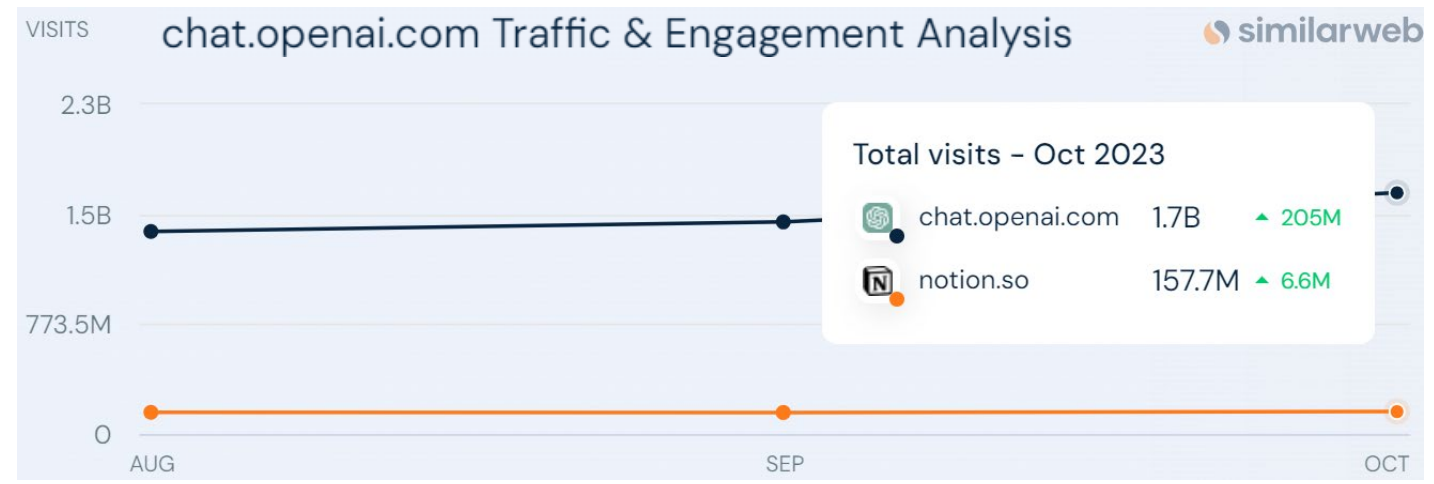
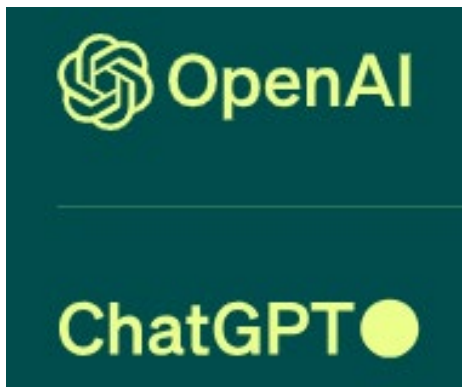


Generative AI for the Industry: More than ChatGPT

Jakub M. Tomczak
Generative AI Group, TU/e (associate professor)
EAISt member

Generativ/e

**Generative AI has changed
our way of thinking about AI**



Dan Milmo *Global technology editor*
 Mon 8 Jan 2024 14.40 CET

'Impossible' to create AI tools like ChatGPT without copyrighted material, OpenAI says



