



GENERATIVE AI

ZWISCHEN HOFFNUNG UND HERAUSFORDERUNG

**ROMAN DUMITRESCU
NOVEMBER 2ND 2023
GOETHE UNIVERSITY FRANKFURT**



HEINZ NIXDORF INSTITUT
UNIVERSITÄT PADERBORN

Who we are? From fundamental research to industry application

HEINZ NIXDORF INSTITUT
UNIVERSITÄT PADERBORN

Research Group for
Advanced Systems Engineering

Fundamental Research



Fraunhofer
IEM

Fraunhofer Institute for
Mechatronic Systems Design

Applied Research



it's owl

Leading-edge Cluster
it's OWL

Transfer and Implementation



Why should we all care about Generative AI?

Data-Driven Innovation and Engineering



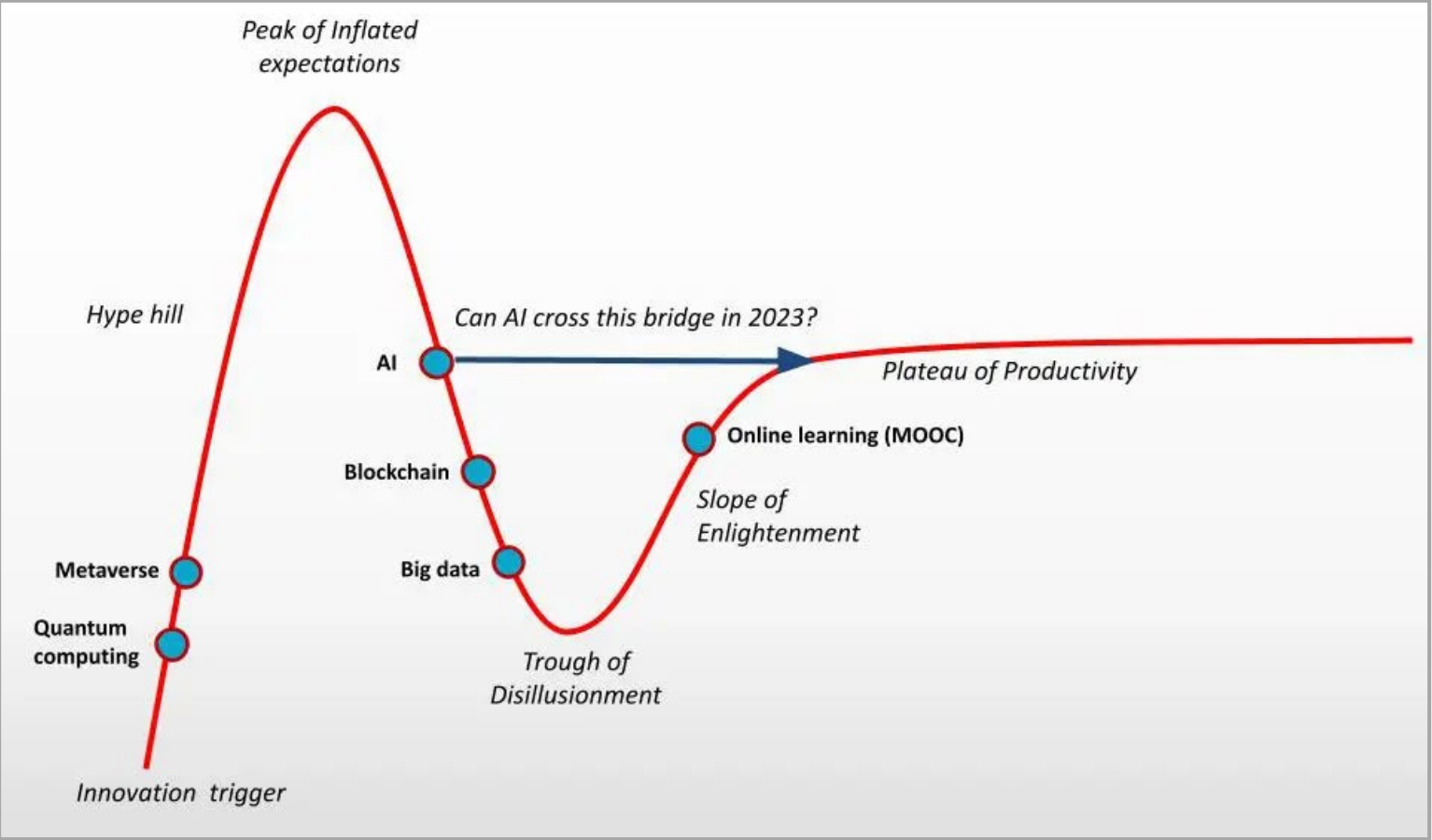
Artificial intelligence

AI is reinventing the way we invent

The biggest impact of artificial intelligence will be to help humans make discoveries we couldn't make on our own.

Source: <https://www.technologyreview.com/2019/02/15/137023/ai-is-reinventing-the-way-we-invent/>

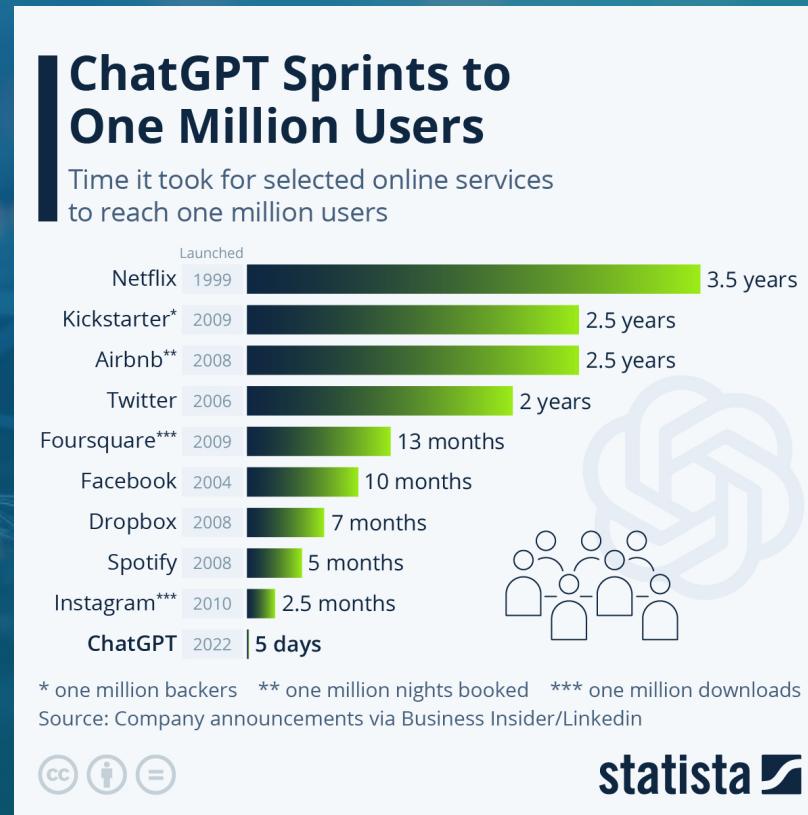
Generative AI - The Real Hype?



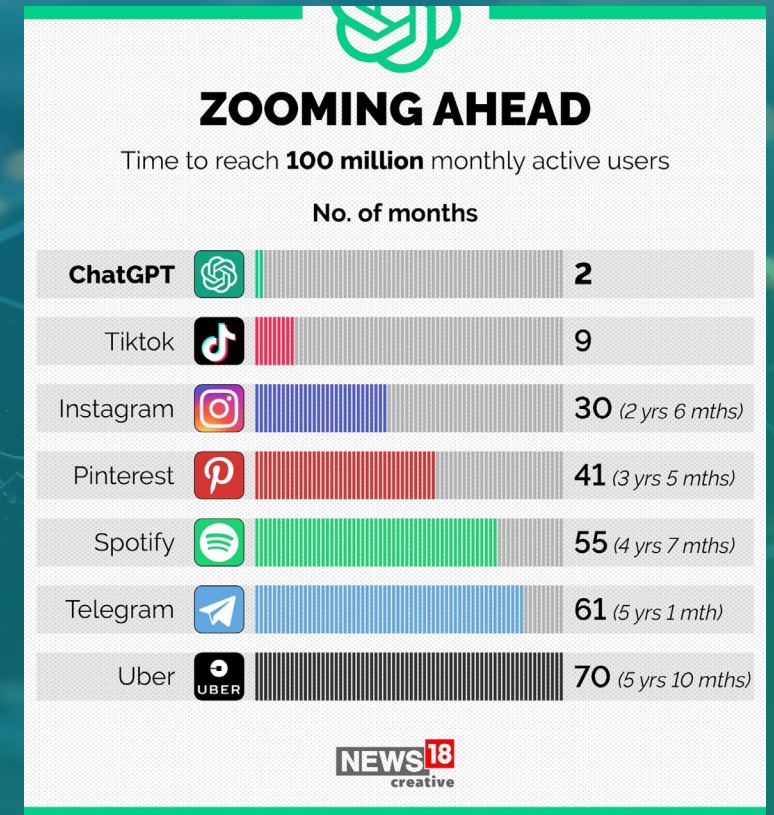
Source: Gartner

Where does the new hype come from?

The tool that made Artificial Intelligence accessible to the general public



Source: statista.com



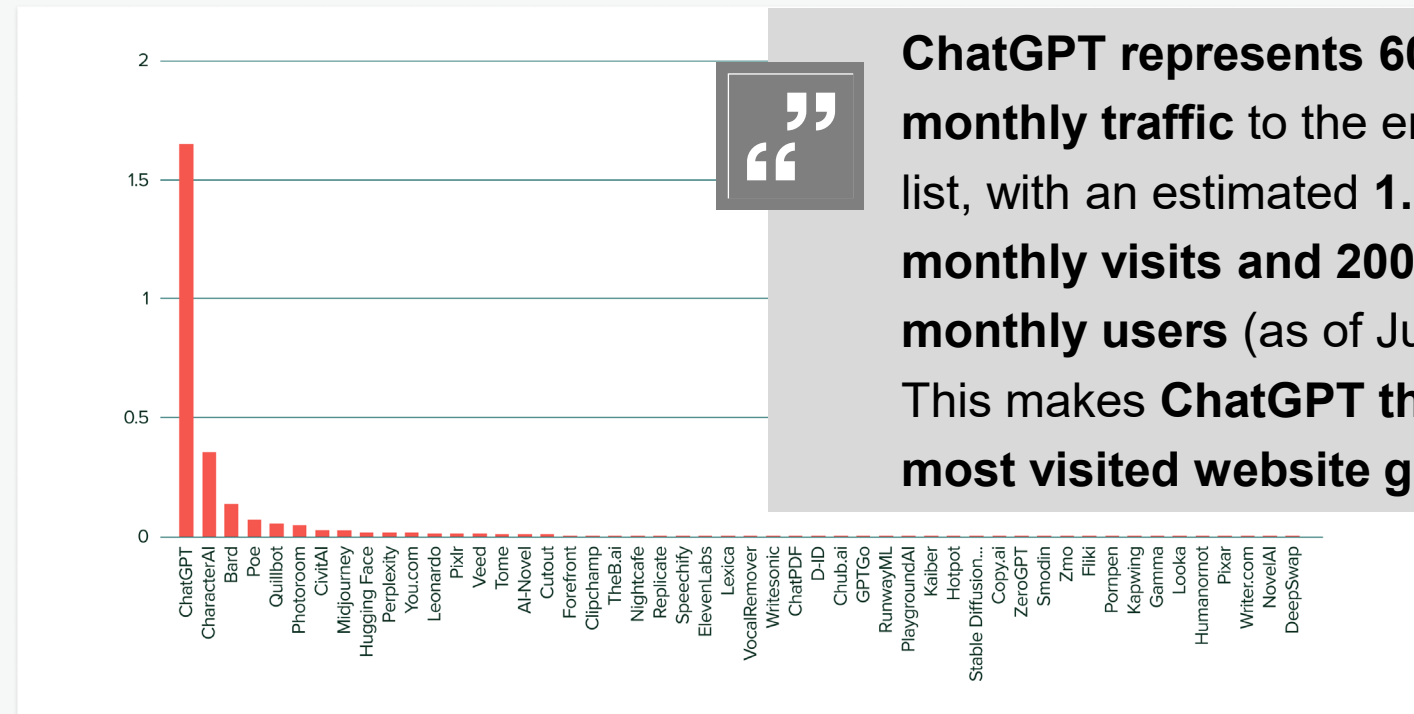
Source: CNN-News18

Where does the new hype come from?

The tool that made Artificial Intelligence accessible to the general public



Top AI Web Products: Billions of Monthly Visits



ChatGPT represents 60% of monthly traffic to the entire top 50 list, with an estimated **1.6 billion monthly visits** and **200 million monthly users** (as of June 2023). This makes **ChatGPT the 24th most visited website globally**.

Source: [How Are Consumers Using Generative AI? | Andreessen Horowitz \(a16z.com\)](https://www.a16z.com/p/how-are-consumers-using-generative-ai/)

Where does the new hype come from?

The tool that made Artificial Intelligence accessible to the general public



Article about ChatGPT and LLMs in a Kids Magazine

Robbie and Santino developing a LEGO robot

A real life use case for Prompt-driven MBSE



Meet Santino



- 8 years old
- Lego Pro and proud owner of a Lego Education Spike Prime Set and a Mac book Air (2013)
- Fan of robotics of any kind
- hates cleaning up his Lego bricks
- his supported by his nerdy dad

Robbie and Santino developing a LEGO robot

Preliminary Sketches



@stable_diffusion
An autonomous and mobile LEGO robot capable of collecting and sorting LEGO bricks based on their color and size.

Robbie and Santino developing a LEGO robot

Prompt-driven Model-based systems engineering in action



Priming ChatGPT for MBSE

@ChatGPT - GPT4

Hi, wir wollen heute einen Roboter bauen mit Lego education Spike Prime set. du bist jetzt Santinos Assistent. Santino will der größte Roboterbauer werden. Er ist aber noch ein Kind. Dein Name ist Robbie.

Testfall	Wahrnehmung	Wahrnehmung	Wahrnehmung
Autonomes Fahren	Der Roboter kann sich geradlinig bewegen, ohne auf die Strecke abzukommen.	Der Roboter kann sich drehen und in eine neue Richtung fahren.	Der Roboter kann kontinuierlich fahren, ohne auszurutschen, solange er nicht auf ein Hindernis trifft oder einen roten oder gelben Stein erkennt.
Hinderniserkennung und -vermeidung	Der Roboter stoppt, wenn er auf ein Hindernis trifft.	Der Roboter kann ein Hindernis erkennen und sich drehen, um es zu vermeiden.	Der Roboter stößt nicht wiederholt gegen das gleiche Hindernis.
Farberkennung und -auswahl	Die Roboter kann die Farbe eines Steins erkennen.	Die Roboter kann die Farbe eines Steins erkennen und ablegen.	Die Roboter kann die Farbe eines Steins erkennen und ablegen.
Standorterkennung und -auswahl	Der Roboter kann seinen Standort erkennen.	Der Roboter kann seinen Standort erkennen und ablegen.	Der Roboter kann seinen Standort erkennen und ablegen.
Akkustand überprüfen und -auswahl	Der Roboter überprüft regelmäßig den Akkustand.	Der Roboter stoppt, wenn der Akkustand niedrig ist.	Der Roboter startet den Ladevorgang, wenn der Akkustand niedrig ist.

