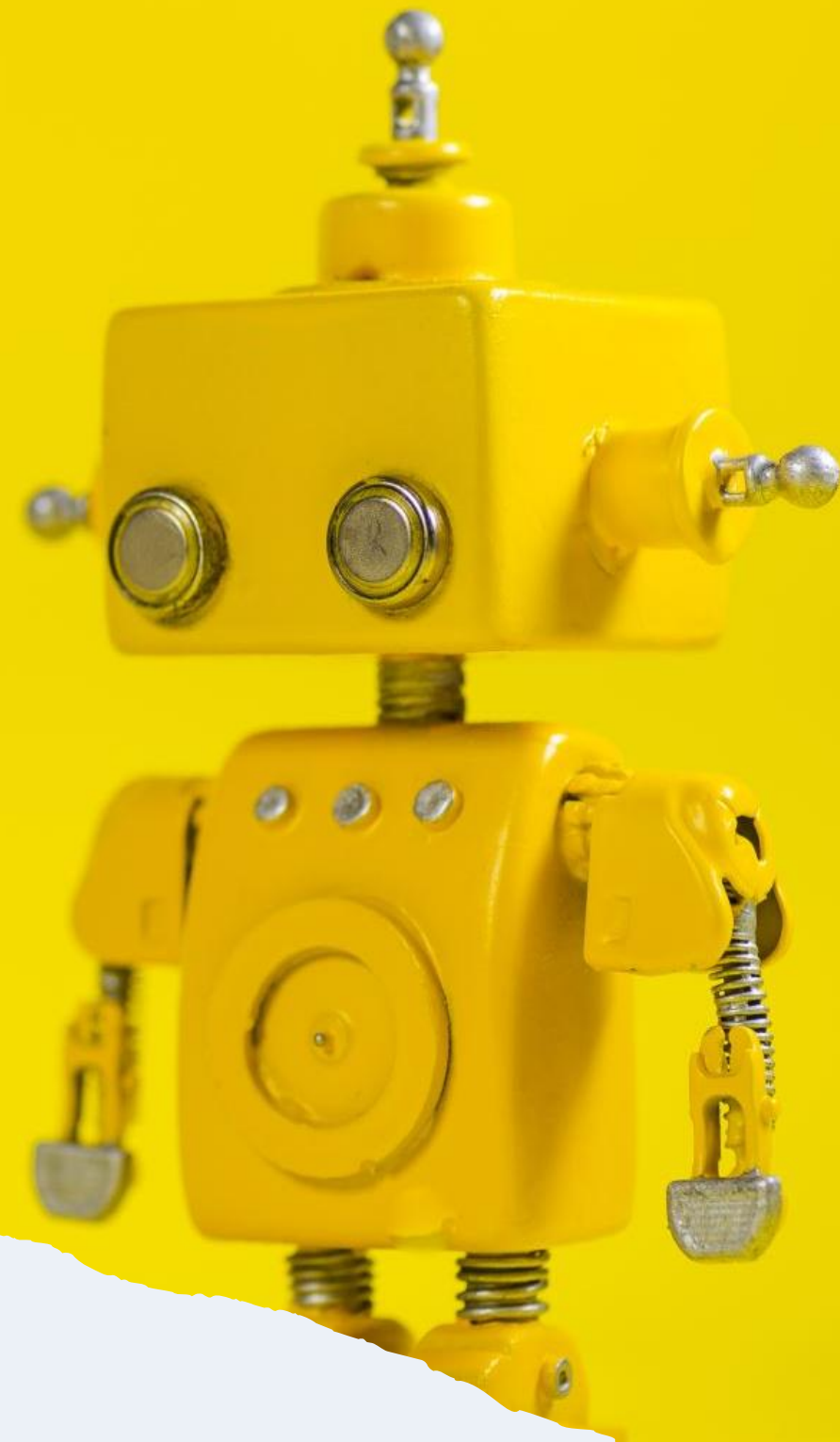
2015: Emergence of Diffusion models

2020: Release of GPT-3

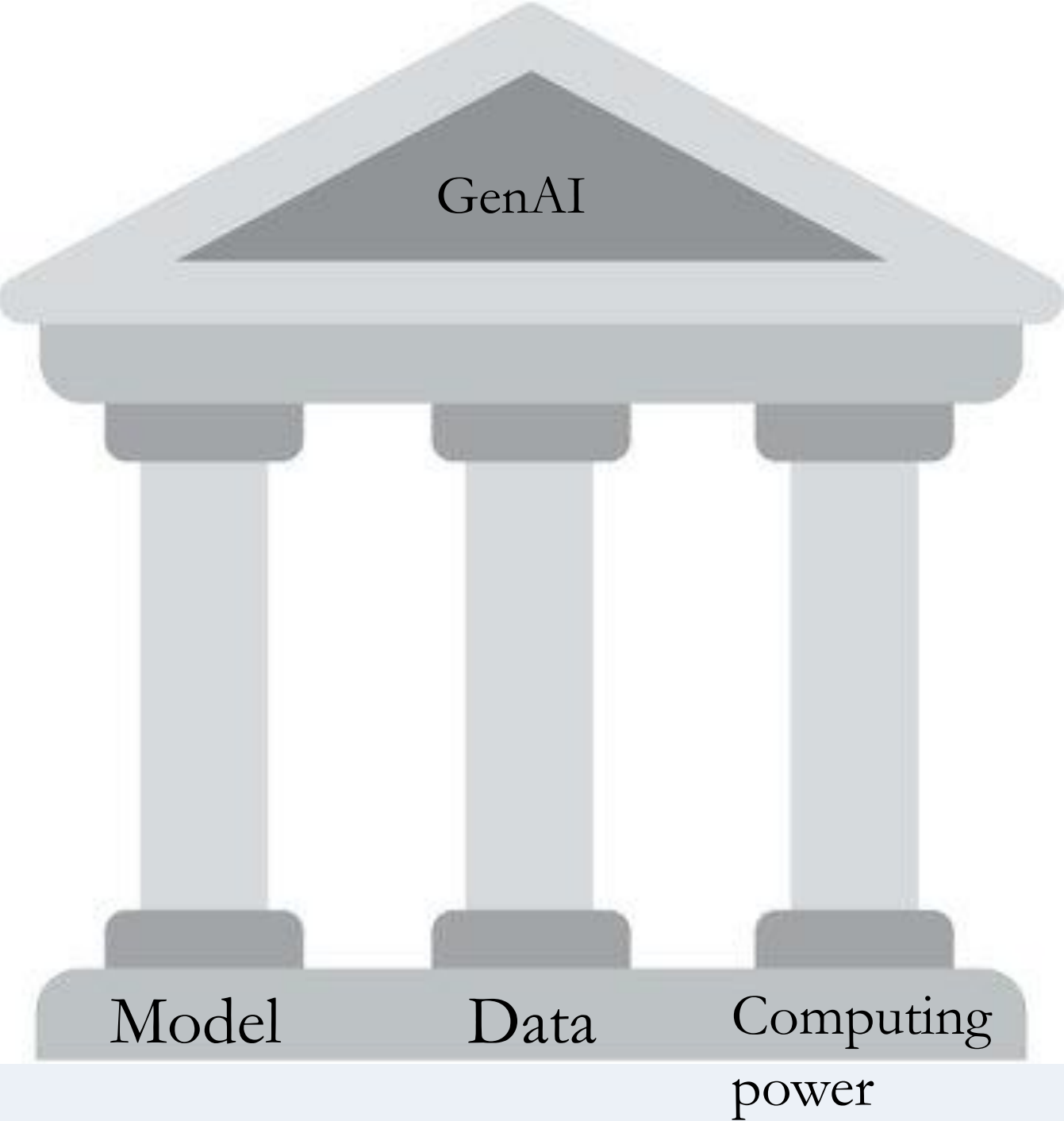
2022: Release of GPT-3.5

2023: Explosion of various GenAI models



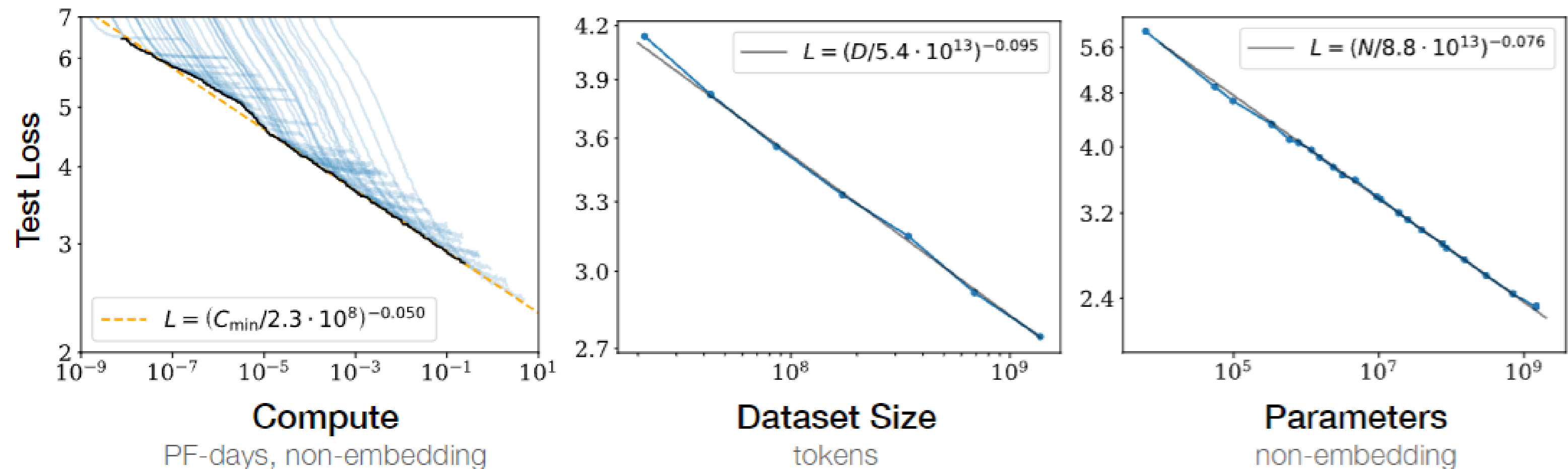


Why is generative AI only emerging now ?



- Language modeling performance improves smoothly as we