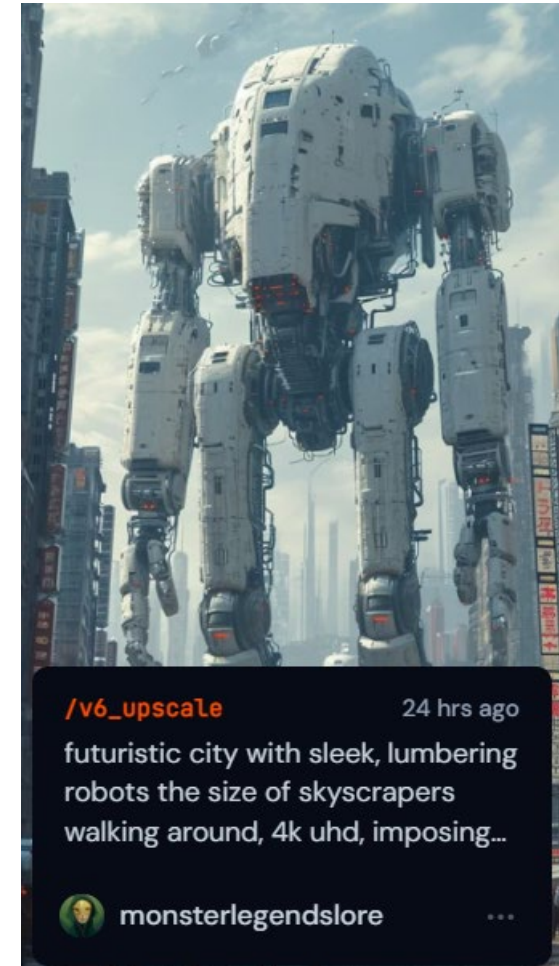
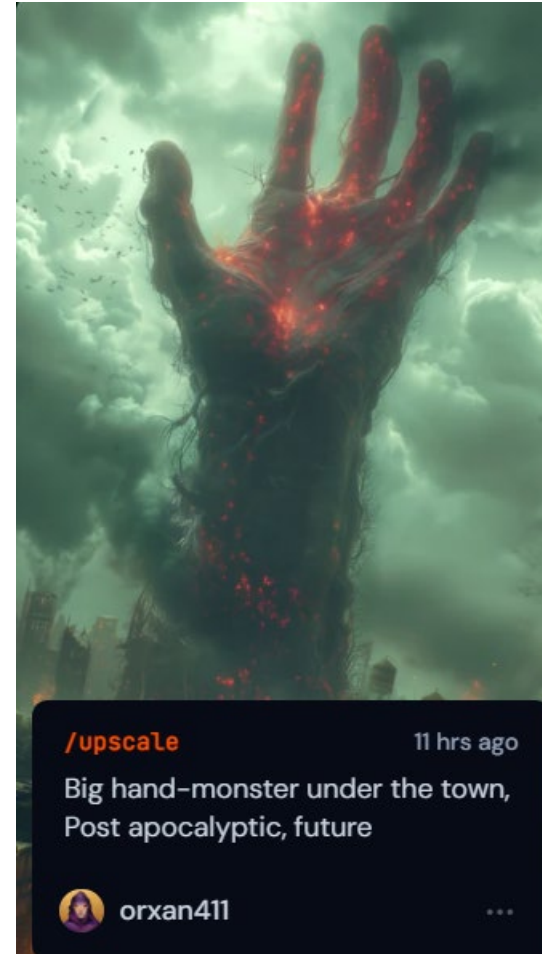
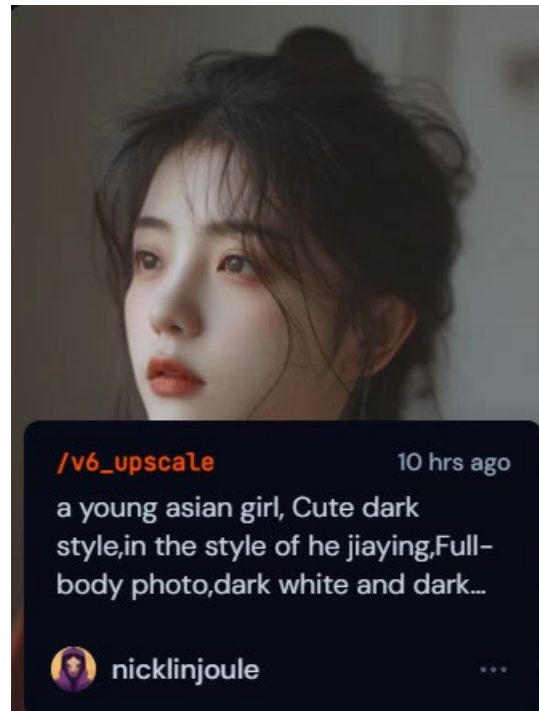
01/08/24 | Wolfsburg | Models | Press Release