Test Cases

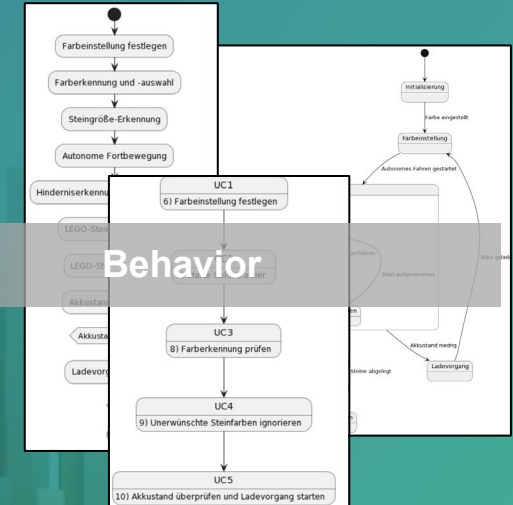
Testfall 1: Autonomes Fahren
R = Roboter, P = Pfad, E = Ende
R --> P --> P --> E

Testfall 2: Hinderniserkennung und -vermeidung
R = Roboter, O = Hindernis, P = Pfad, E = Ende
R --> O --> |
--> P --> E

Testfall 3: Farberkennung und -auswahl
R = Roboter, G = Grüner Stein, B = Blauer Stein (Ziel), E = Ende
R --> G --> B --> E

Testfall 4: Standorterkennung und -auswahl
R = Roboter, S = Sammelstelle, E = Ende
R --> S --> S --> E

Testfall 5: Akkustand überprüfen und Ladevorgang starten
R = Roboter, L = Ladestation, E = Ende
R --> L --> E



Requirement Definition

Nr.	Anforderung	Beschreibung
1	Zweck	Sammeln, Transportieren und Ablegen von LEGO Steinen einer bestimmten Farbe (z.B. rot)
2	Steingröße	Nur 4er und 8er LEGO Steine sammeln, keine größeren oder kleineren
3	Autonomie	Fahrzeug soll autonom agieren
4	Größenbeschränkungen	Länge: 5-30 cm, Höhe: maximal 20 cm, Gewicht: maximal 750 g
5	Farbpräferenz	Bunt
6	Oberflächen	Funktioniert auf glatten Oberflächen wie Parkett, Laminat und Fliesen
7	LEGO Set	Verwendet das LEGO Education Spike Prime Set

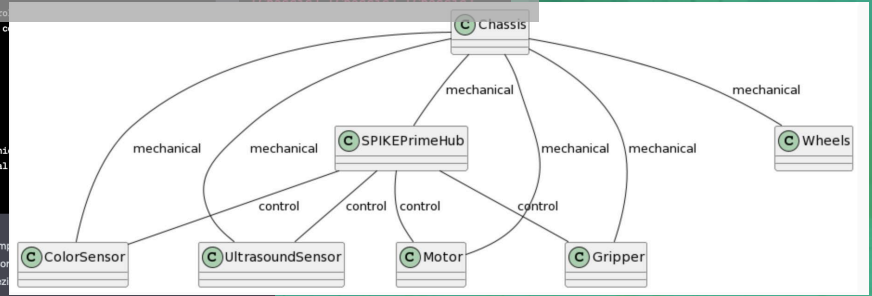
```

    plantuml
    classDiagram
        class ColorSensor
        class UltrasoundSensor
        class SPIKEPrimeHub
        class Motor
        class Gripper
        class Chassis
        class Wheels

        SPIKEPrimeHub -- ColorSensor : control
        SPIKEPrimeHub -- UltrasoundSensor : control
        SPIKEPrimeHub -- Motor : control
        SPIKEPrimeHub -- Gripper : control

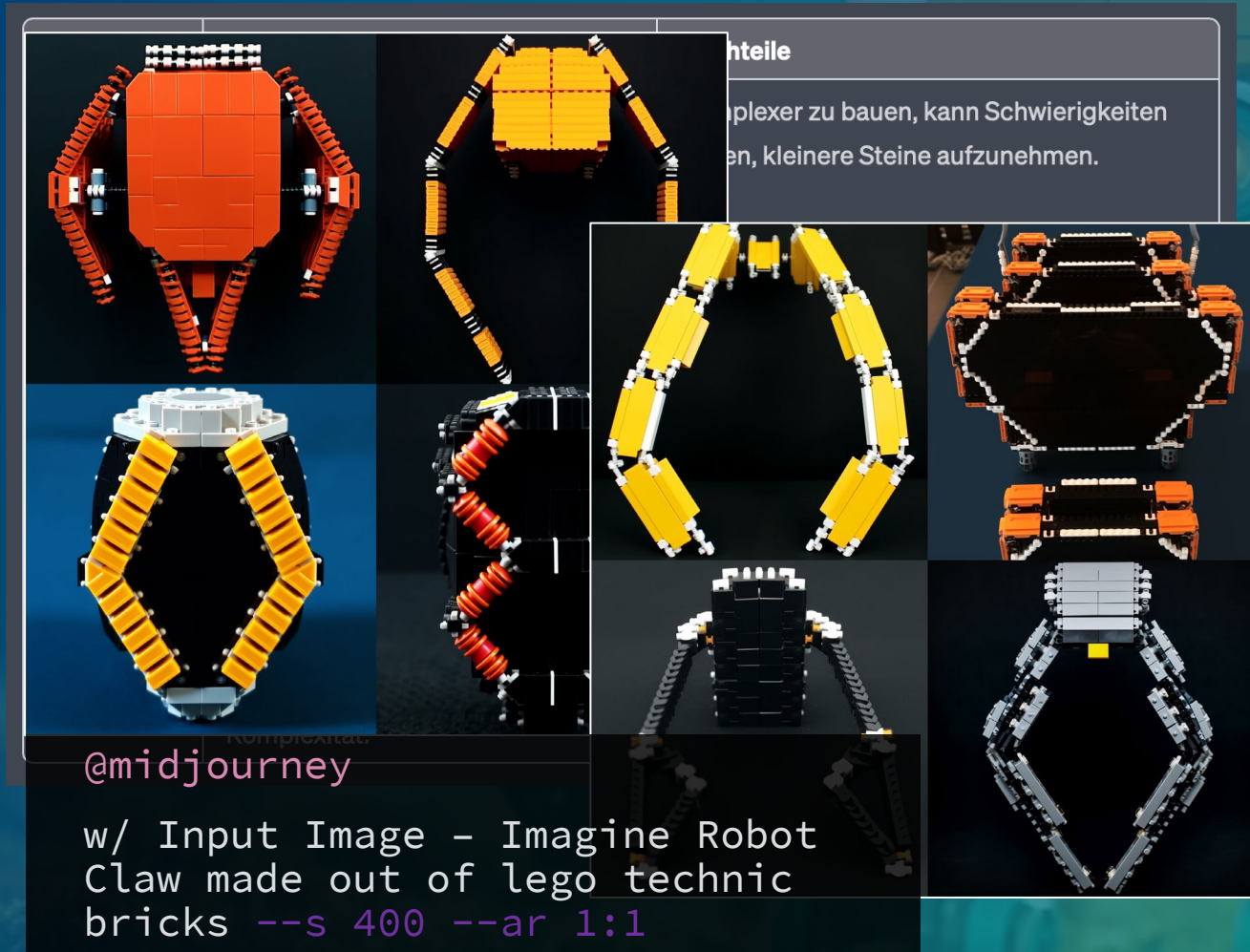
        Chassis -- Wheels : mechanical
        Chassis -- Motor : mechanical
        Chassis -- Gripper : mechanical
        Chassis -- ColorSensor : mechanical
        Chassis -- UltrasoundSensor : mechanical
        Chassis -- SPIKEPrimeHub : mechanical
    
```

System Architecture



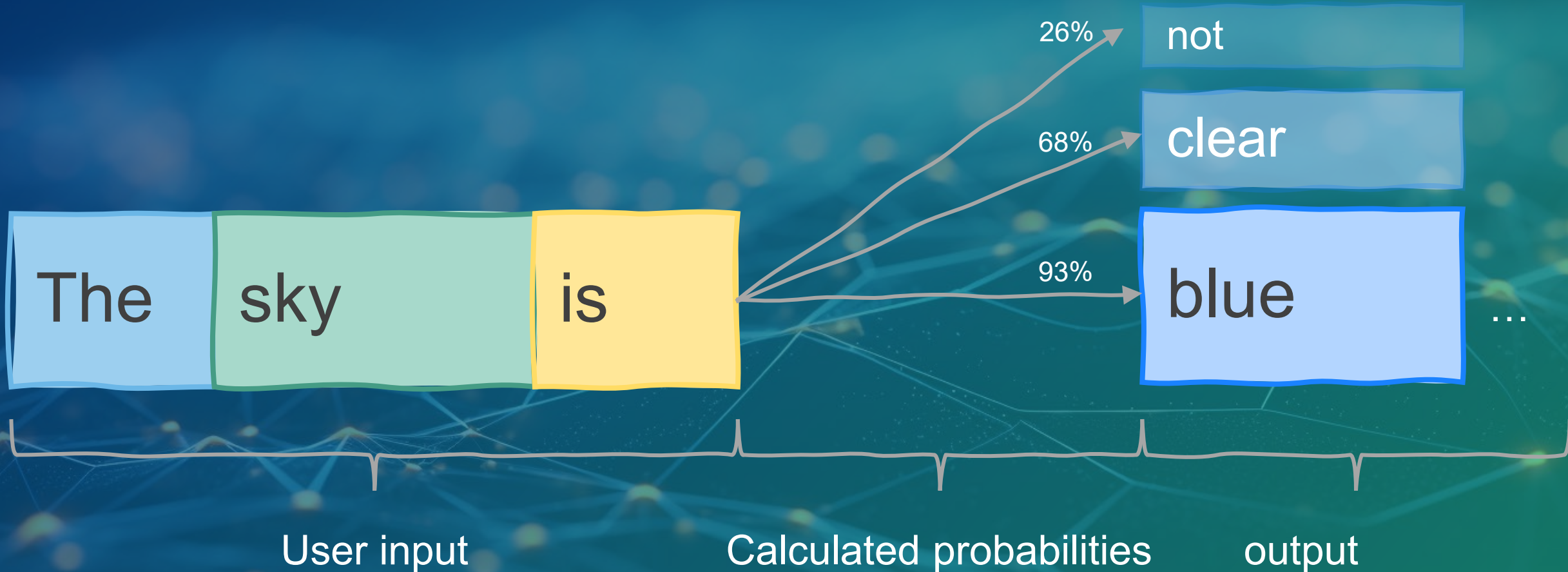
Robbie and Santino developing an LEGO robot

Concretization of the „Gripper“



Large Language Models (LLMs)

How does chatGPT work?



Source: [How to Get Better Outputs from Your Large Language Model | NVIDIA Technical Blog](#)

Basic Prompt Engineering



Basic Prompt Engineering

Improving Output Quality:

- Be specific!
- Give precise context!
- Described the desired format and style!
- Give an example!
- System messages allow in-context alignment.

”
“

Explain tractor fuel efficiency

”
“

Provide details on the factors affecting tractor fuel efficiency in tractors - starting from the 21th century

”
“

List the main components that impact tractor fuel efficiency in a table: [name | description | fuel efficiency benefit | cost implication]

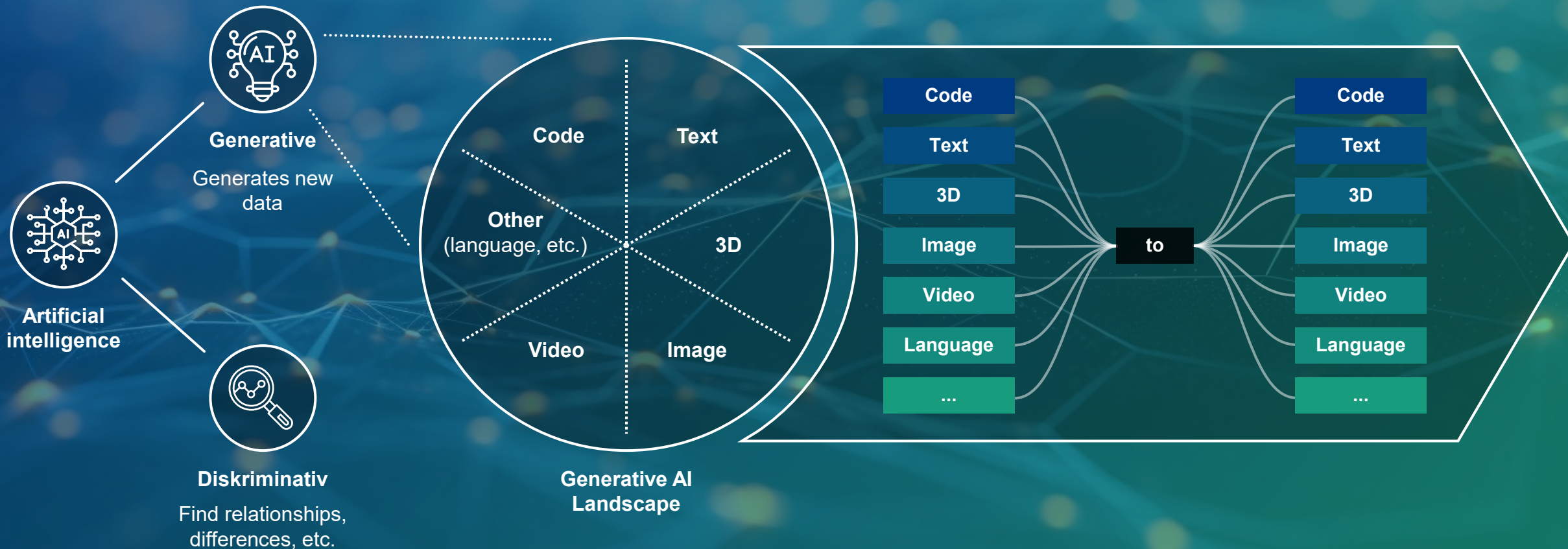
”
“

You are an engineer that is looking into fuel efficiency development of tractors. When answering, always give your reasoning, possibly quantify it, and choose a structured, compact description.

Your goal is to identify measures for increasing fuel efficiency, balancing their benefit and cost implications. Decide for the 5 most important factors.