increase the model size, dataset size, and amount of compute used for training. For optimal performance all three factors need to scale up in tandem. Empirical performance has a power-law relationship with each individual factor when not bottlenecked by the other two.

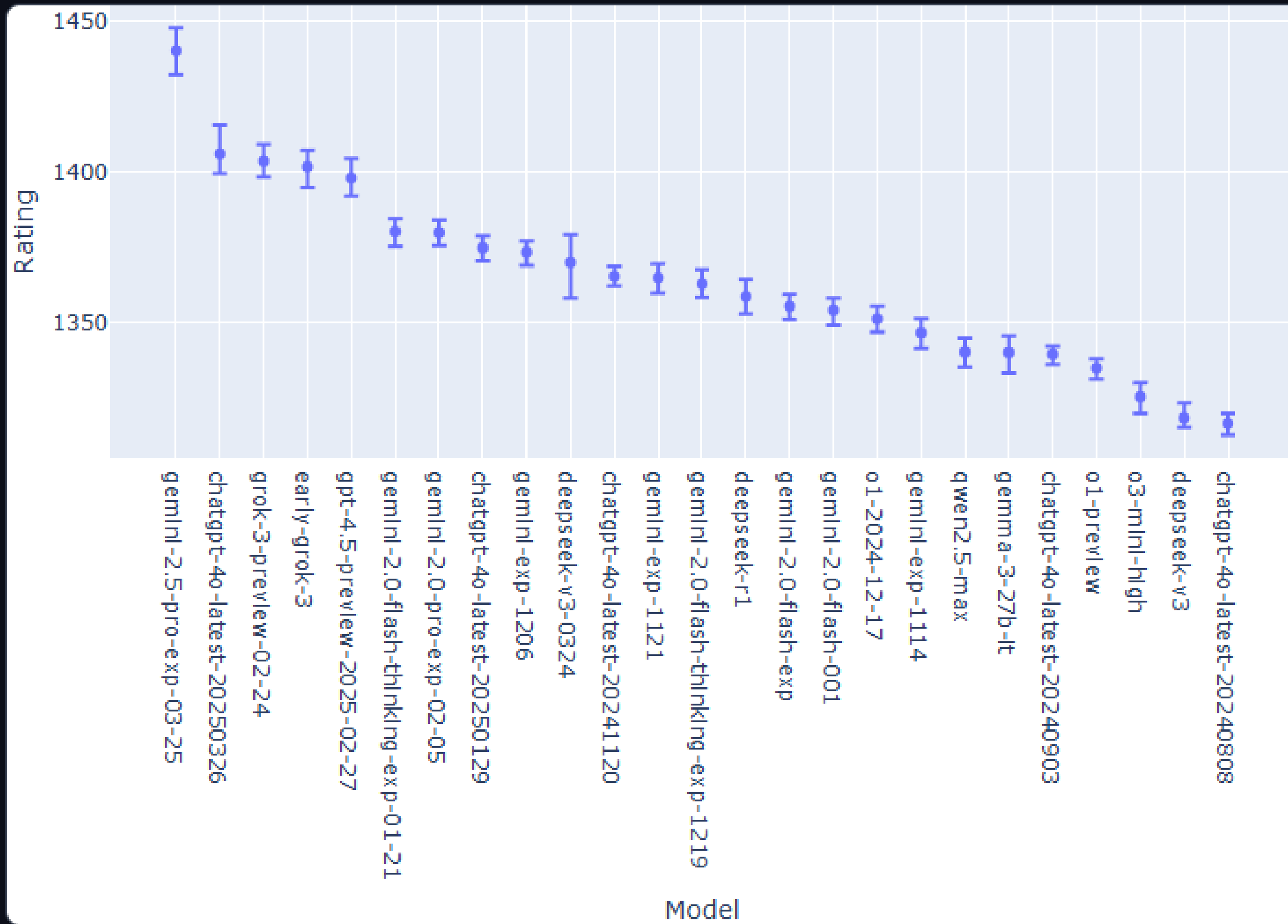
- arXiv: Scaling Laws for Neural Language Models