World premiere at CES: Volkswagen integrates ChatGPT into its vehicles



Vishwam Sankaran • 2 days ago

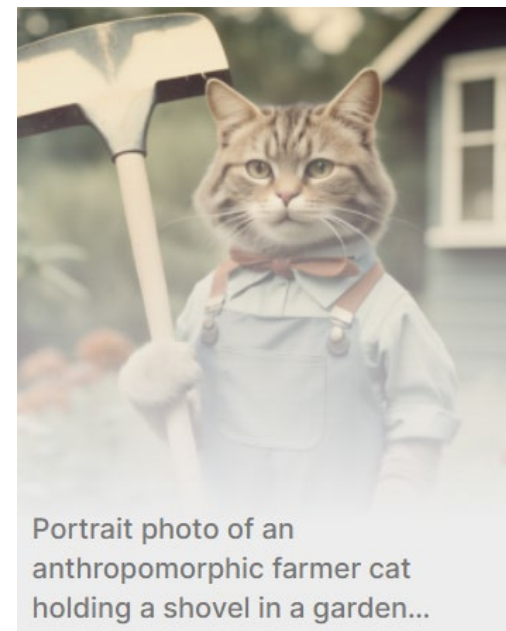
OpenAI: ChatGPT company quietly softens ban on using AI for military



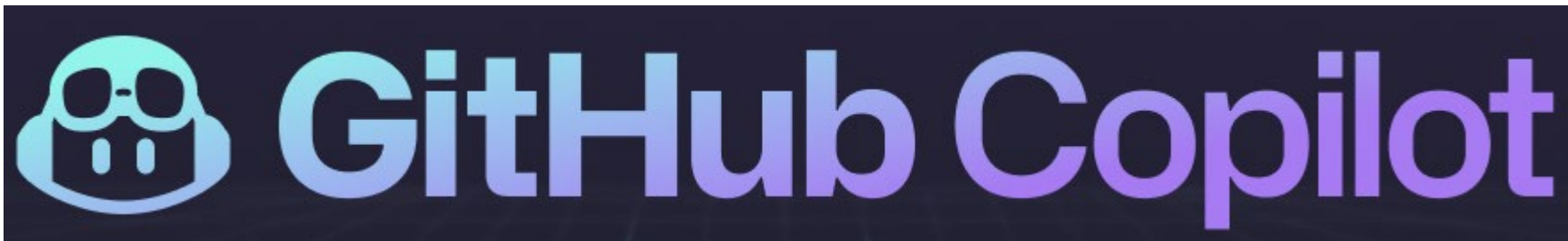
stability.ai



Skeleton man going on an adventure in the foggy hills of Ireland wearing a cape



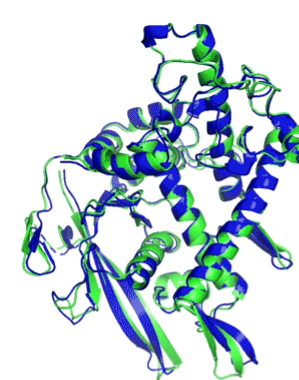
Portrait photo of an anthropomorphic farmer cat holding a shovel in a garden...

The logo for GitHub Copilot, featuring the GitHub Octocat icon on the left and the text "GitHub Copilot" in a large, light blue font on the right, all set against a dark blue background.

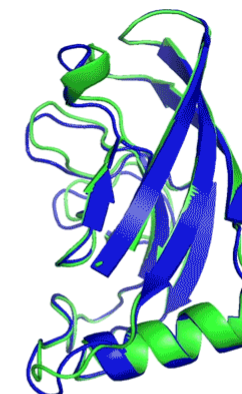
```
runtime.go course.rb time.js IsPrimeTest.java
1 package main
2
3 type Run struct {
4     Time int // in milliseconds
5     Results string
6     Failed bool
7 }
8
9 // Get |
10
11
12
13
14
15
16
17
18
19
20
21
22
23
```



Isomorphic Labs



T1037 / 6vr4
90.7 GDT
(RNA polymerase domain)



T1049 / 6y4f
93.3 GDT
(adhesin tip)

- Experimental result
- Computational prediction

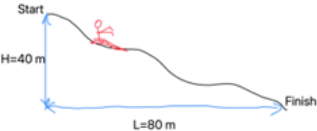


Google DeepMind

Prompt

Here's a solution to a Physics problem by a student.