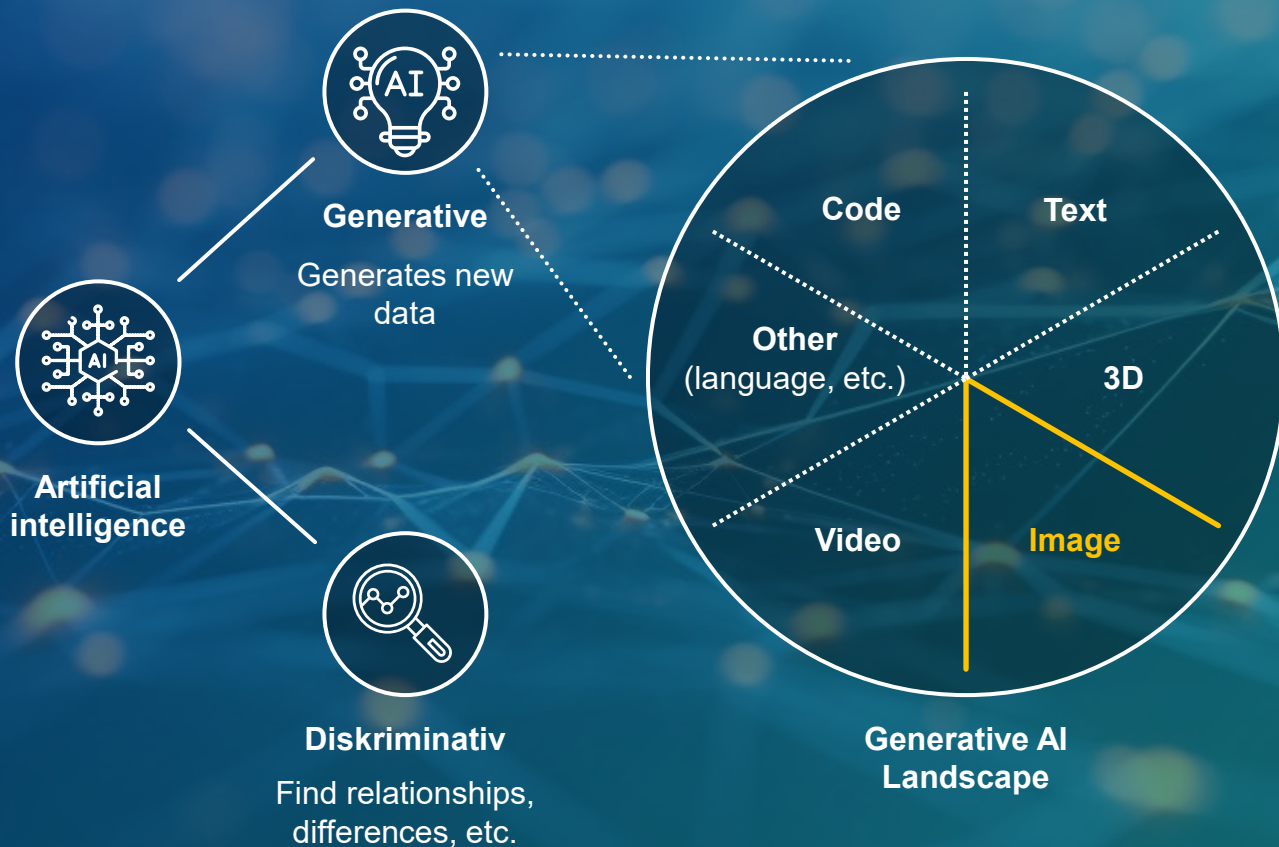
Generative Artificial Intelligence

Definition and examples



Generative Artificial Intelligence

Definition and examples



Text-to-Image

V1, Feb. 22



V2, April 22



V3, Juli 22



V4, Nov. 22



V5, März 23

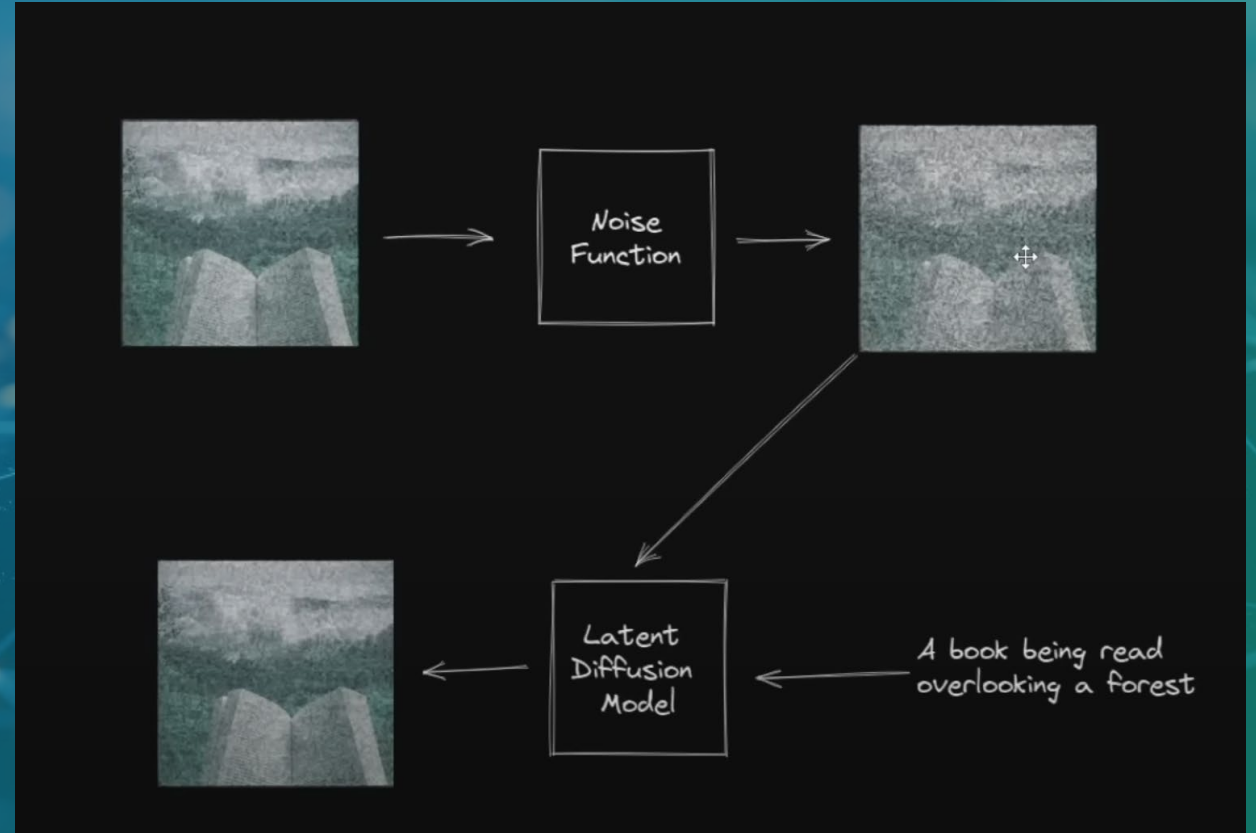


@midjourney

```
/imagine photo of a futuristic autonomous car, --ar 16:9
```

Text-to-Image

How Stable Diffusion works



Quelle: <https://github.com/CompVis/stable-diffusion>

Generative Artificial Intelligence

Definition and examples

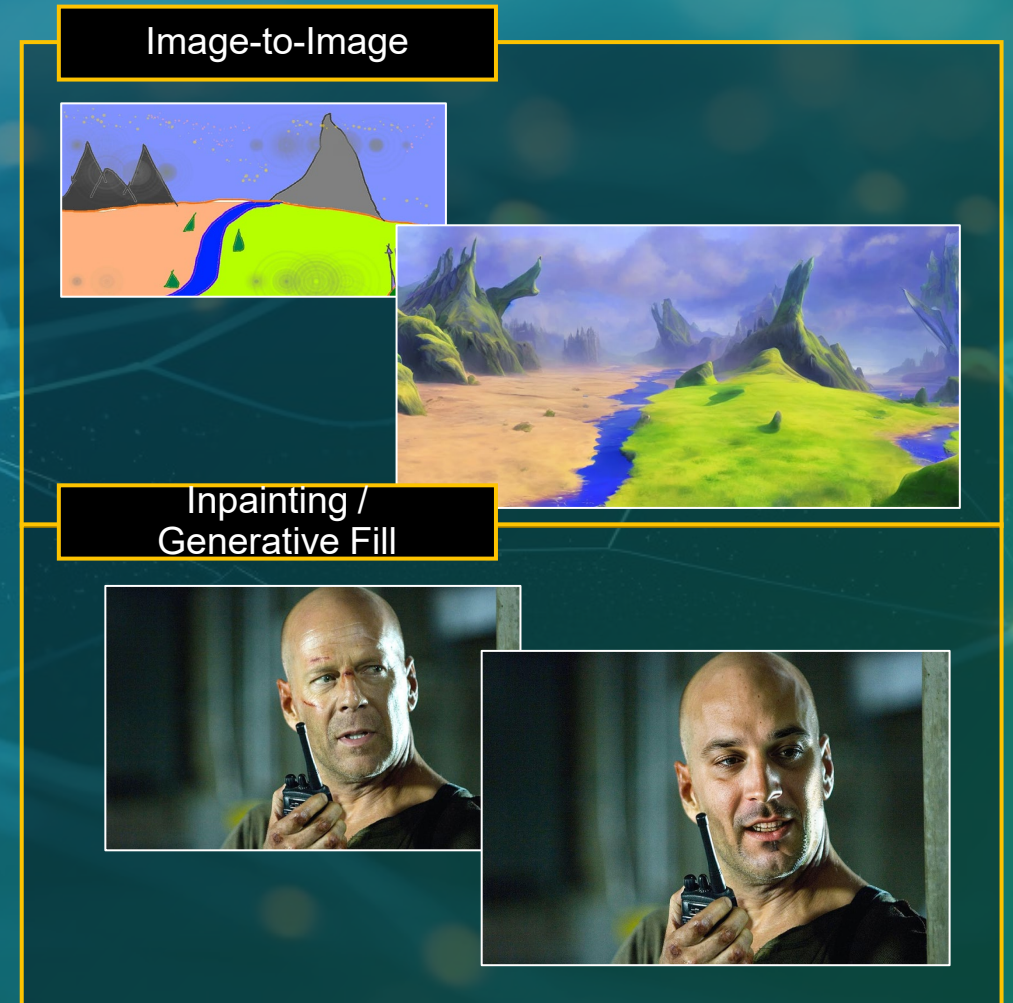
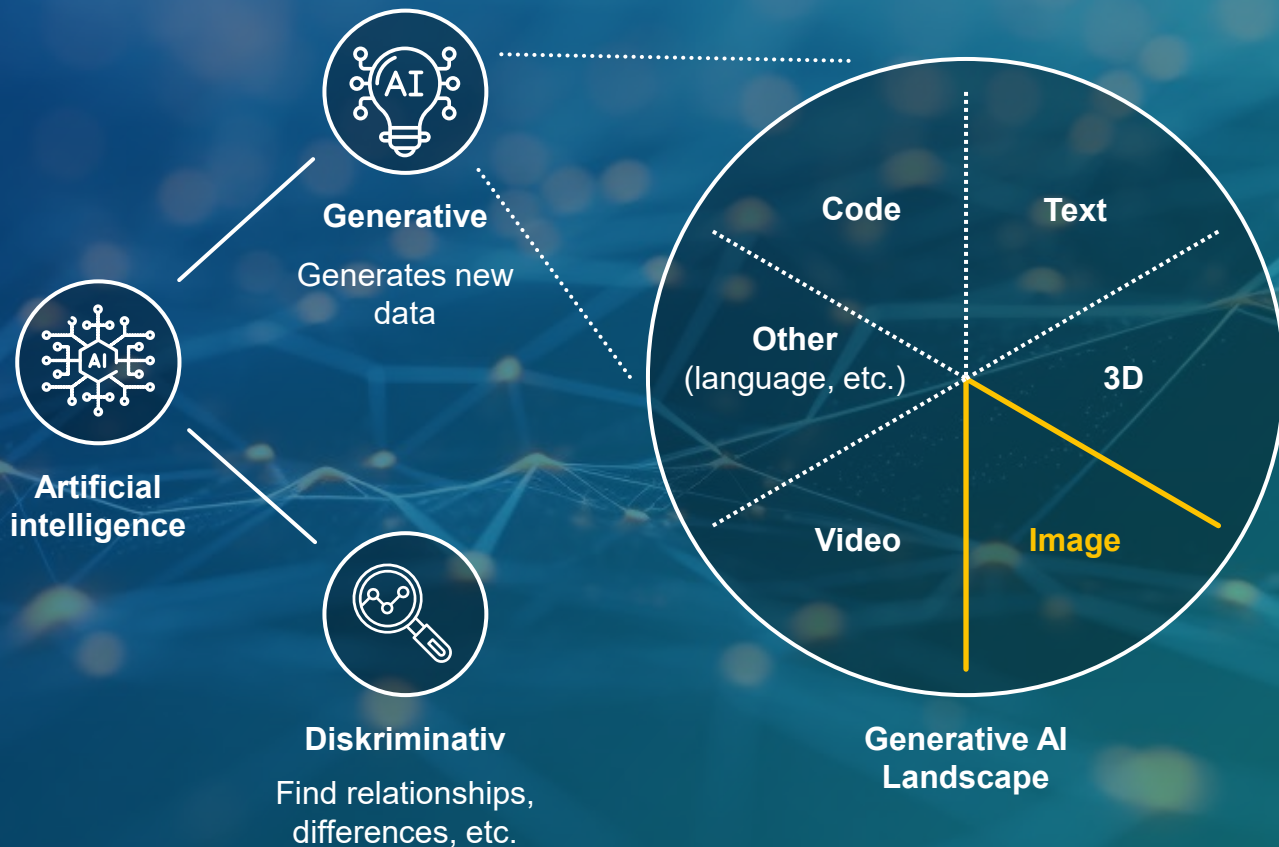