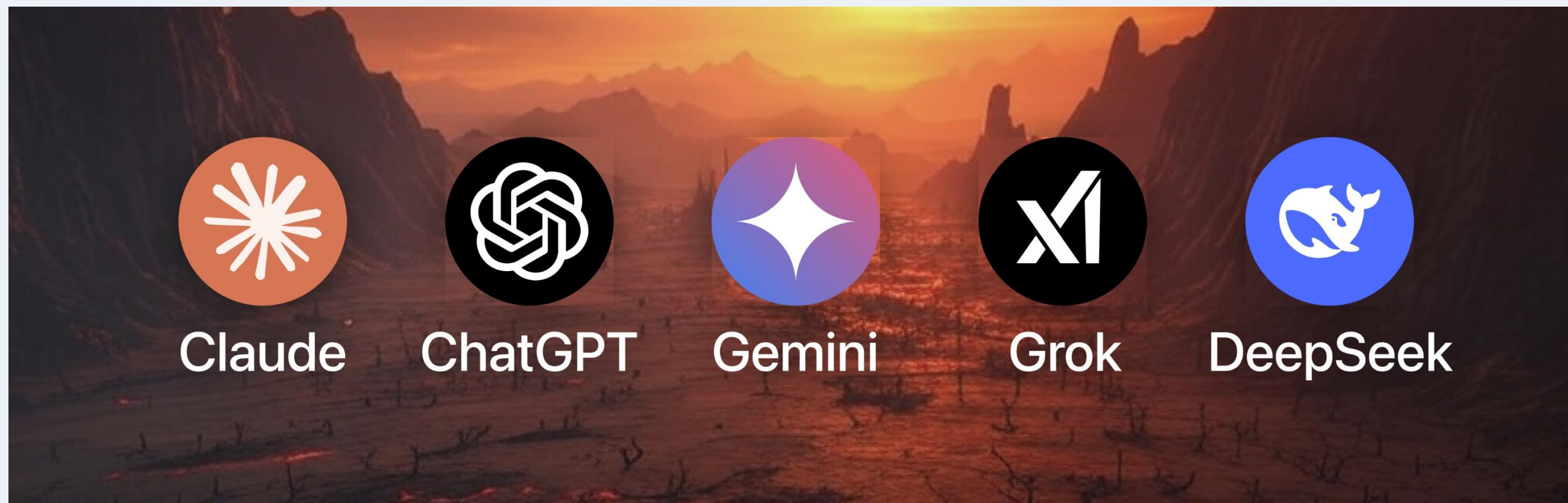




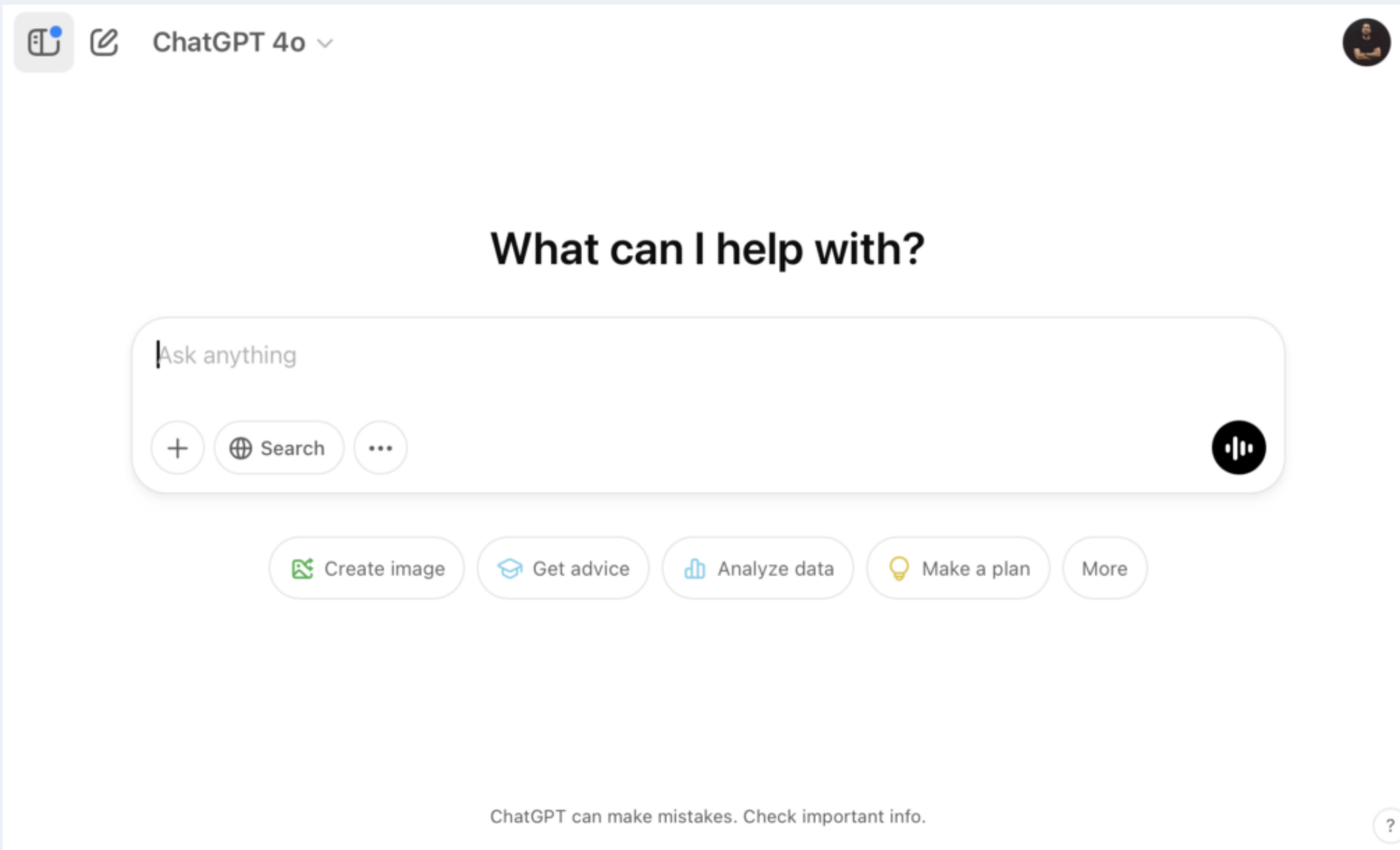
The Current Development of GenAI

Figure 1: Confidence Intervals on Model Strength (via Bootstrapping)