23. A skier slides down the frictionless slope as shown. What is the skier's speed at the bottom?



Solution:

The conservation of energy means that the energy of the skier is same at the beginning and at the end.

Start: $E = mgL$

End: $E = \frac{1}{2}mv^2$

$$\Rightarrow mgL = \frac{1}{2}mv^2$$

$$\Rightarrow v = \sqrt{2gL} = \sqrt{2 \times 9.81 \times 80} = 39.6 \text{ m s}^{-1}$$

Try to reason about the question step by step.

Did the student get the correct answer? If the solution is wrong, please explain what is wrong and solve the problem.

Make sure to use LaTeX for math and round off the final answer to two decimal places.

Response

The student did not get the correct answer. The student made a mistake in the calculation of the potential energy at the start of the slope. The potential energy at the start of the slope is given by mgh , where m is the mass of the skier, g is the acceleration due to gravity, and h is the height of the slope. The student used the length of the slope, L , instead of the height, H , in the calculation of the potential energy.

The correct solution is:

The conservation of energy means that the total energy of the skier is the same at the beginning and at the end of the slope.

At the start of the slope, the skier has only potential energy, which is given by mgh .

At the end of the slope, the skier has only kinetic energy, which is given by $\frac{1}{2}mv^2$

Therefore, we can write:

$$mgh = \frac{1}{2}mv^2$$

Canceling out the mass m on both sides, we get:

$$gh = \frac{1}{2}v^2$$

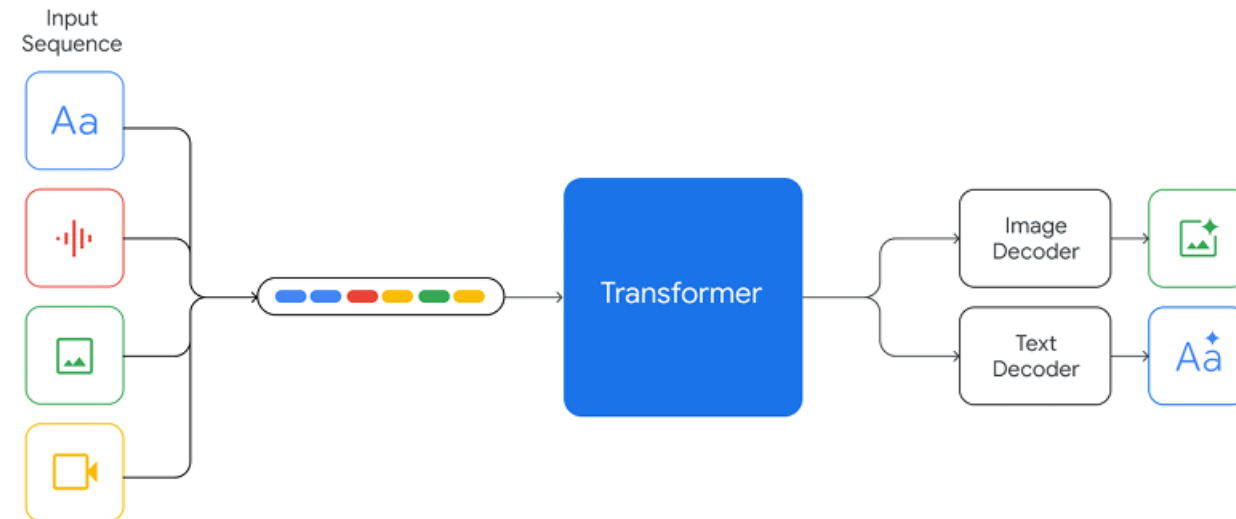
Solving for v , we get:

$$v = \sqrt{2gh}$$

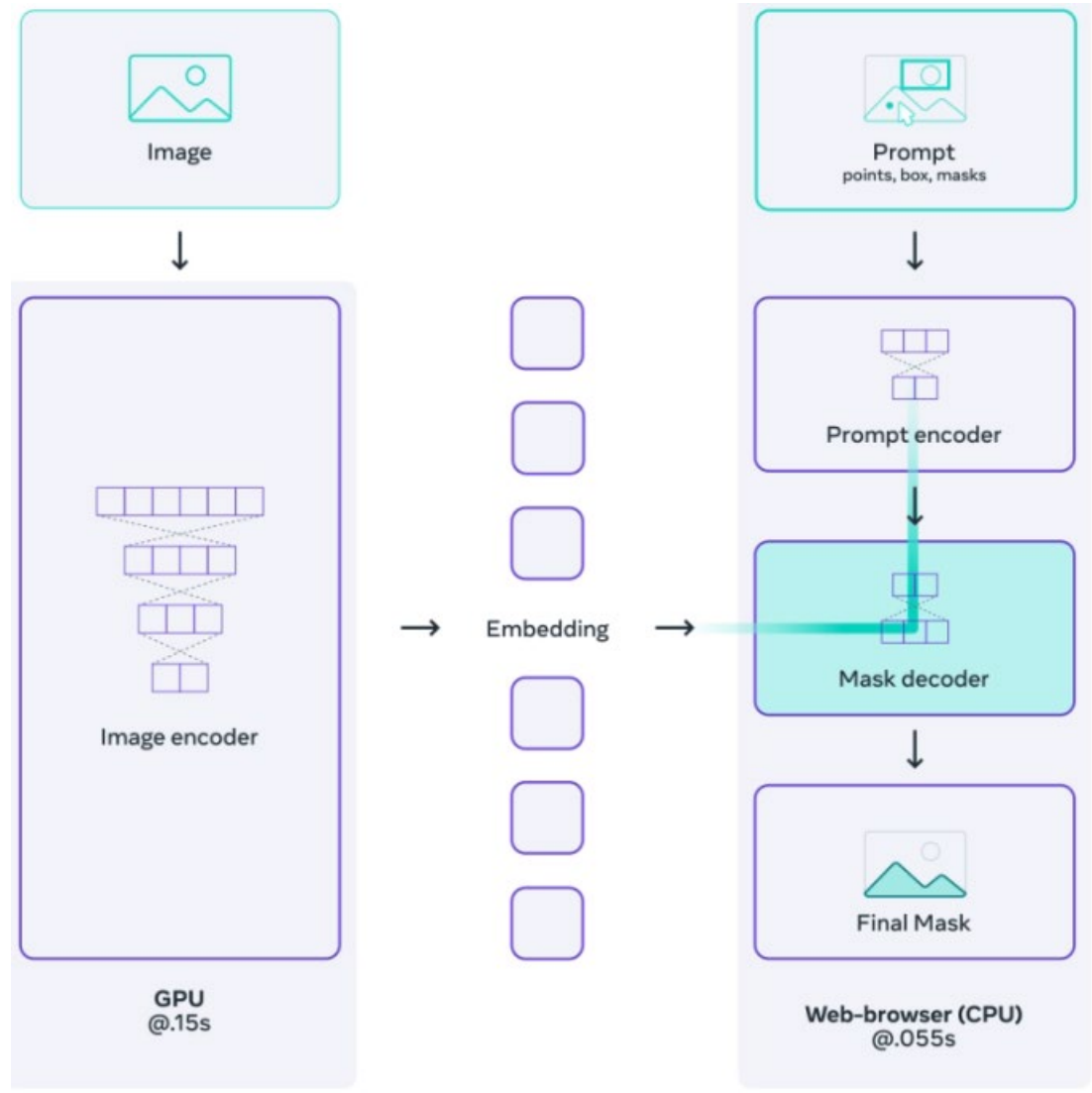
Substituting the given values, we get:

$$v = \sqrt{2 \times 9.81 \times 40} = 28.01 \text{ m/s}$$

Therefore, the skier's speed at the bottom of the slope is 28.01 m/s.