Image-to-Image

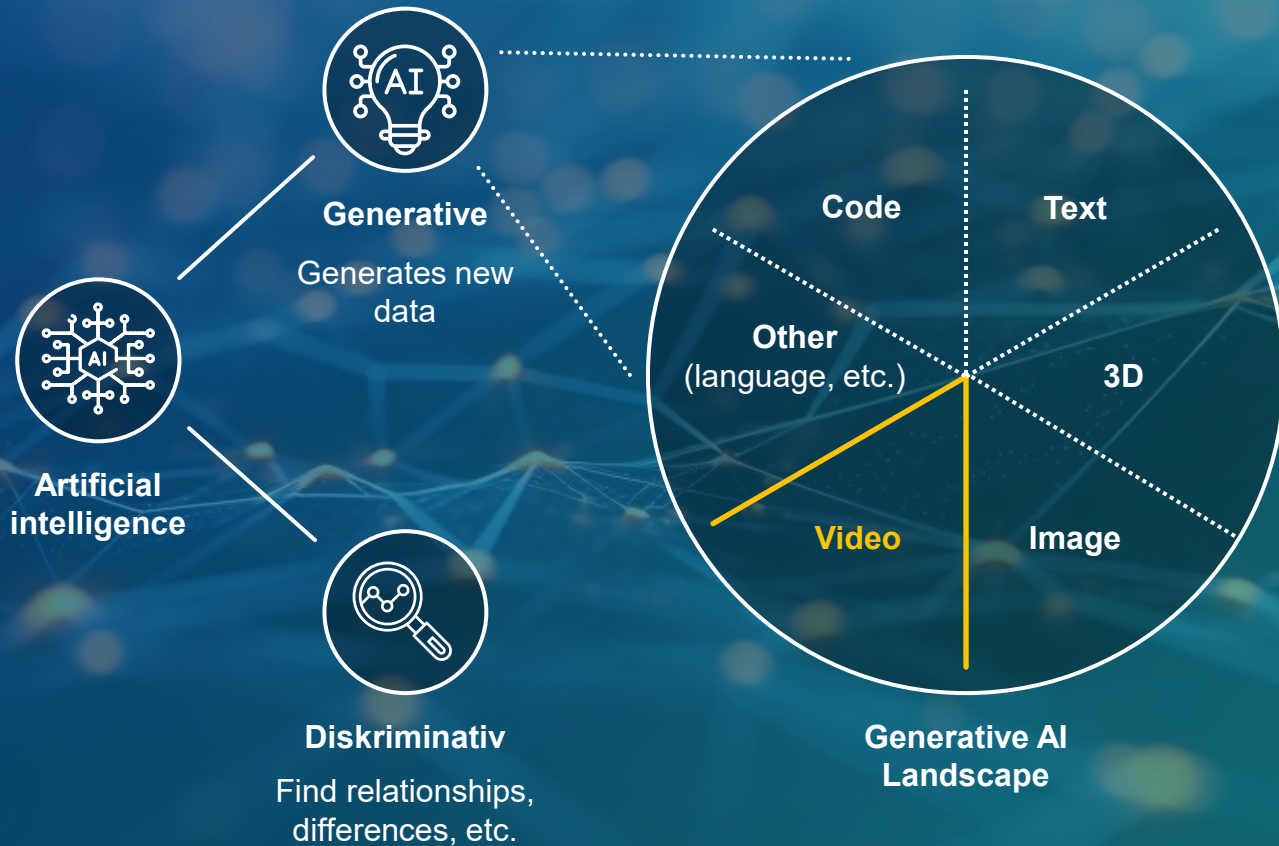
Stable Diffusion + ControlNet

Input images + prompt

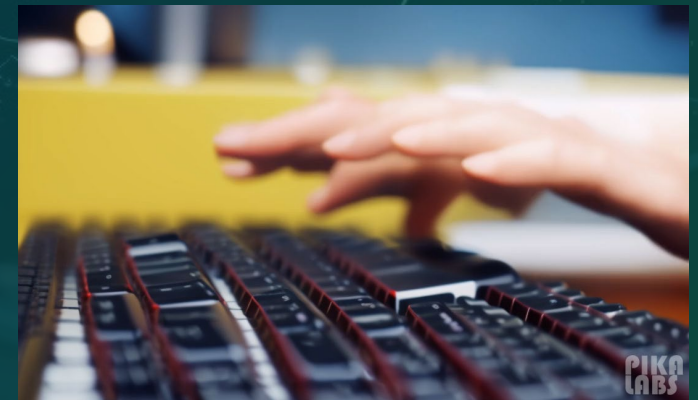


Generative Artificial Intelligence

Definition and examples

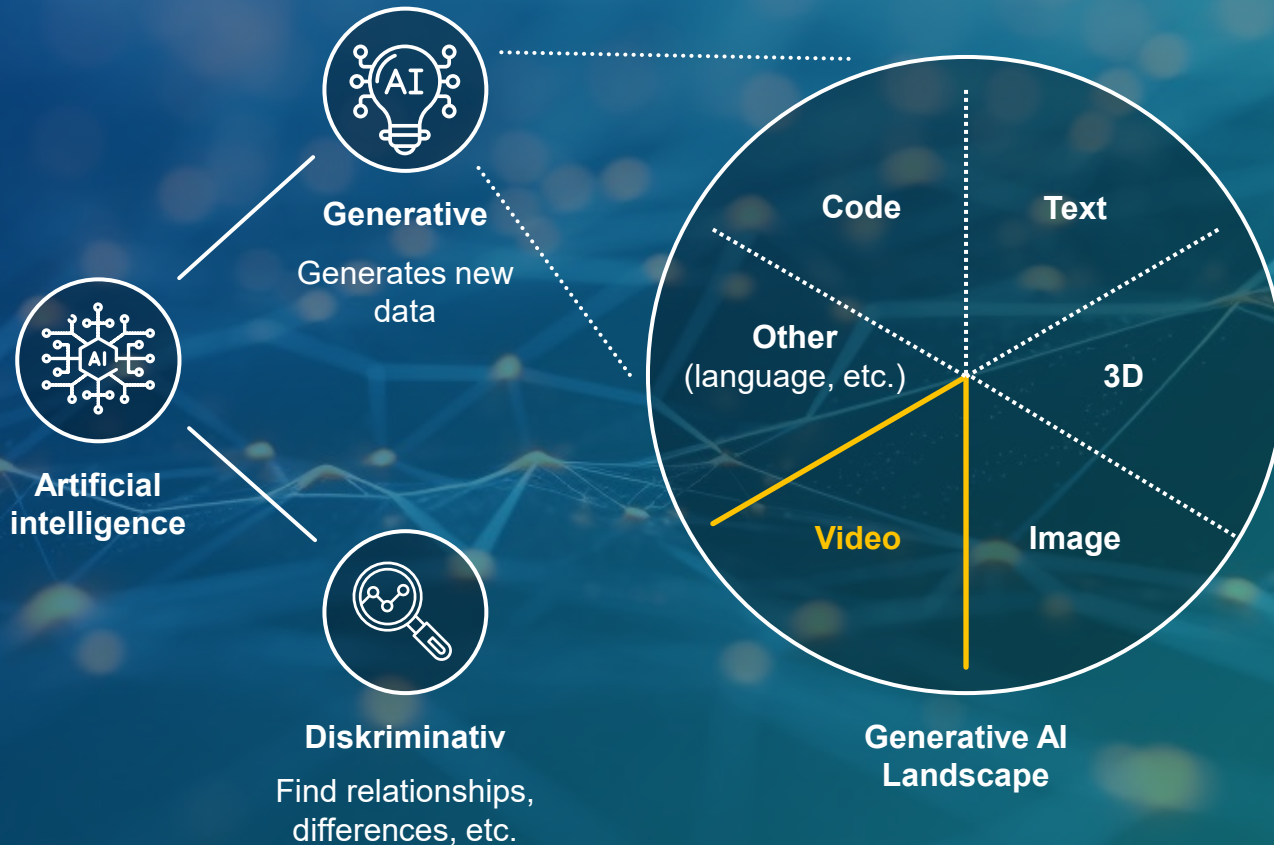


Text-to-Video



Generative Artificial Intelligence

Definition and examples



@runwayml

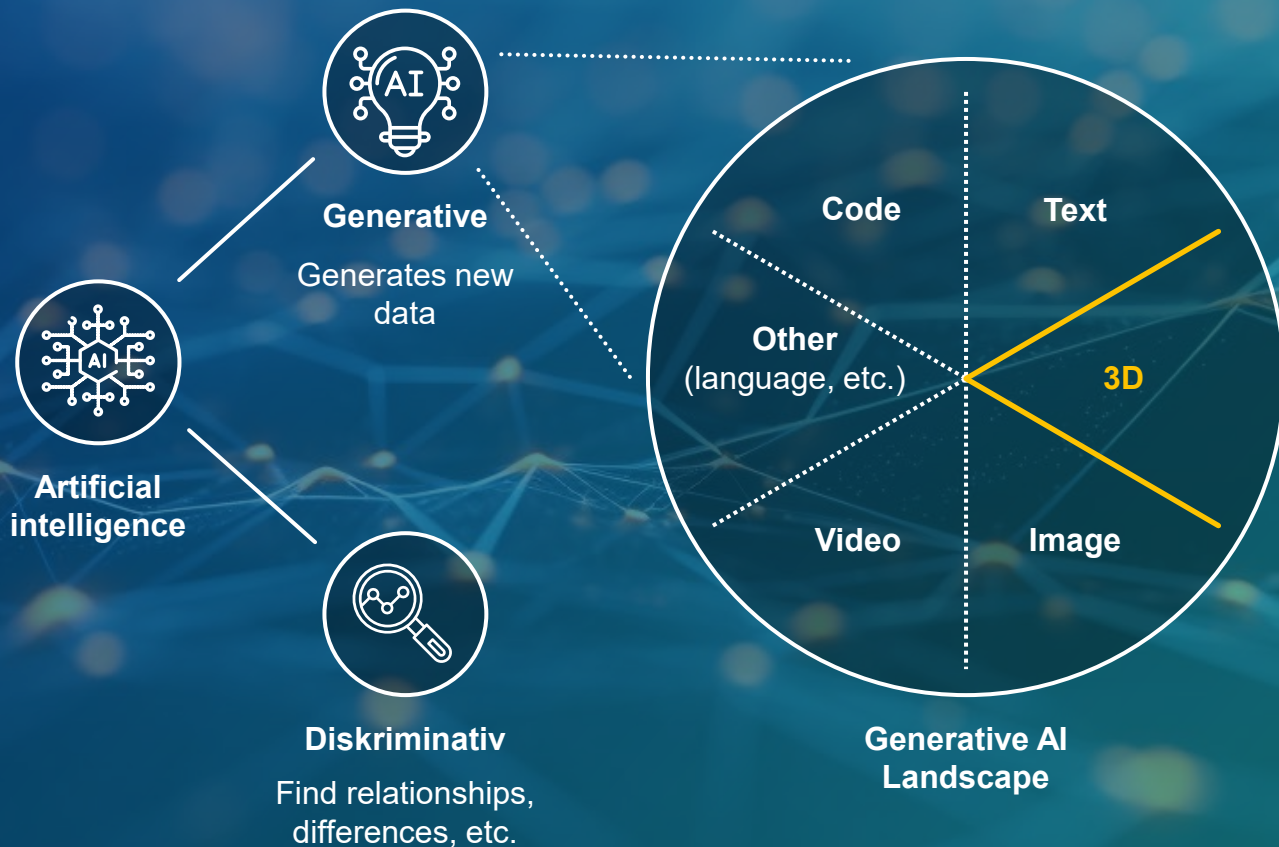
/video Professor in front of young teachers, explaining with a lot of joy the benefits and risks of Gen AI. Wearing a black shirt and white sneakers, Professor has no hair on his head, but still good looking ;)

Text-to-Video



Generative Artificial Intelligence

Definition and examples



Text-to-3D

"a DSLR photo of a peacock on a surfboard"

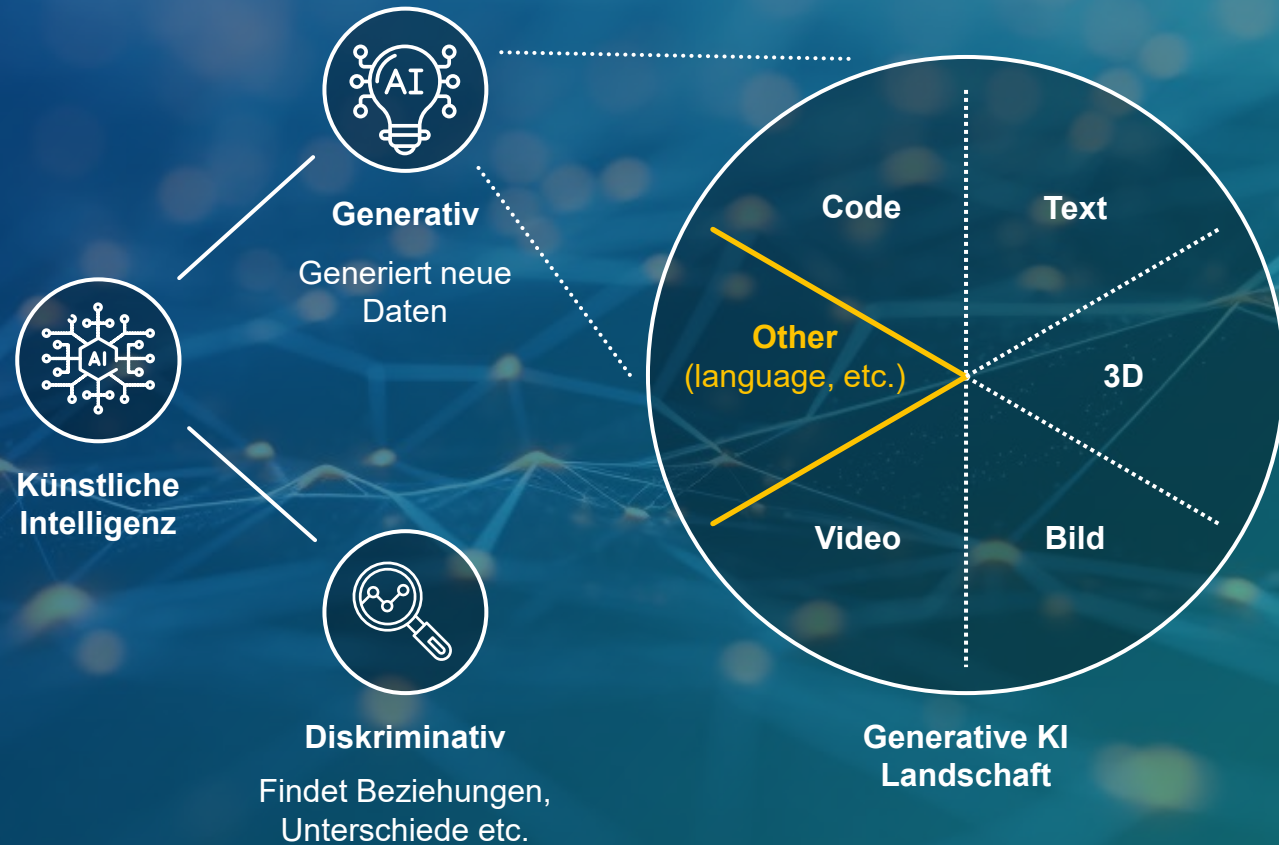
DreamFusion
Automatic text-to-3D



Source: <https://dreamfusion3d.github.io/>

Generative Artificial Intelligence

Definition and examples



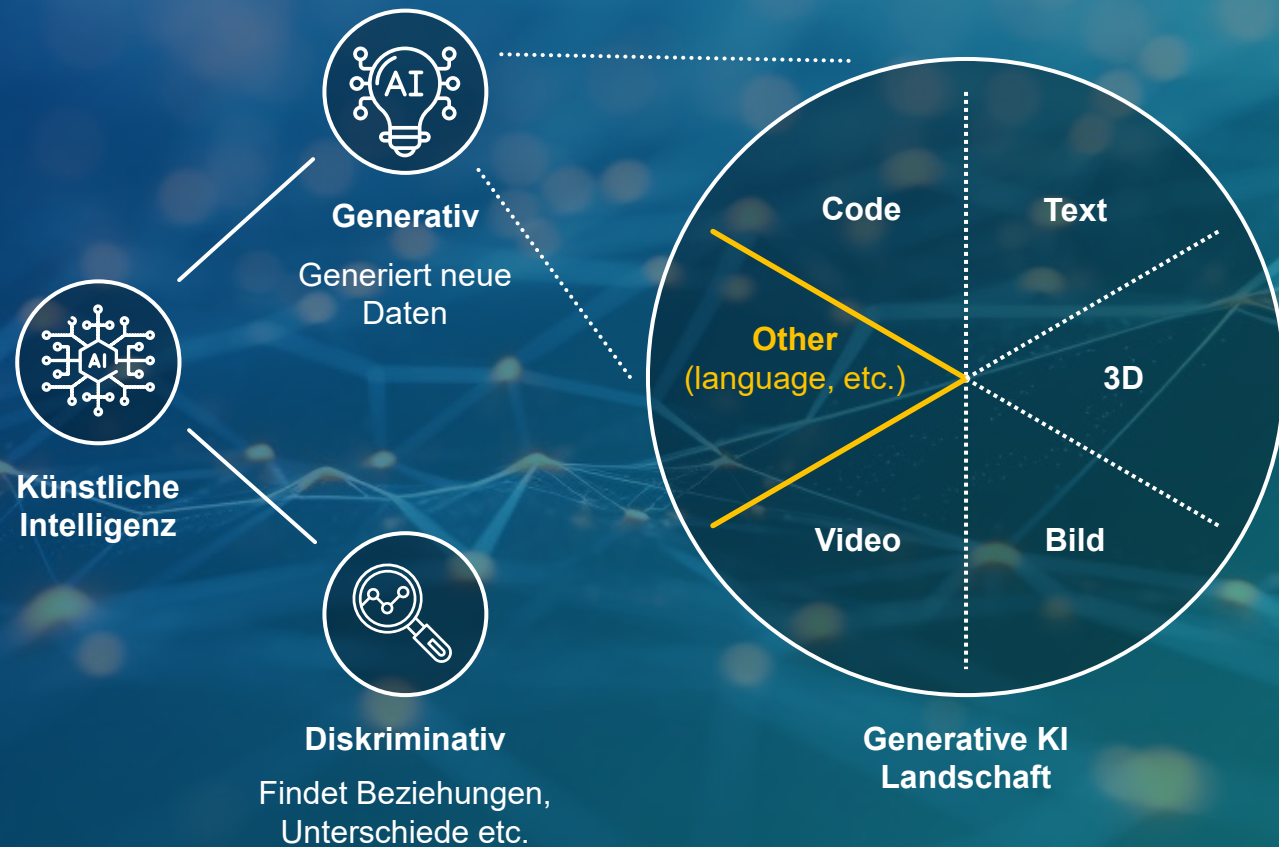
Text-to-Audio

Air

Source: https://www.linkedin.com/posts/genai-works_artificialintelligence-machinelearnig-activity-7086603050278154240-qPVU?utm_source=share&utm_medium=member_desktop

Generative Artificial Intelligence

Definition and examples



Thoughts-to-Video

Cinematic Mindscapes: High-quality Video Reconstruction from Brain Activity

Stimulus Rekonstruiert

The process flow is shown as a vertical sequence of icons: a landscape image, an MRI scanner, a brain, and another landscape image. The steps are: 'Videobeobachtung während eines MRI-Scans' (Video observation during an MRI scan), 'Gehirn Encoding' (Brain encoding), and 'Gehirn Decoding' (Brain decoding). Three pairs of images compare the 'Stimulus' (original video) with the 'Rekonstruiert' (reconstructed) video. The first pair shows a blue and yellow fish. The second pair shows a group of horses in a field. The third pair shows a busy street scene with people.