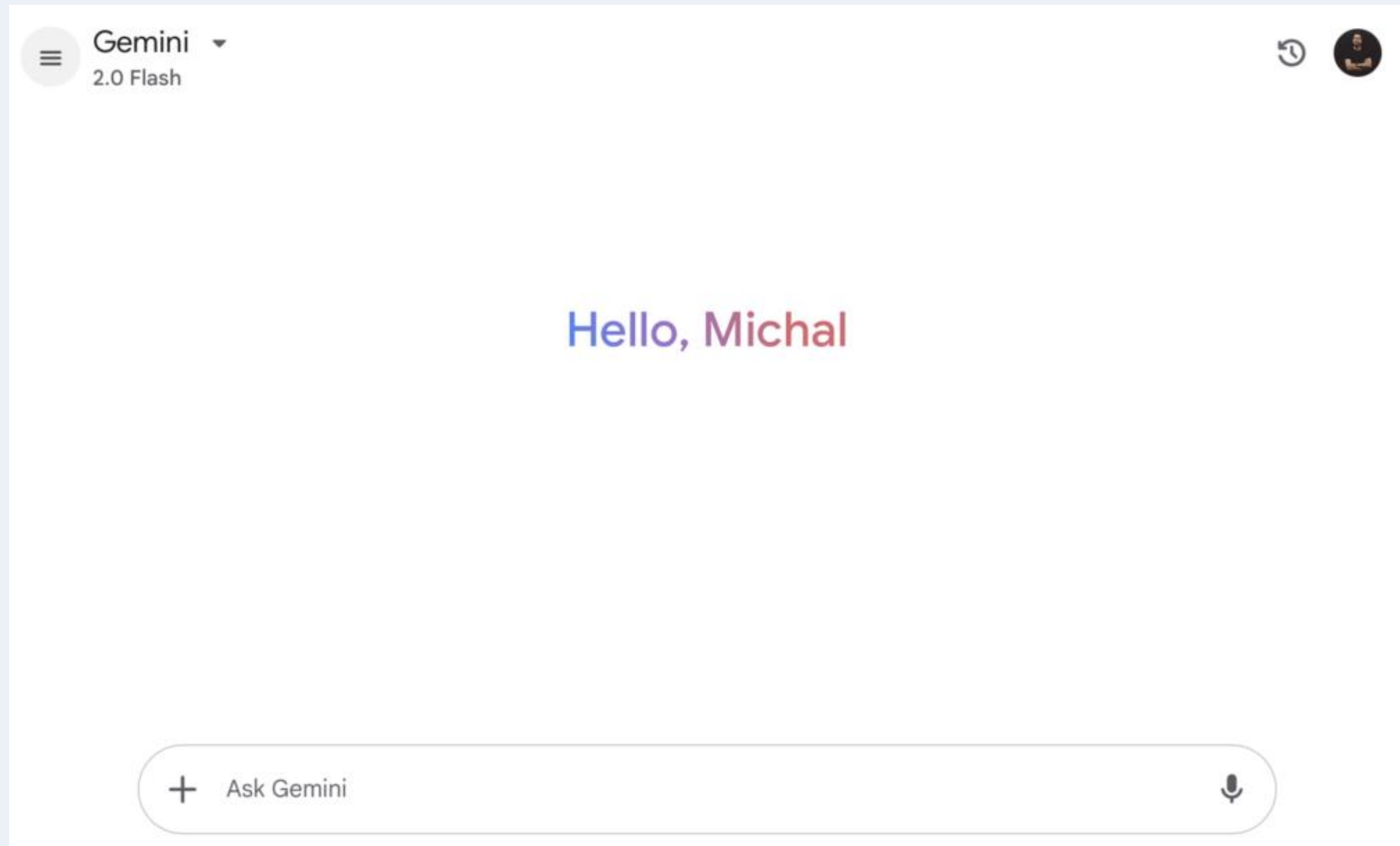
OpenAI GPT



Search
Deep Search
Interactive mode
Canva
Operator
Customized GPT

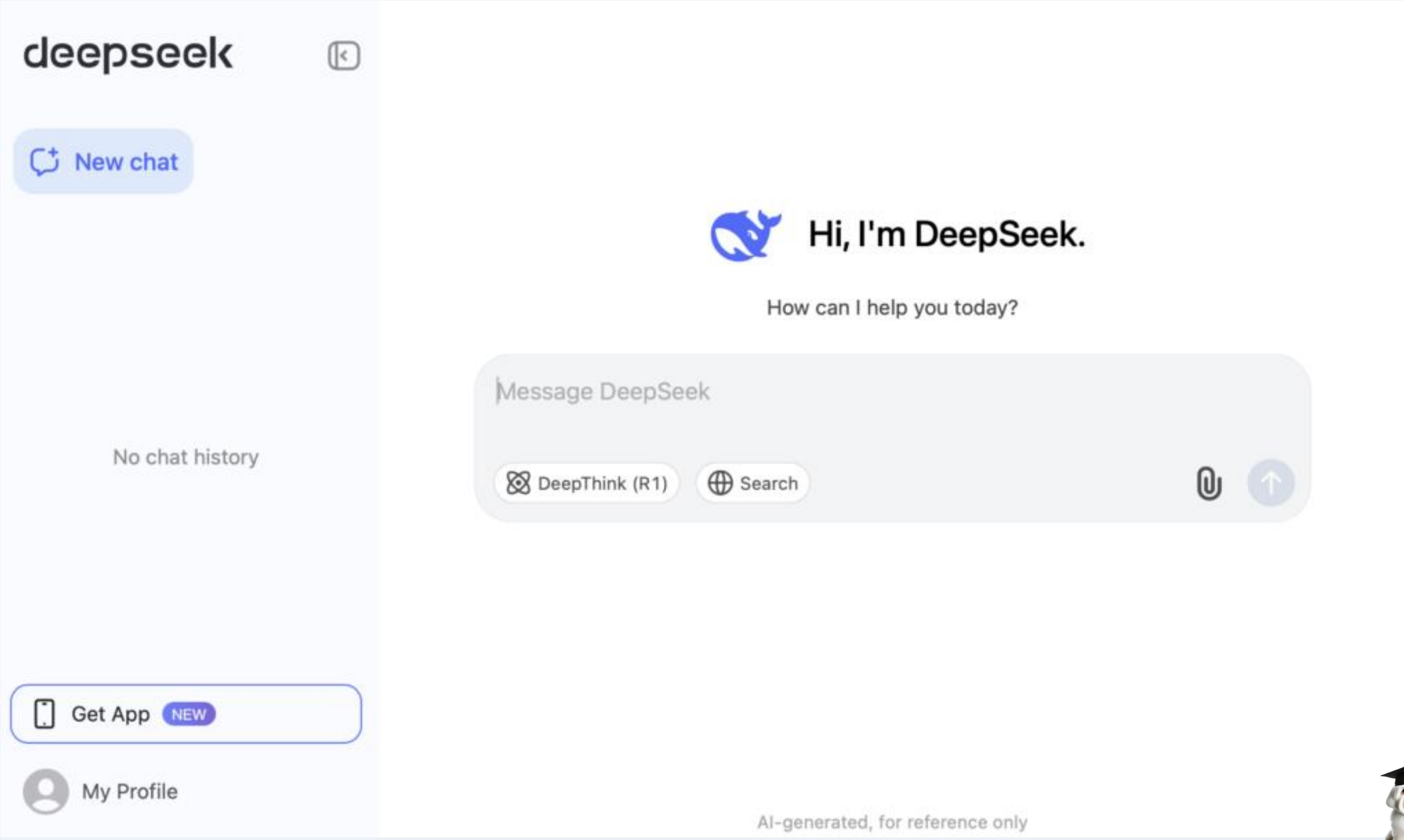


Gemini

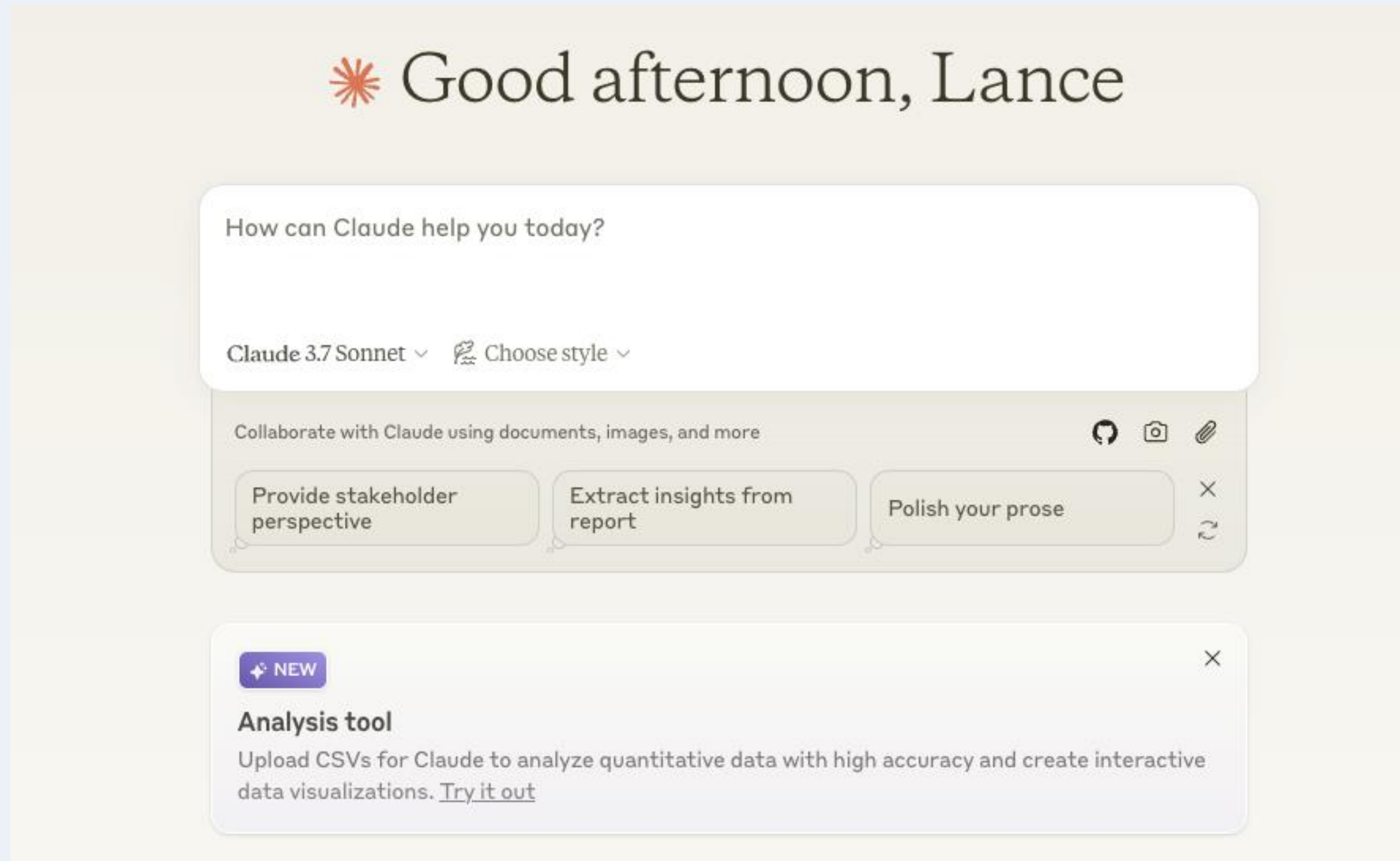


Efficient (low cost and fast)
Notebook LM
Co-scientist
Learn about

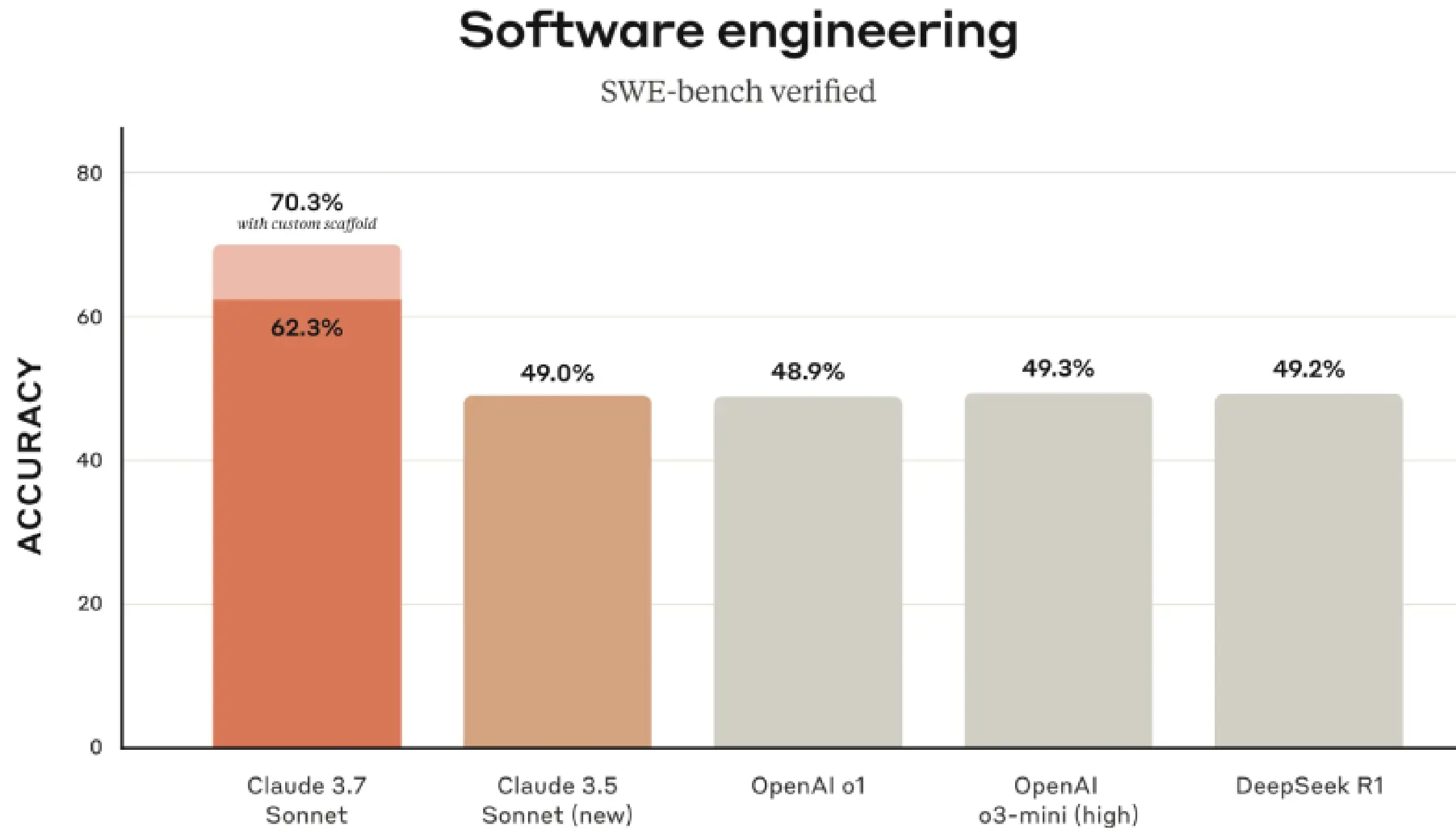
Deepseek R1



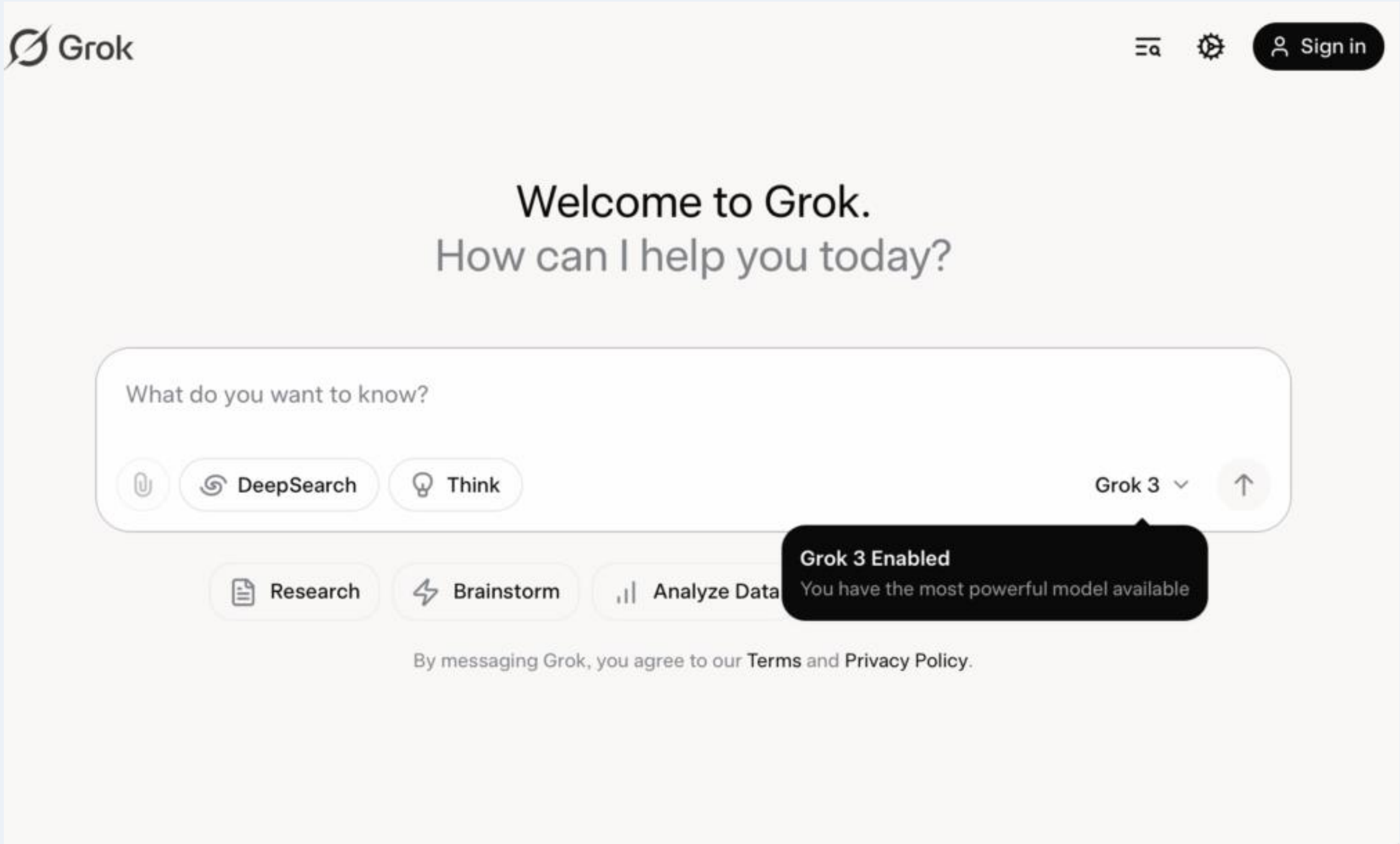
Claude 3.7



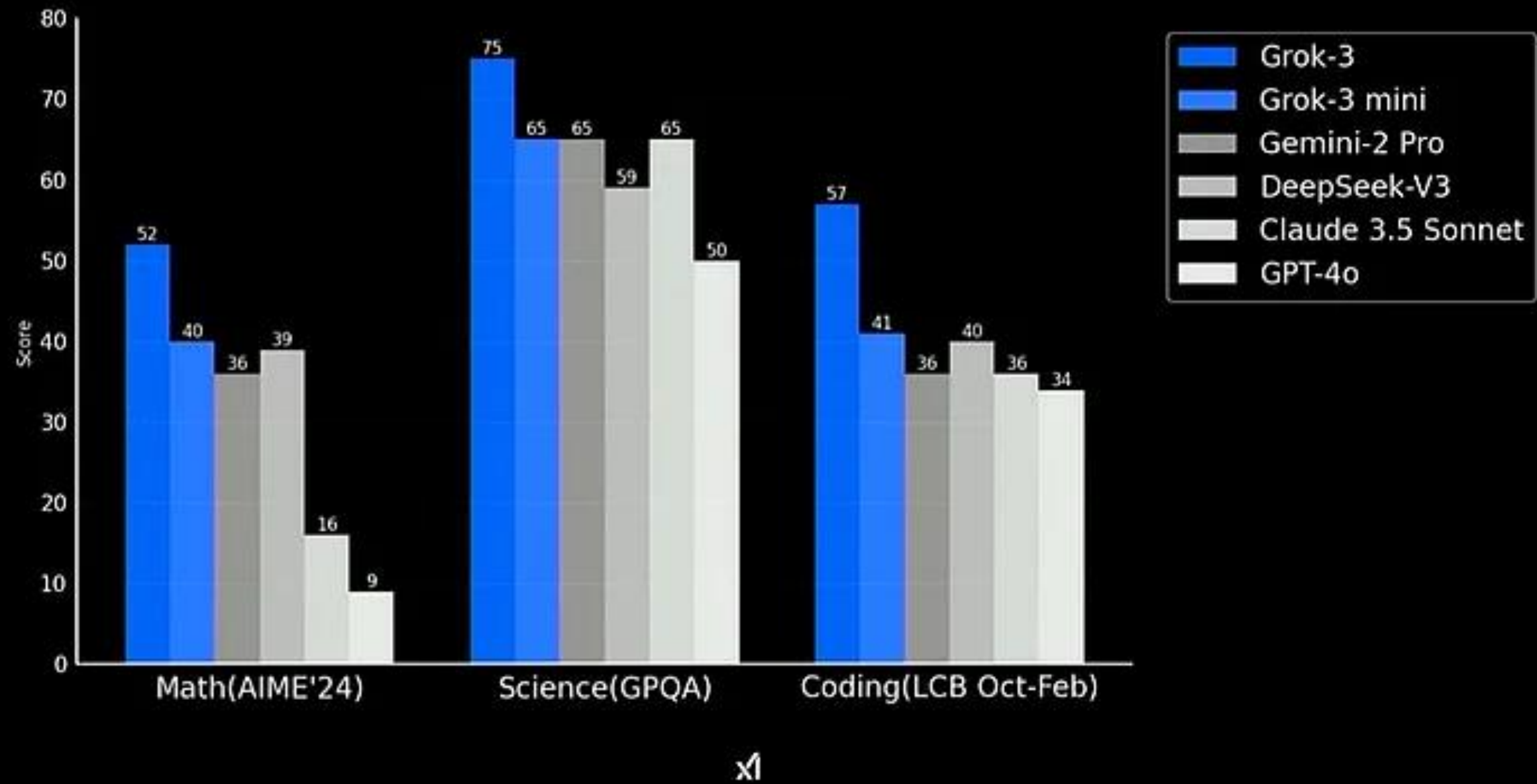
Claude 3.7



Grok 3



Benchmarks



Generative AI Applications

Text Generation:

- Utilizes large language models to generate contextually relevant text
- Can be used for tasks such as dialogue, explanation, summarization, etc.

Image Generation:

- Uses techniques like GANs and VAEs to generate high-quality, realistic images
- Applied in fields such as art, design, entertainment, etc.

Audio Generation:

- Creates music, text-to-speech, synthesized voices
- Applied in media, entertainment, education, and other fields

Generative AI Applications

Video Generation:

- Creates dynamic videos based on text descriptions or images