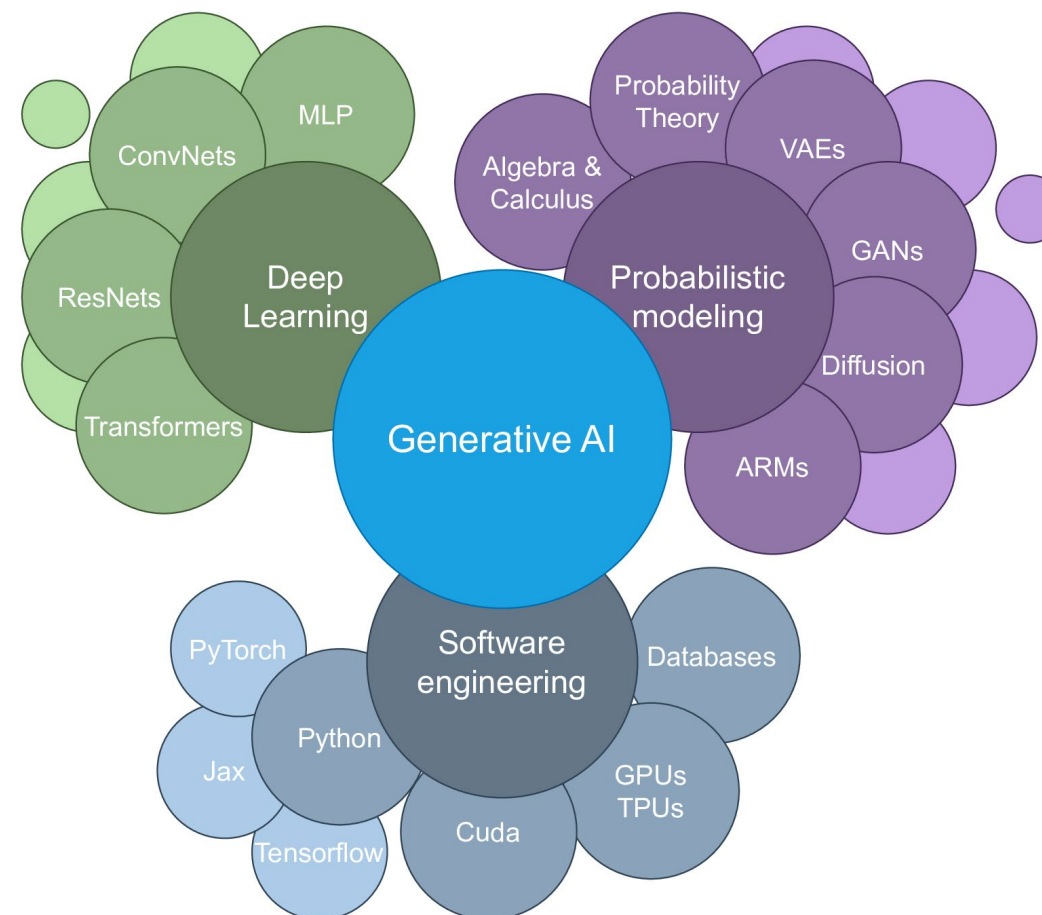
Meta



How Generative AI works?