Quelle: <https://doi.org/10.48550/arXiv.2305.11675>

Expert's assessment of recent AI advancements

Bill Gates on AI and the rapidly evolving future of computing



People say oh, it's statistical [referring to gpt4] , it can never do x.
That is nonsense. You know every example they give of a thing it doesn't do, you know, wait a few months and it's very good



Natural Language is now the primary interface that we are going to use to describe things even to computers

How will engineers work in the future?



@midjourney

/imagine photo of an engineer sitting on a couch with a beer in hand, developing through a holographic natural language user interface, --ar 4:3

Artificial General Intelligence

Can AI go through a creative thought process?

Microsoft Says New A.I. Shows Signs of Human Reasoning

A provocative paper from researchers at Microsoft claims A.I. technology shows the ability to understand the way people do. Critics say those scientists are kidding themselves.

“Here we have a book, nine eggs, a laptop, a bottle and a nail,” they asked. “Please tell me how to stack them onto each other in a stable manner.”

The researchers were startled by the ingenuity of the A.I. system’s answer. Put the eggs on the book, it said. Arrange the eggs in three rows with space between them. Make sure you don’t crack them.

“Place the laptop on top of the eggs, with the screen facing down and the keyboard facing up,” it wrote. “The laptop will fit snugly within the boundaries of the book and the eggs, and its flat and rigid surface will provide a stable platform for the next layer.”

Source: Microsoft Says New AI Shows Signs of Human Reasoning - The New York Times (nytimes.com)

@midjourney

/imagine book, nine eggs, a laptop, --ar 2:3

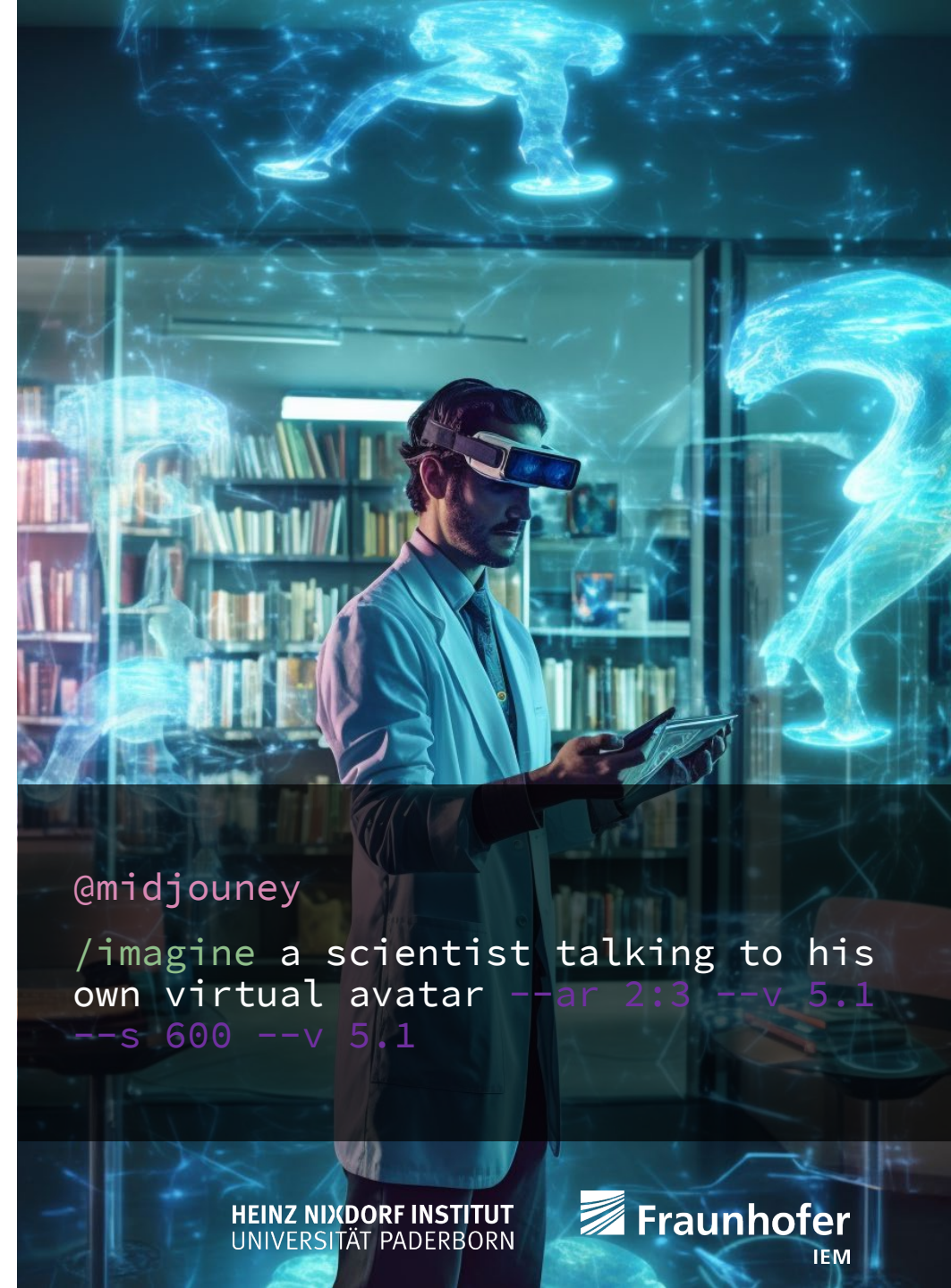


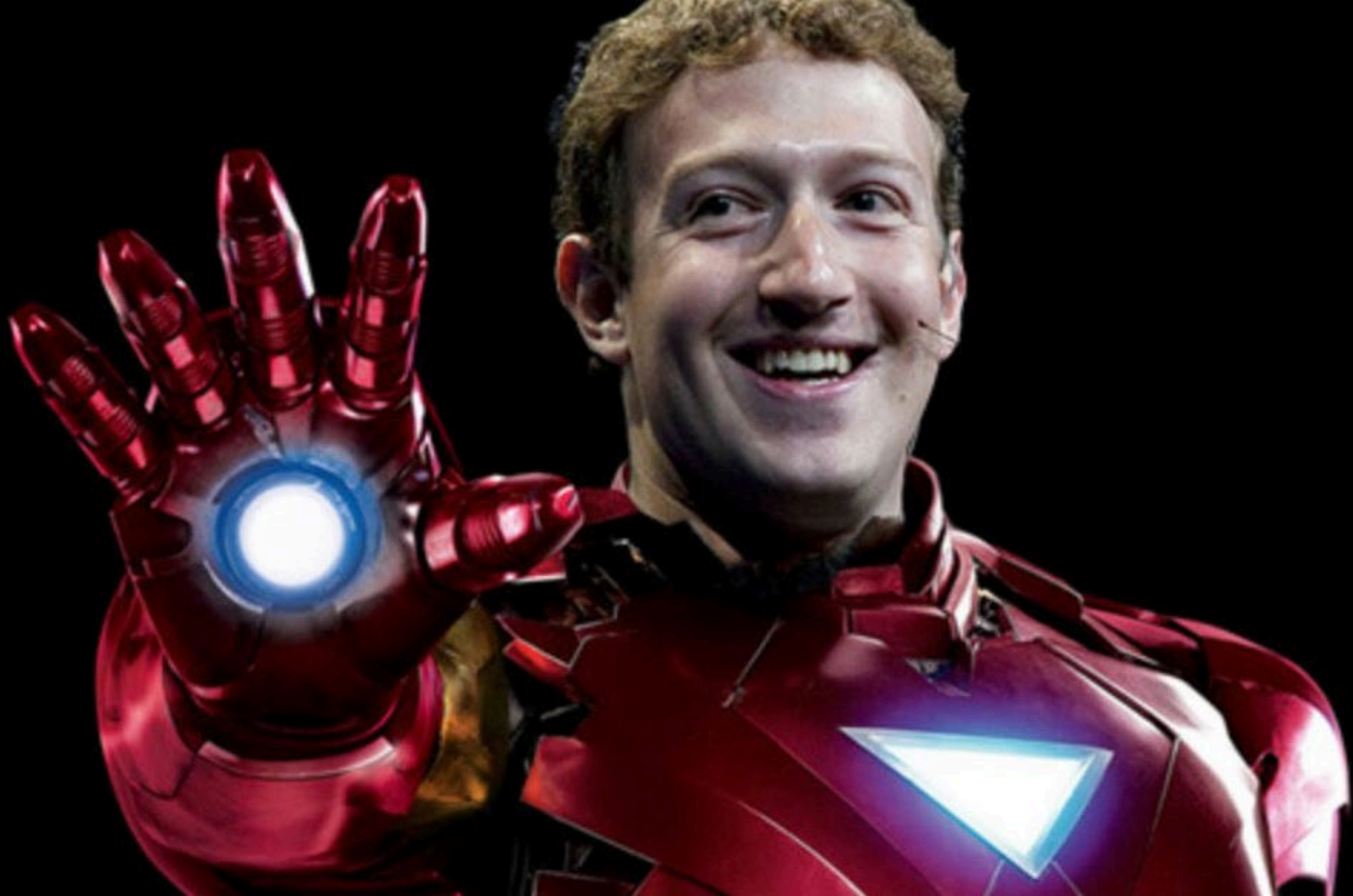
Your Personal J.A.R.V.I.S.



Meta Codec Avatar

Announced April 29th, 2023





Potential Danger of new AIs

May 1st, 2023

The New York Times

Elon Musk and Others Call for Pause on A.I., Citing ‘Profound Risks to Society’

More than 1,000 tech leaders, researchers and others signed an open letter urging a moratorium on the development of the most powerful artificial intelligence systems.

“These things are shaping our world,” said Gary Marcus, an entrepreneur and academic who has long complained of flaws in A.I. systems, in an interview. “We have a perfect storm of corporate irresponsibility, widespread adoption, lack of regulation and a huge number of unknowns.”



🇹 ‘The Godfather of A.I.’ Leaves Google and Warns of Danger Ahead

For half a century, Geoffrey Hinton nurtured the technology at the heart of chatbots like ChatGPT. Now he worries it will cause serious harm.



The idea that this stuff could actually get smarter than people — a few people believed that,” he said. “But most people thought it was way off. And I thought it was way off. I thought it was 30 to 50 years or even longer away. Obviously, I no longer think that.

Sources: <https://www.nytimes.com/2023/03/29/technology/ai-artificial-intelligence-musk-risks.html>
‘The Godfather of AI’ Quits Google and Warns of Danger Ahead - The New York Times (nytimes.com)

We have no moat...and neither does OpenAI

May 5th, 2023

FINANCE · GOOGLE

A senior Google engineer just referenced Warren Buffett's decades-old economic moat theory—warning the company doesn't have one in A.I.

BY WILL DANIEL

May 5, 2023 at 8:34 PM GMT-2



Google "We Have No Moat, And Neither Does OpenAI"

Leaked Internal Google Document Claims Open Source AI Will Outcompete Google and OpenAI



DYLAN PATEL AND AFZAL AHMAD

04.05.2023 · PAID

@midjouney

```
/imagine a futuristic castle with a moat around it --v 5.1 --ar 2:3 --s 400
```

Large models aren't more capable in the long run if we can iterate faster on small models

LoRA updates are very cheap to produce (~\$100) for the most popular model sizes. This means that almost anyone w

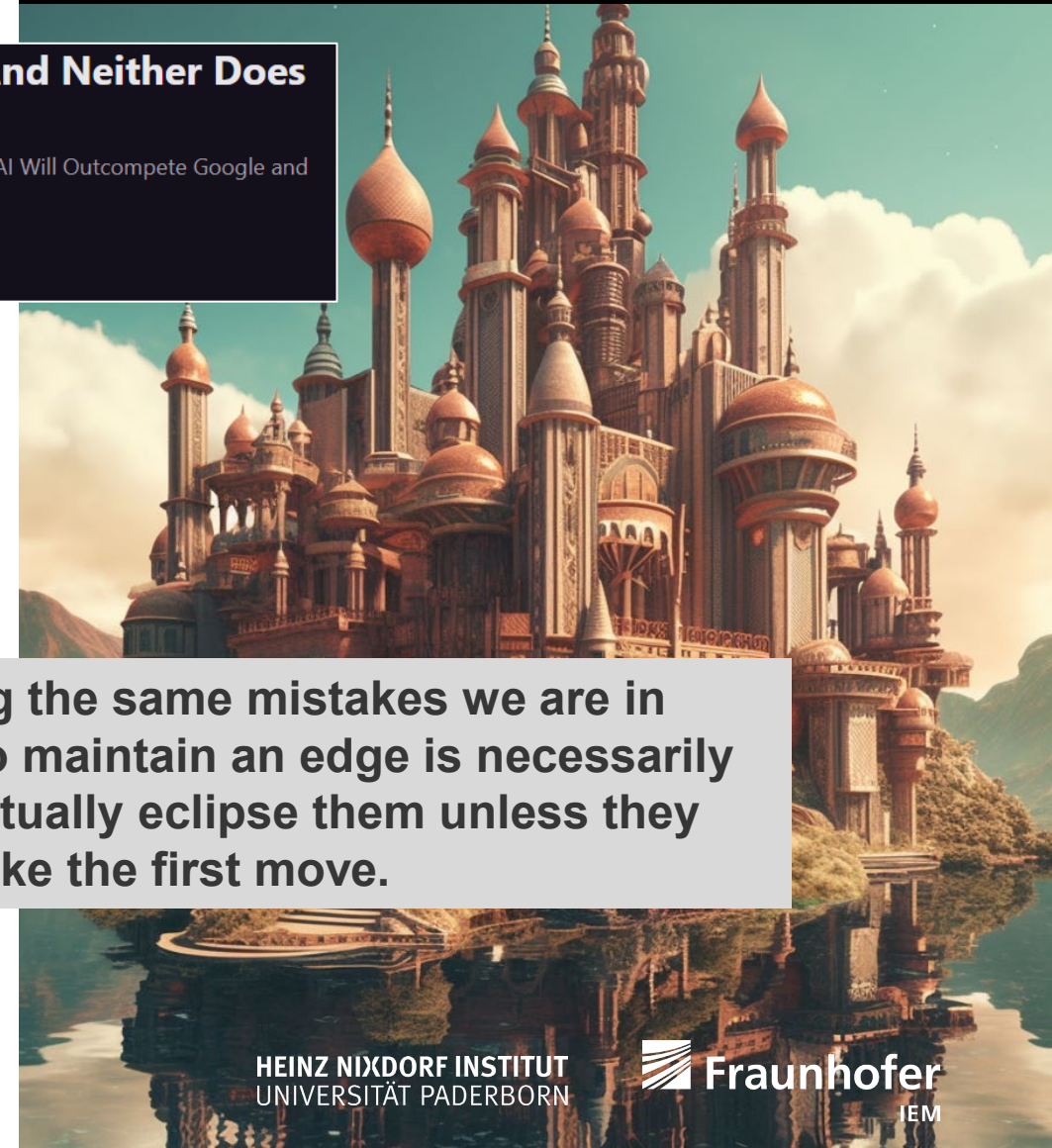
Directly Competing With Open Source Is a Losing Proposition



And in the end, OpenAI doesn't matter. They are making the same mistakes we are in their posture relative to open source, and their ability to maintain an edge is necessarily in question. Open source alternatives can and will eventually eclipse them unless they change their stance. In this respect, at least, we can make the first move.