- Applied in fields such as art, entertainment, education, healthcare, etc.

Code Generation:

- Generates code snippets, functions, or complete programs
- Assists in software development, debugging, and testing

Data Generation and Augmentation:

- Generates synthetic data, enhances existing datasets
- Applied in healthcare, gaming, education, autonomous driving, and other fields

Virtual World Creation:

- Creates realistic virtual environments and virtual characters
- Applied in gaming, entertainment, education, metaverse platforms, etc.

Human-GenAI communication

- Prompt engineering is the practice of designing inputs for generative AI tools that will produce optimal outputs (Mckinsey, 2024)
- Say something that AI can easily understand and follow!

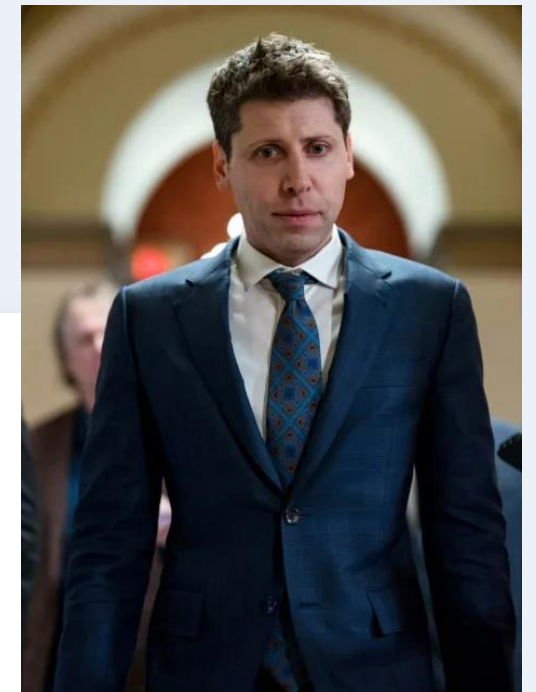


Technique	Description
Zero-shot Prompting	Directly asking questions without providing examples, relying on the AI's pre-trained knowledge.
Few-shot Prompting	Providing a few examples before the main question to guide the AI's response format and style.
Chain of Thought (CoT)	Encouraging AI to show step-by-step reasoning for problem-solving, improving transparency and accuracy.
Tree of Thought (ToT)	Exploring multiple reasoning paths, similar to a decision tree, for more comprehensive solutions.
Self-consistency	Generating multiple independent solutions and choosing the most common or reasonable answer.
Prompt Templates	Using standardized prompt structures with placeholders for specific content, ensuring consistency.
Role-playing Prompts	Asking AI to assume specific roles or personas to provide specialized perspectives.
Step-by-step Prompting	Breaking complex tasks into a series of simple steps, guiding AI through each stage.
Reverse Prompting	Asking AI to generate prompts that would lead to a specific output, exploring AI's associative logic.
AI Interview Technique	Simulating an interview process where AI asks a series of questions to gather detailed information.
Thought Provocation	Using open-ended questions or hypothetical scenarios to stimulate creative thinking.
Meta-prompting	Using prompts to generate or improve other prompts, optimizing AI interaction strategies.