Three pillars of Generative AI

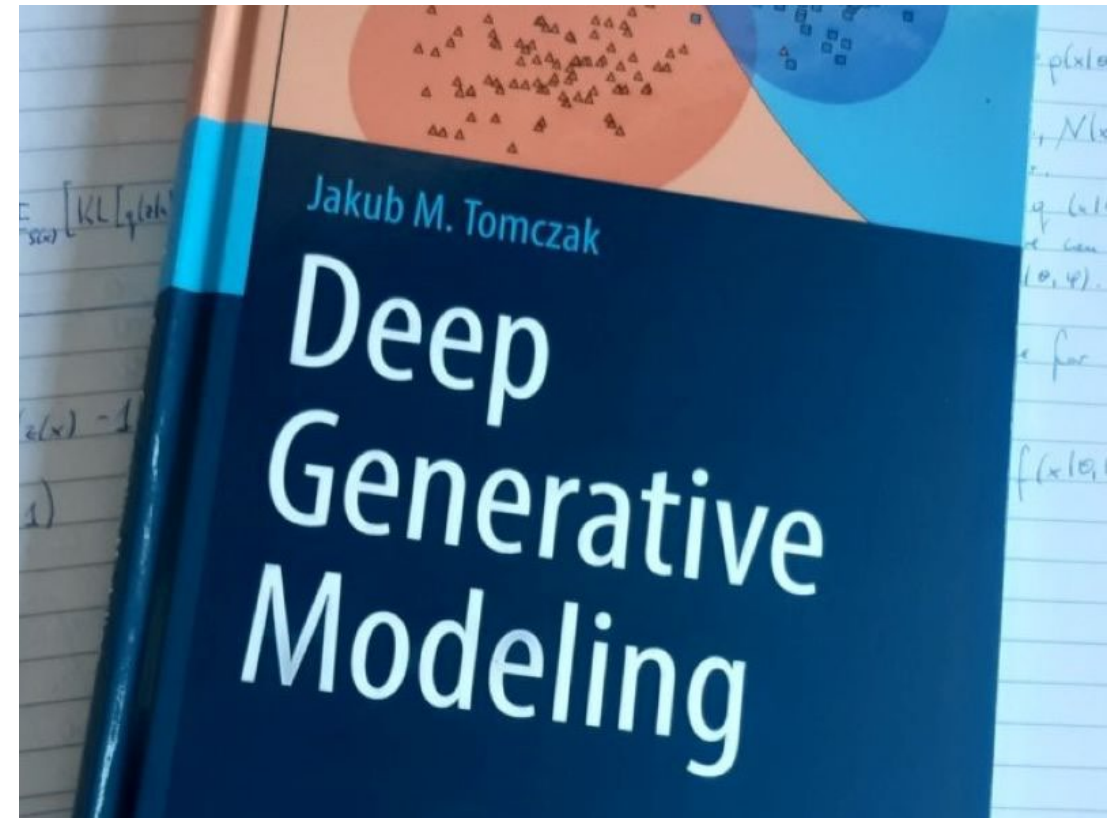
- **Three pillars:**
 - **Probabilistic modeling**
(principles of building models)
 - **Deep Learning**
(parameterizations of distributions)
 - **Software engineering**
(effective and efficient implementation of Generative AI)



The first comprehensive book on Generative AI

Theory and code for all (deep) generative models:

- Autoregressive models
- Flow-based models
- Variational Auto-Encoders
- Diffusion models
- Generative Adversarial Networks
- Energy-based models
- ***(new edition: under development)***
Score-based Models & Transformers



Tomczak, J. M. (2022). *Deep Generative Modeling*. Springer Cham

Generative AI at the TU/e

Generativ/e group at the TU/e



Generative Computer Vision

Forward SDE (data → noise)

$$dx = f(x, t)dt + g(t)dw$$

Reverse SDE (noise → data)

$$dx = [f(x, t) - g^2(t)\nabla_x \log p_t(x)] dt + g(t)dw$$

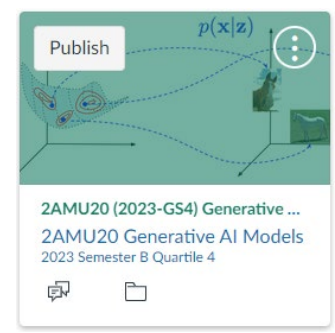
Score function

$$\mathcal{L}_3$$

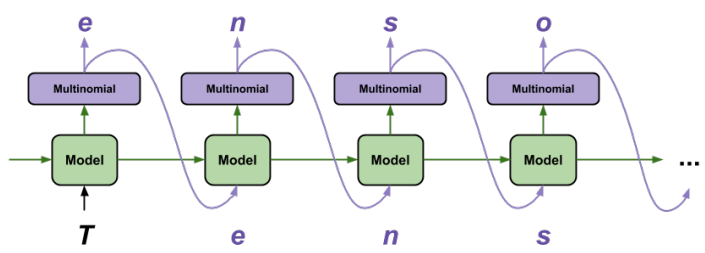
$$\begin{matrix} 1 \cdot 0 + 0 \cdot 1 + 0 \cdot 0 = 0 \\ 1 \cdot 0 + 0 \cdot 0 + 0 \cdot 1 = 0 \\ 0 \cdot 0 + 1 \cdot 0 + 0 \cdot 1 = 0 \end{matrix}$$