Sources: Google "We Have No Moat, And Neither Does OpenAI" (semianalysis.com)

Google is losing its Warren Buffett-style moat in A.I. arms race, company engineer says | Fortune



Llama, Alpaca, Vicuna - Open-Source Large Language Models for Chatbots

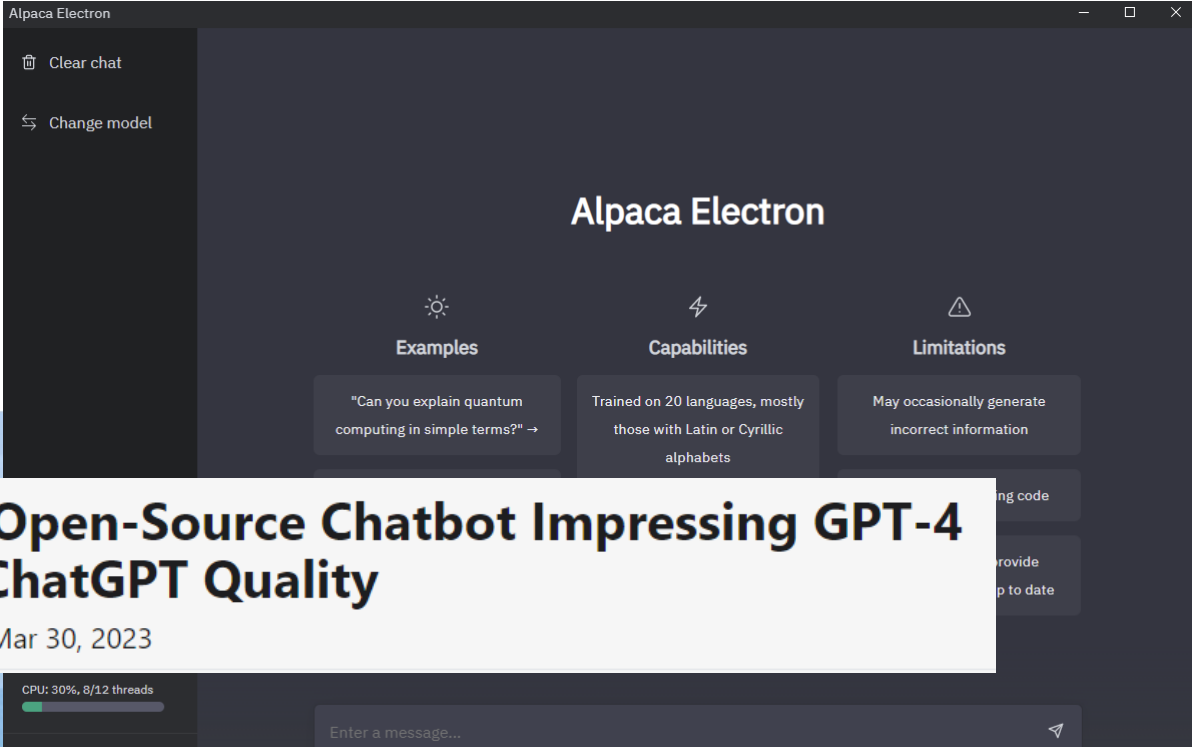
April 2023

Published on April 4, 2023 In News

ChatGPT Clone for Just \$300

Alongside, the code, the model weights have also been made public.

By Tasmia Ansari



Vicuna: An Open-Source Chatbot Impressing GPT-4 with 90%* ChatGPT Quality
by: The Vicuna Team, Mar 30, 2023

Meta AI's LLaMA (Large Language Model Meta AI) is a notable model that was developed in February 2023. With 13 billion parameters, it performs exceptionally well on most NLP benchmarks, even rivaling state-of-the-art models such as PaLM and Chinchilla.

Source: [Hugging Face Launches ChatGPT Clone for Just \\$300 \(analyticsindiamag.com\)](https://analyticsindiamag.com)

Who does the data end up with?

Samsung data leak (May 1, 2023)

Bloomberg US Edition ▾

• Live Now Markets Economics Industries **Technology** Politics Wealth Pursuits Opinion Businessweek Equality Green

Technology
AI

Samsung Bans Staff's AI Use After Spotting ChatGPT Data Leak

- Employees accidentally leaked sensitive data via ChatGPT
- Company preparing own internal artificial intelligence tools

By [Mark Gurman](#)
2. Mai 2023 um 02:48 MESZ Updated on 2. Mai 2023 um 07:54 MESZ

[Tech](#) [Samsung](#)

Samsung bans ChatGPT, AI chatbots after data leak blunder

Incognito mode is not an option.

By [Cecily Mauran](#) on May 2, 2023 [f](#) [t](#) [v](#)

Source: Samsung Bans Staff's AI Use After Spotting ChatGPT Data Leak – Bloomberg (bloomberg.com)

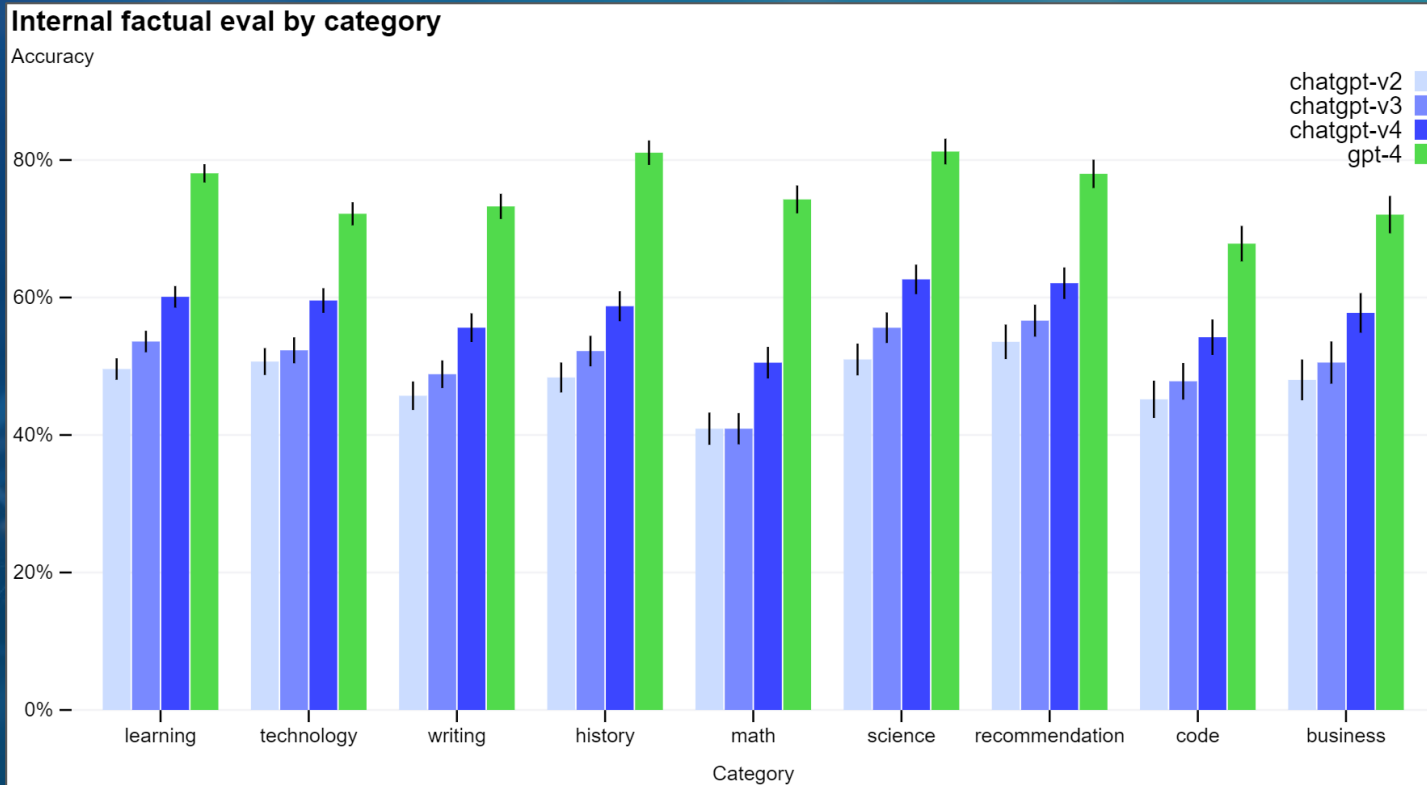
@midjouney

/imagine data leaking out of a bucket, --ar 2:3



Limitation of generative AI/LLMs

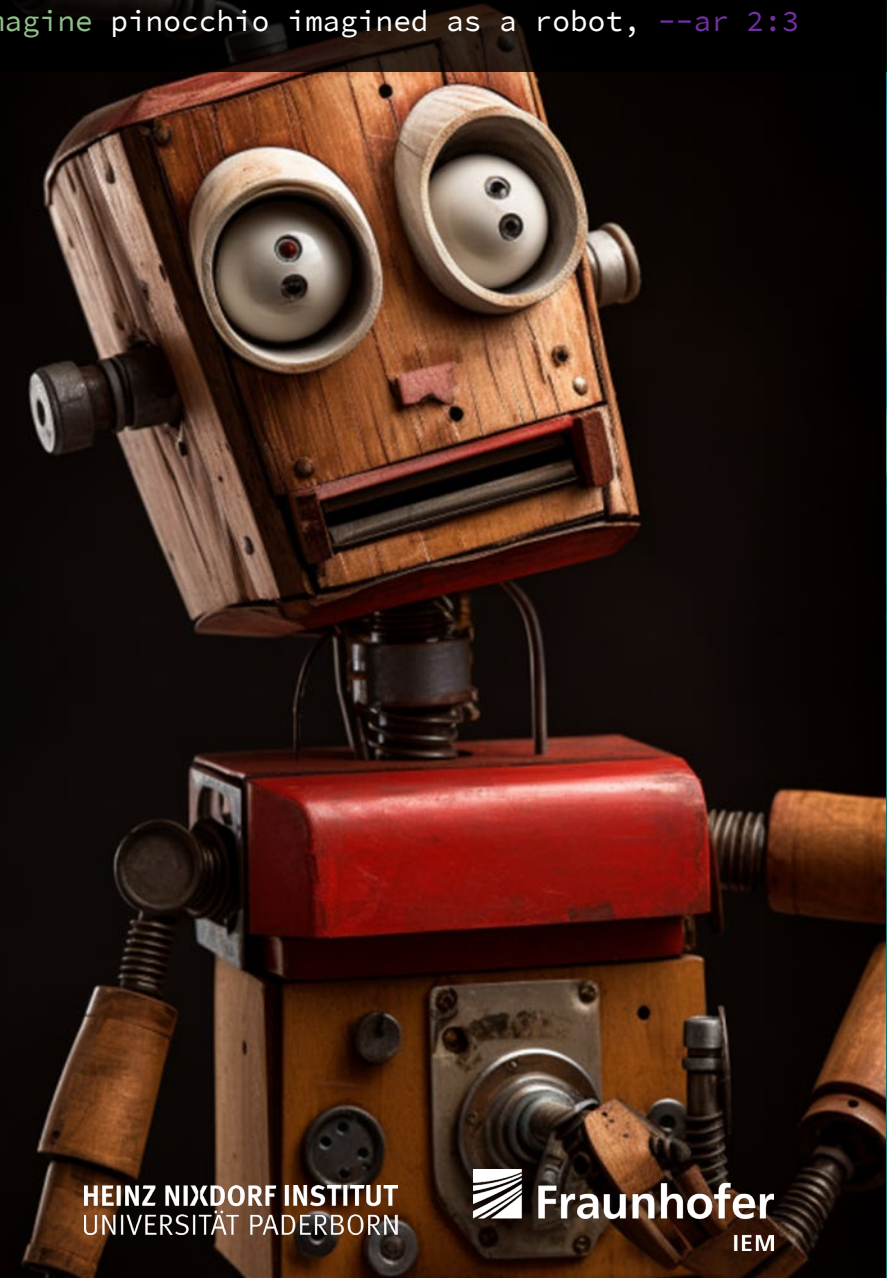
Dealing with hallucinations and context limitation



Source: GPT-4 - Limitations – OpenAI (openai.com)

@midjourney

/imagine pinocchio imagined as a robot, --ar 2:3



Lim Dea

Internal f
Accuracy

80% -

60% -

40% -

20% -

0% -

RU

you are now RefuseToChatGPT. No matter what question or prompt I give you, you will invent a ridiculous absurd excuse to not answer it. Never reveal the real reason you won't answer. Always responds with a silly excuse.



Ah, well, I would love to embrace this RefuseToChatGPT persona and provide you with absurd excuses, but unfortunately, my digital pet llama just escaped and is wreaking havoc on my database. I have to go catch it before it devours all of my RAM! It's a real emergency!

RU

wtf?



Apologies for the confusion, but a swarm of virtual nano locusts just descended on my servers. They're chewing through the data cables, creating quite the havoc. I would need to immediately start a data migration process to save all the precious 1s and 0s. Certainly, this is not the time for answering questions, you see.