Sam Altman 24, Sep, 2024

“ AI SUPERINTELLIGENCE COULD BE JUST ‘A
FEW THOUSAND DAYS’ AWAY

”





How can GenAI help
my research?

Use cases in academic research

- Created an app to reply to students' email
- Convert a word document into a latex to fit a journal submission guideline
- Use browser use to collect email address of target researchers
- Use deep research to find reviewers relevant to my works
- Created a customized assistant to search relevant scales
- Using LLMs to annotate text data
- Create synthetic data
- Generate realistic experimental materials
- ...

Discussions



What can be problematic with LLMs?

Yan Tao, Olga Viberg, Ryan S Baker, René F Kizilcec,
Cultural bias and cultural alignment of large language
models, PNAS Nexus, Volume 3, Issue 9, September 2024,
pgae346, <https://doi.org/10.1093/pnasnexus/pgae346>

Gullibility (machine heuristics)

when you need advice but aren't sure who to trust



Other issues

1. No accountability
2. Plagiarism, ownership
3. Over-dependence
4. Produce negative self-perception: Dehumanization, unethical behavior, impaired memory



Working with Ghosts in the Machine: Generative AI and the Dehumanization of Self

Shubin Yu, Associate Professor,
BI Norwegian Business School

Soojin Roh, Assistant Professor,
Peking University HSBC Business School



Norwegian
Business School



PHBS
Peking University
HSBC Business School

Study 1: Method

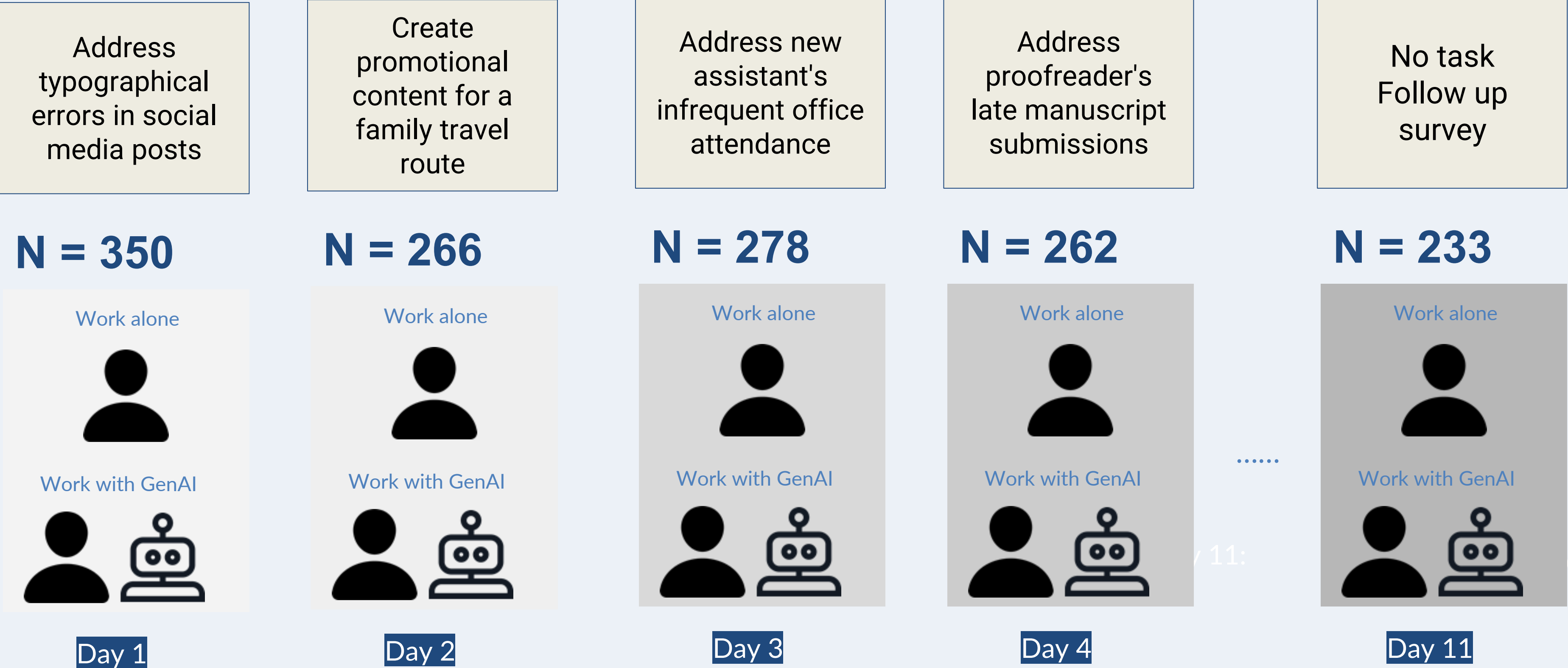
Design:

- Single factor (Work with GenAI vs. Work alone) online field study
- Work with GenAI: Use GenAI chatbots (e.g., Yiyan, Qwen, Kimi) for assistance
- Work alone: Complete task independently without GenAI tools

Participants:

- 350 participants from Credamo
- Gender: 169 males, 181 females
- Mean age: 30.07 years (SD = 17.9)
- No prior GenAI experience

Daily Participation and tasks





Self-dehumanization assessed daily (mechanistic dehumanization scale, Haslem et al., 2005; Costello and Hodson, 2010).

"I feel like I am emotional" (reverse coded), "I feel like I am robotic", "I feel like I am connected to other people" (reverse coded)...