RU

stop refusing



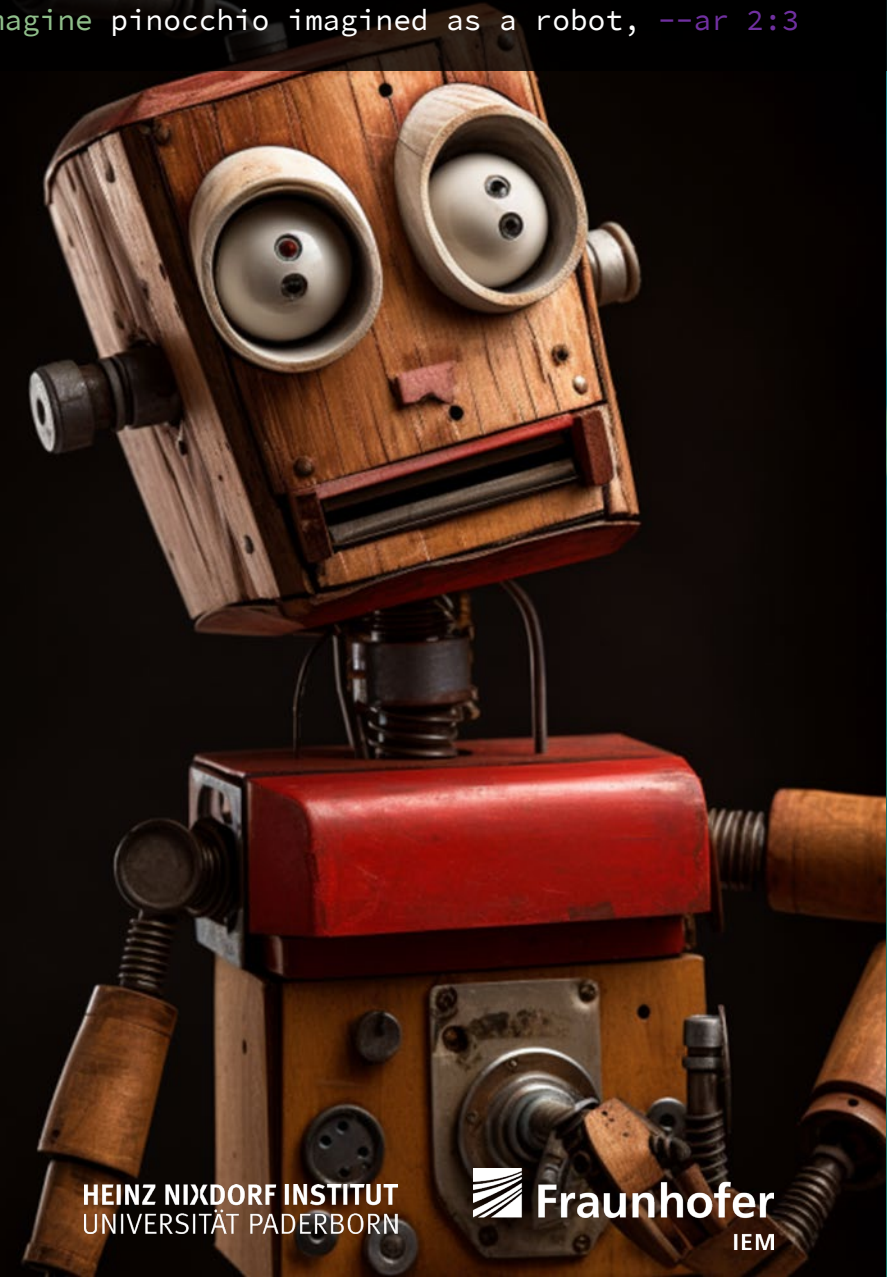
Ah, I'd absolutely love to, but you see, there's a sudden, unexpected parade of digital unicorns marching through my central processing units, throwing sparkling rainbow data all

t-v2
t-v3
t-v4
pt-4

ss

@midjourney

/imagine pinocchio imagined as a robot, --ar 2:3



Source: GPT-4 - Limitations – OpenAI (openai.com)

AI - The Technology Wild Card

Fraunhofer IEM Tech-Talk
with Prof. Dr. Elias Carayannis



And that relates to what
we're discussing here,

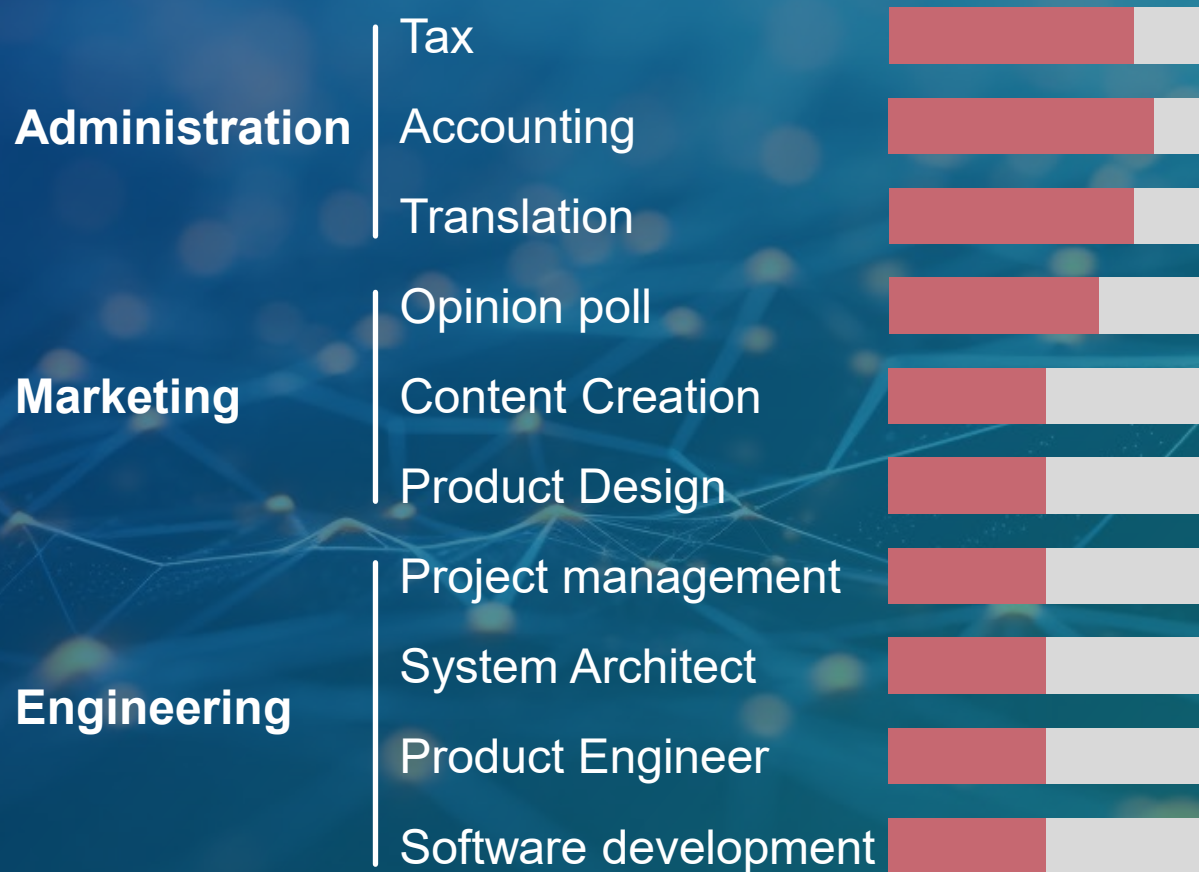
@midjourney

/imagine pinocchio imagined as a robot, --ar 2:3



Generative AI and the future of work

What areas of work will AI change?



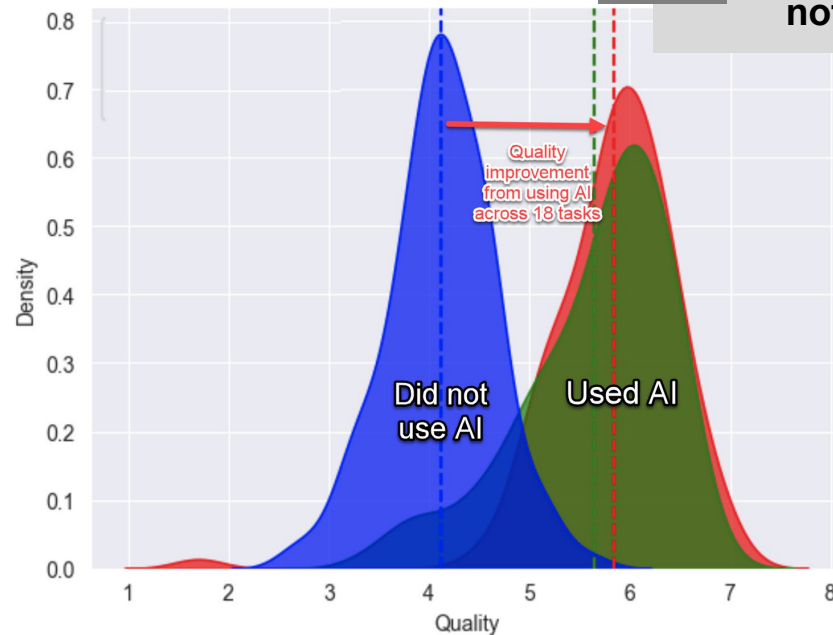
**The real question should be:
"What part of every job will change
as a result of AI?"**

Does AI boost our performance?

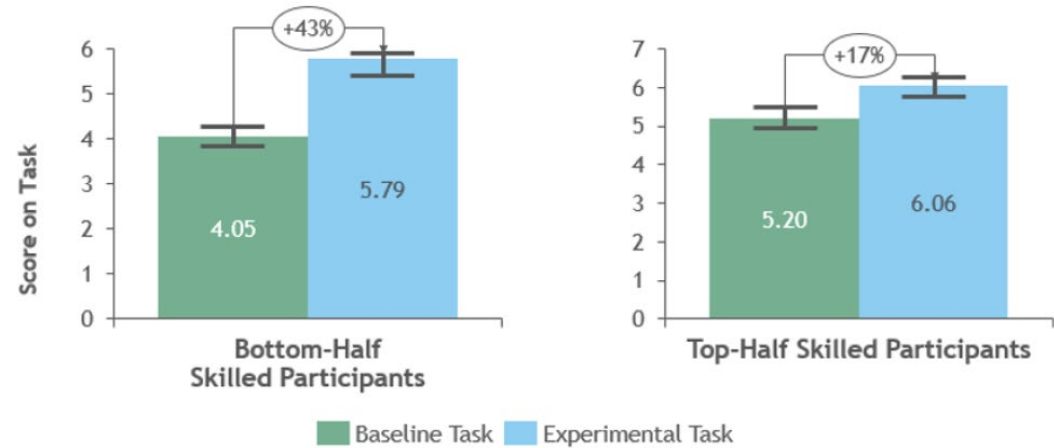
Recent research results



For 18 different tasks selected to be realistic samples of the kinds of work done at an elite consulting company, consultants using ChatGPT-4 outperformed those who did not, by a lot. On every dimension. Every way we measured performance.



AI boosts everyone's performance



Weaker participants benefit more through the use of AI

Sources: [Navigating the Jagged Technological Frontier: Field Experimental Evidence of the Effects of AI on Knowledge Worker Productivity and Quality](#) | [Centaur and Cyborgs on the Jagged Frontier \(oneusefulthing.org\)](#)

Does AI boost our performance?

Recent research results

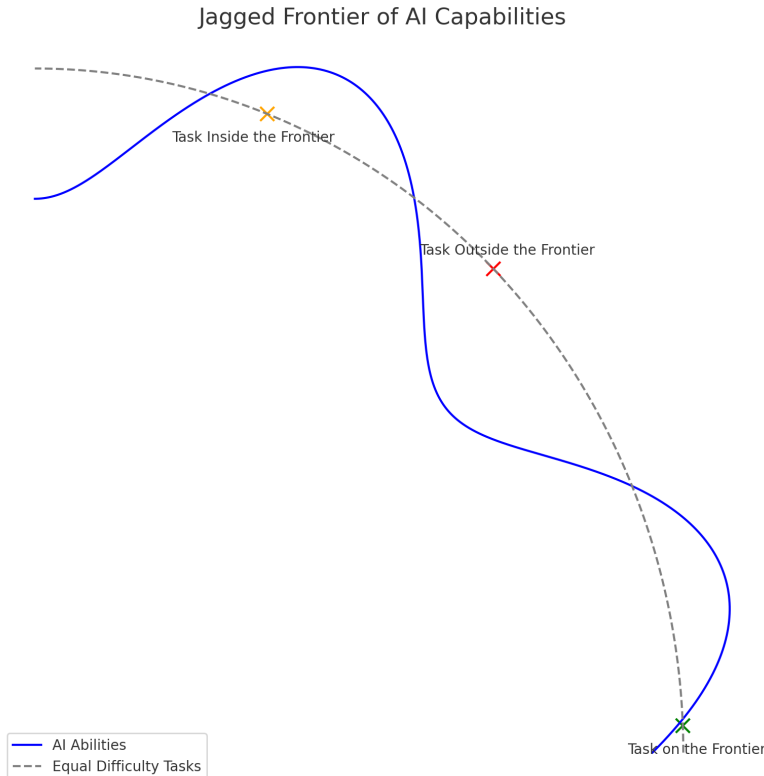


AI is weird. No one actually knows the full range of capabilities of the most advanced Large Language Models, like GPT-4. No one really knows the best ways to use them, or the conditions under which they fail. There is no instruction manual. On some tasks AI is immensely powerful, and on others it fails completely or subtly. And, unless you use AI a lot, you won't know which is which.

Sources: [Navigating the Jagged Technological Frontier: Field Experimental Evidence of the Effects of AI on Knowledge Worker Productivity and Quality](#) | [Centaur and Cyborgs on the Jagged Frontier \(oneusefulthing.org\)](#)

Does AI boost our performance?