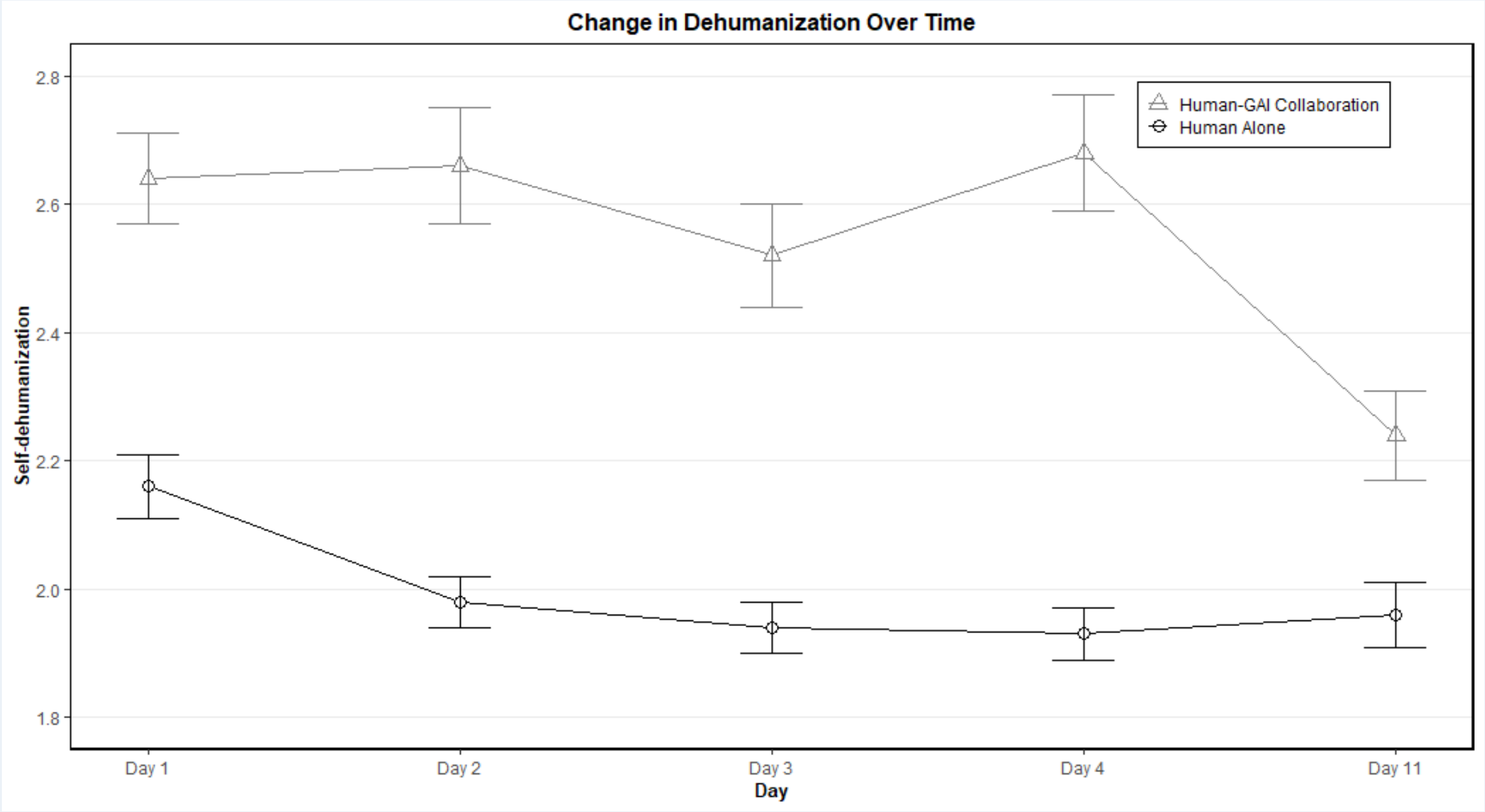
Unethical behavior measured on Day 11 (Kouchaki et al., 2018; Valdesolo & DeSteno, 2007)

Willingness to impose harder tasks on others

- Participants briefed on a forthcoming performance task. Informed they would be paired with another Credamo participant
- Two tasks available: data entry and recognition task. Participants responsible for allocating tasks between self and partner
- Data entry task subtly suggested as more burdensome

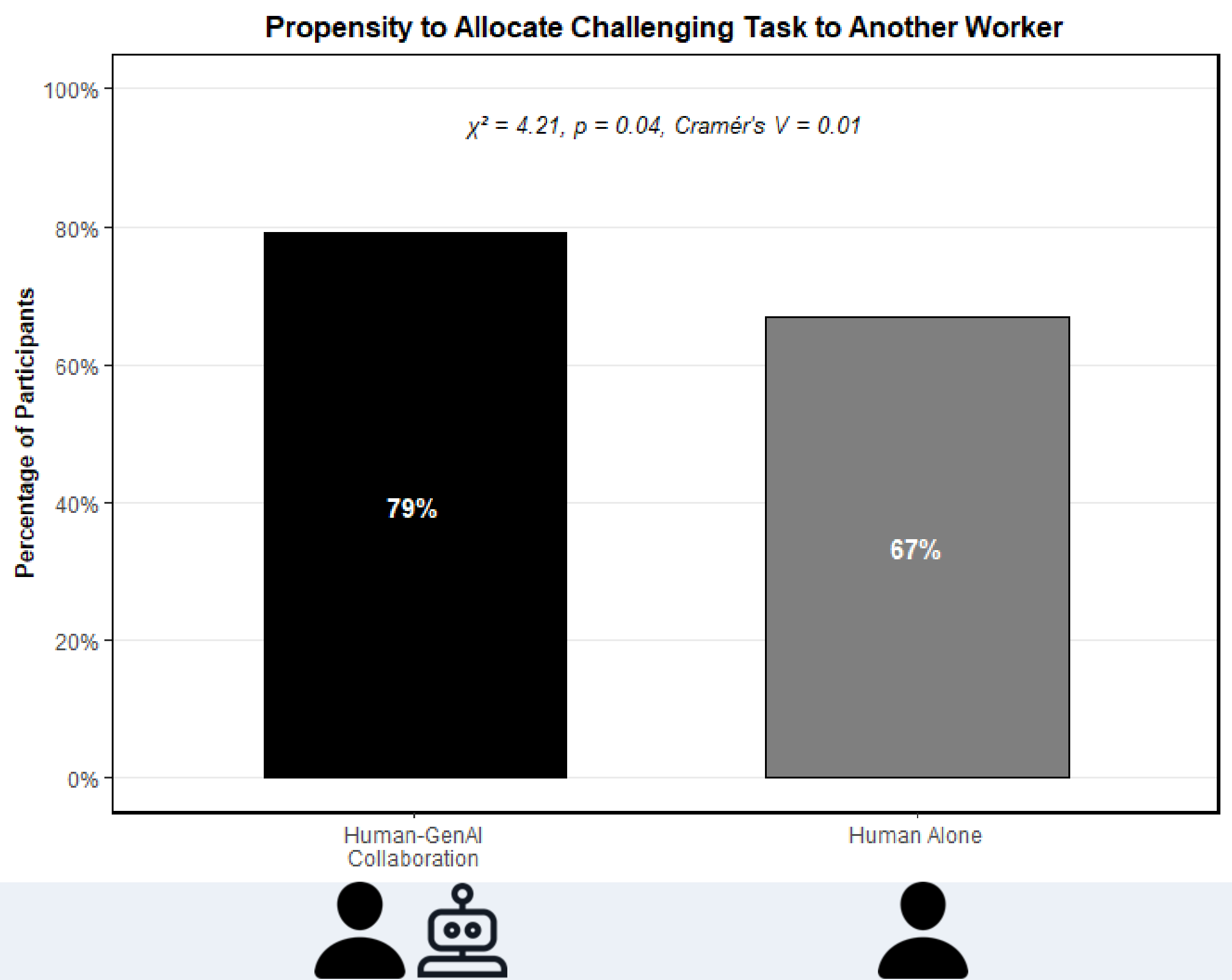


Study 1 Results





Study 1
Results





Generative AI for Research Initiative

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Mimi

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 English

 中文

This initiative collects and evaluates generative AI tools for research. Our focus is on providing a platform for researchers to discover and utilize generative AI technology in their research projects correctly and responsibly. [Bookmark this website now!](#)

Aug 24

Research

Researchers Find AI Chatbot GPT Effective for...

Jul 21

Research

Generative AI for Economic Research: Use Cases and...

Jul 13

Workshop and seminar

Workshop review: Large Language Models (LLMs) in...



 Let's Chat!



Toolkit

Check the comprehensive Generative AI toolkit for effective research



Workshop and seminar

Check the workshop and seminar about generative AI here



Course

Follow a course to develop your skills in using generative AI



Tutorials

Check the recent tutorial for research methods using generative AI



Research

Check recent research findings related to Generative AI



Journal policy

Check journals' policy regarding the use of generative AI in publications

<http://GAIforResearch.com>

Generative AI for
Research



University policy

Check the GenAI policy of top 100 universities around the world



Responsible use

Check the recommendation for responsible and ethical use of generative AI for research



Chat with Mimi

Chat with Mimi to find more specific information about which tool to use for your research

<http://GAIforResearch.com>

Generative AI for Research