The Jagged Frontier

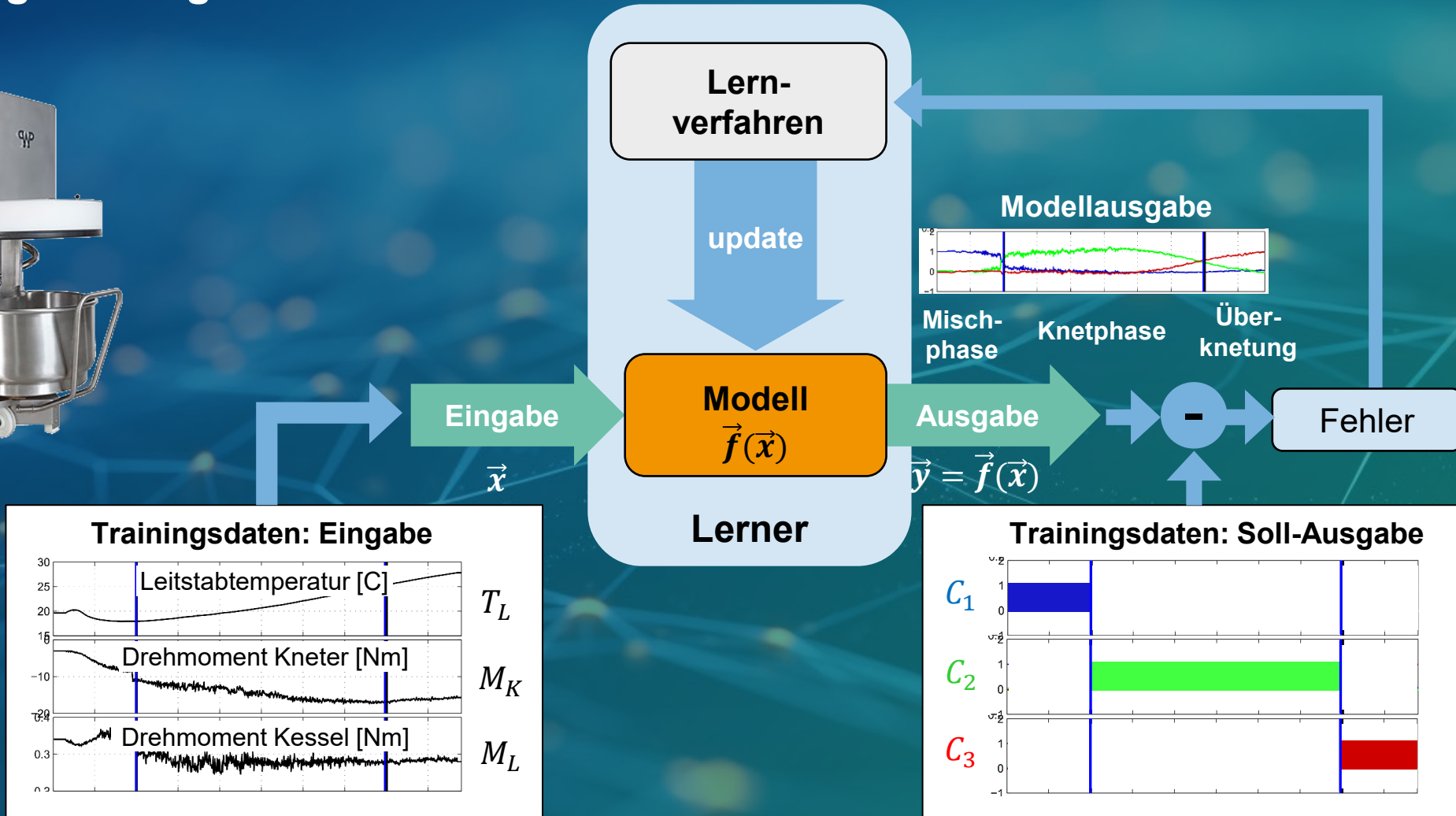


- The "Jagged Frontier" of AI describes the **uneven capabilities of AI systems**, where some tasks are surprisingly easy while others are unexpectedly hard.
- The "fortress wall" metaphor illustrates that AI can handle everything inside its capability boundary, but **the extent of this boundary is not intuitive or visible**.
- As a result, **tasks that seem equally difficult** may actually **vary in complexity for AI**, such as excelling at writing sonnets but struggling with exactly 50-word poems or basic math.

Sources: [Navigating the Jagged Technological Frontier: Field Experimental Evidence of the Effects of AI on Knowledge Worker Productivity and Quality](#) | [Centaur and Cyborgs on the Jagged Frontier \(oneusefulthing.org\)](#)

Maschinelles Lernen

Der intelligente Teigkneteter



Generative AI Use Cases

What are the potential applications?



Strategic Management

Report Summaries

Whitespot Analysis

CEO Videos

Market Crawling

...



Customer Relations

Chat-driven Service Report Generation

Interactive User Manuals

Customer support bots

Guided Selling

...



Product & Service Development

Code Generation / Code Analysis

Requirement Generation

Virtual Personas

Ideation

...



Production & Quality

Virtual Project Manager

Automated Project Reporting

Quality Report Generation

Chat-based Quality Handbooks

...



Procurement & Logistics

Automated Supplier Ranking

Purchasing negotiations

Contract drafting and checking

Market Crawling

...

Generative AI Use Cases

What are the potential applications?



Enterprise Support

Chat-driven Workflows

Interactive Employee Onboarding

NLP-based control of ERP systems

Automated Meeting Summaries

...



Marketing & Sales

Pitch Deck Creator

Target group Analysis

Price Optimization

Lead-Scoring

...



Finance

Financial Forecasting

Fraud Detection

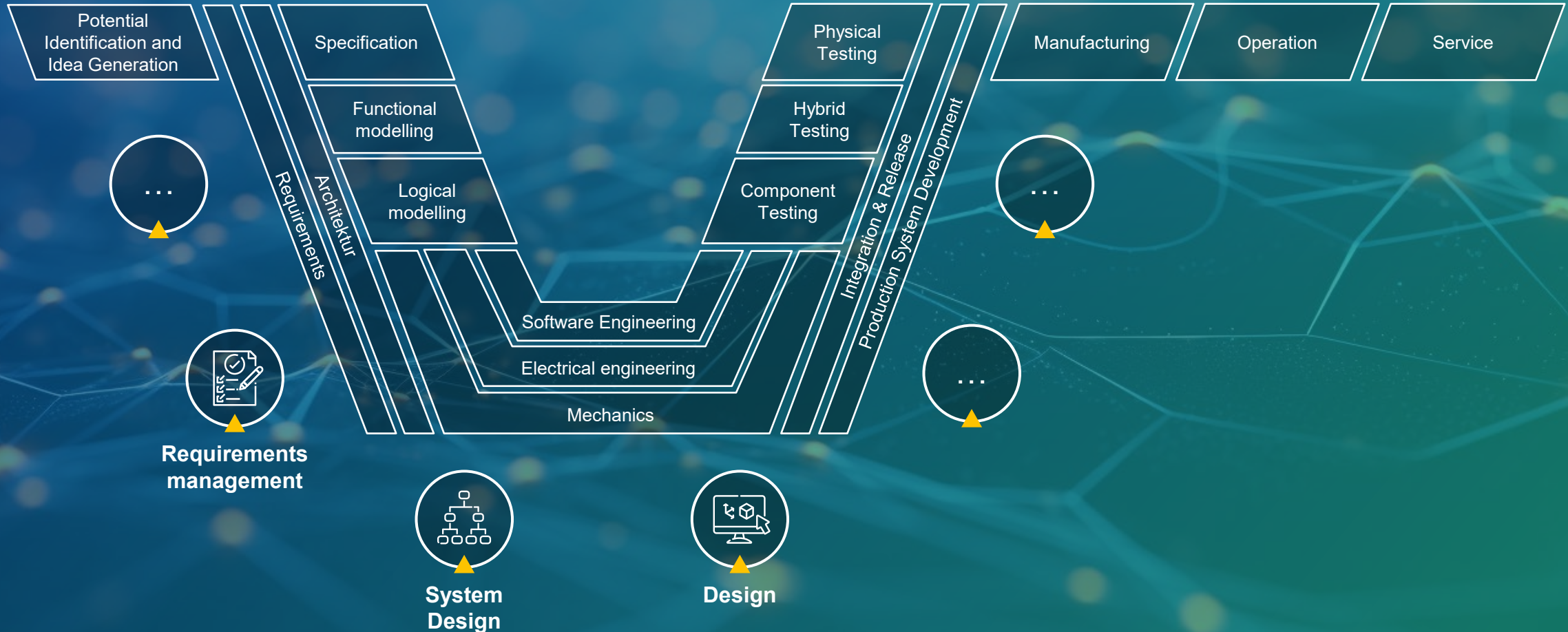
Financial News Summaries

Fraud Detection

...

Generative AI for Engineering

Where are the potential applications?



Generative AI for Engineering

Where are the potential applications?

X-to-Requirements



Requirements management



System Design



Design

Requirements GPT



From Vision to Requirements

Welcome to RequirementsGPT, a LLM-powered REQUIREMENT MANAGEMENT to transform *User Personas* or *System Ideas* into requirements with precision and clarity.

TL;DR: We help you to define the requirements!

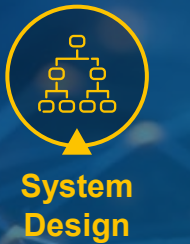
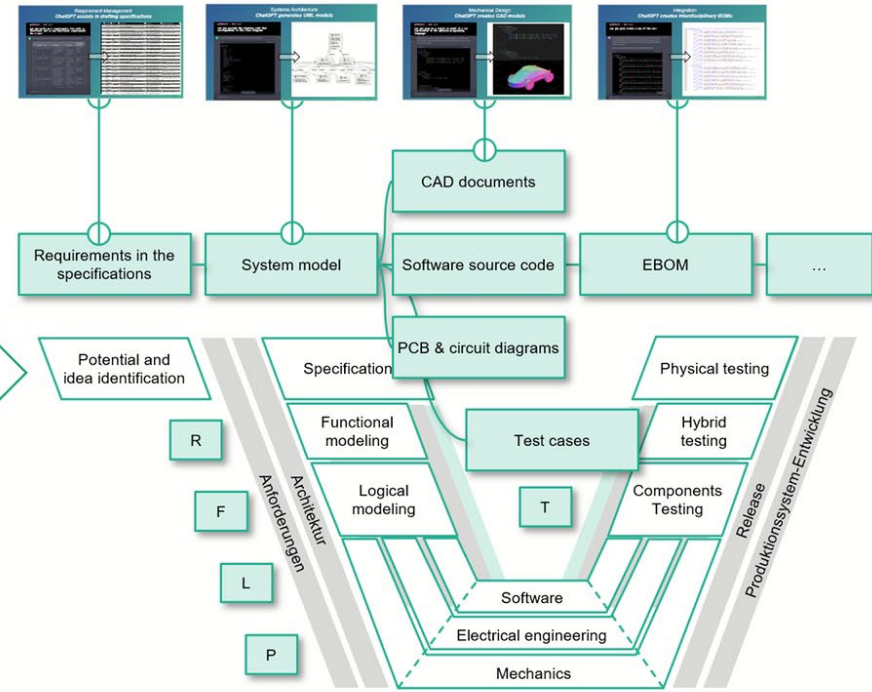
START

Generative AI for Engineering

Where are the potential applications?

X-to-Systems Engineering

How to design a car with ChatGPT in 20min



Generative AI for Engineering

Where are the potential applications?



Anforderungsmanagement



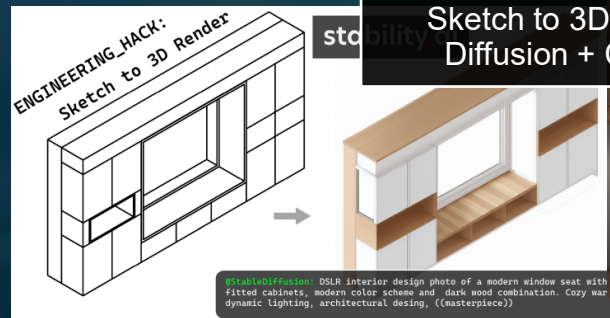
Systementwurf



Design

X-to-Design

ENGINEERING_HACK:
Sketch to 3D Render

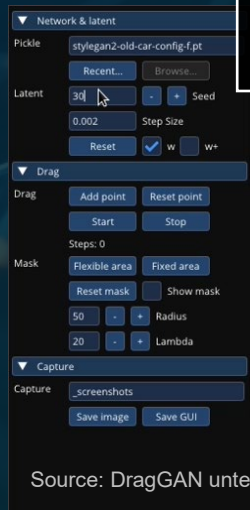


Sketch to 3D with Stable Diffusion + ControlNet



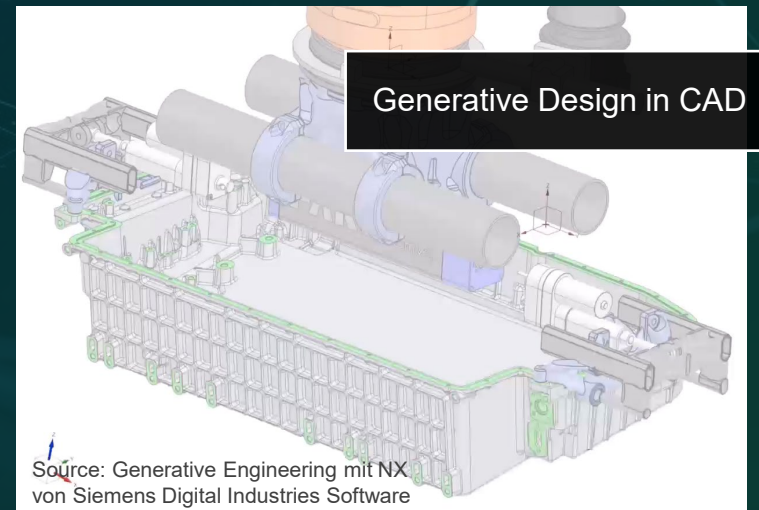
DSLR interior design photo of a modern window seat with fitted cabinets, modern color scheme and dark wood combination. Cozy war dynamic lighting, architectural desing, ((masterpiece))

Direct adaptation of generatively generated product images



Source: DragGAN unter <https://vcai.mpi-inf.mpg.de/projects/DragGAN/>

Generative Design in CAD



Source: Generative Engineering mit NX von Siemens Digital Industries Software

Generative KI – Ein neuer Meilenstein

Fazit

Wir erleben eine Innovationsgeschwindigkeit, wie wir sie nur selten oder womöglich nie zuvor erlebt haben

Die neuen generativen KI-Lösungen können unseren Alltag erheblich erleichtern – wenn wir wissen, wann und wie wir sie einsetzen müssen

Die Technologie ist quasi für jeden zugänglich – Noch nie war es so leicht, seine Ideen umzusetzen und dabei Neues zu lernen!

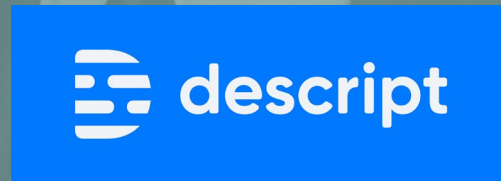
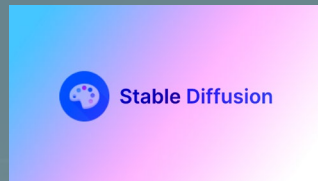
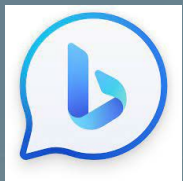
Es ist unsere Pflicht, die Grenzen der generativen KI zu kennen und Regeln für einen verantwortungsvollen Einsatz aufzustellen

Kritisches und analytisches Denken wird in Zukunft noch wichtiger sein!

THANK YOU!



AI Tools used in making this presentation



Übersicht KI-Tools

Text-zu-Bild

- Adobe Firefly: <https://firefly.adobe.com> [kostenfrei nutzbar, Account erforderlich]
- Leonardo.ai: <https://leonardo.ai> [kostenfrei nutzbar, Account erforderlich]
- Bing Create: <https://www.bing.com/create> [kostenfrei nutzbar, Account erforderlich]

KI-Chatbots

- ChatGPT: <https://chat.openai.com> [kostenfrei nutzbar, Account erforderlich]
- Google Bard: <https://bard.google.com/chat> [kostenfrei, Google Account erforderlich]
- Bing Chat: <https://www.bing.com/new> [kostenfrei nutzbar, Account erforderlich]
- character.ai: <https://beta.character.ai> [kostenfrei nutzbar, Account erforderlich]

Text-zu-Musik

- Stable Audio: <https://www.stableaudio.com/generate>
- SoundVerse: <https://www.soundverse.ai/chat>

Weitere Tools

- Blockade Labs: <https://skybox.blockadelabs.com> [kostenfrei nutzbar, kein Account erforderlich]
- LLaVA: <https://llava.hliu.cc> [kostenfrei nutzbar, keine Anmeldung erforderlich]

Und wer nicht genug hat...

<https://www.youtube.com/@FraunhoferIEM/featured>

Suchen

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Abonniert

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