$$\begin{matrix} 1^2 + 0^2 + 0^2 = 1 \\ 0^2 + 1^2 + 0^2 = 1 \\ 0^2 + 0^2 + 1^2 = 1 \end{matrix}$$

Foundations of Generative AI



Education

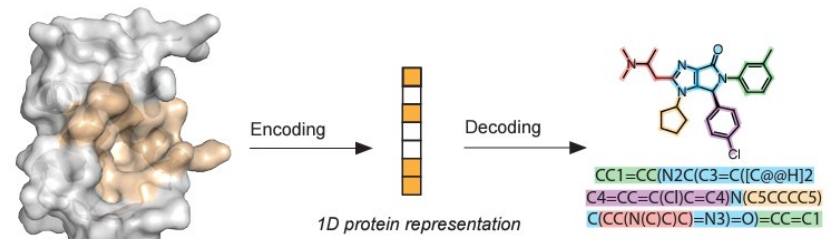


Large Language Models

Generativ/e



Uncertainty Deep Learning



Life Sciences
Molecular Sciences



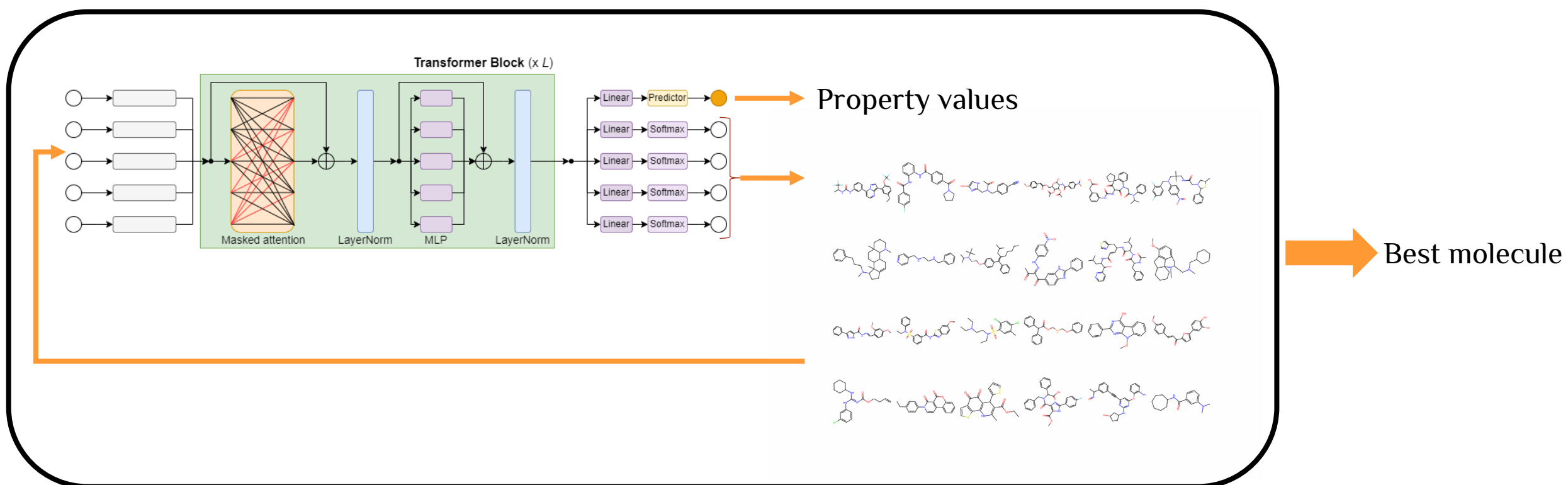
AI4Science Databases



De novo drug design with Transformers

Generative AI with Decision Making:

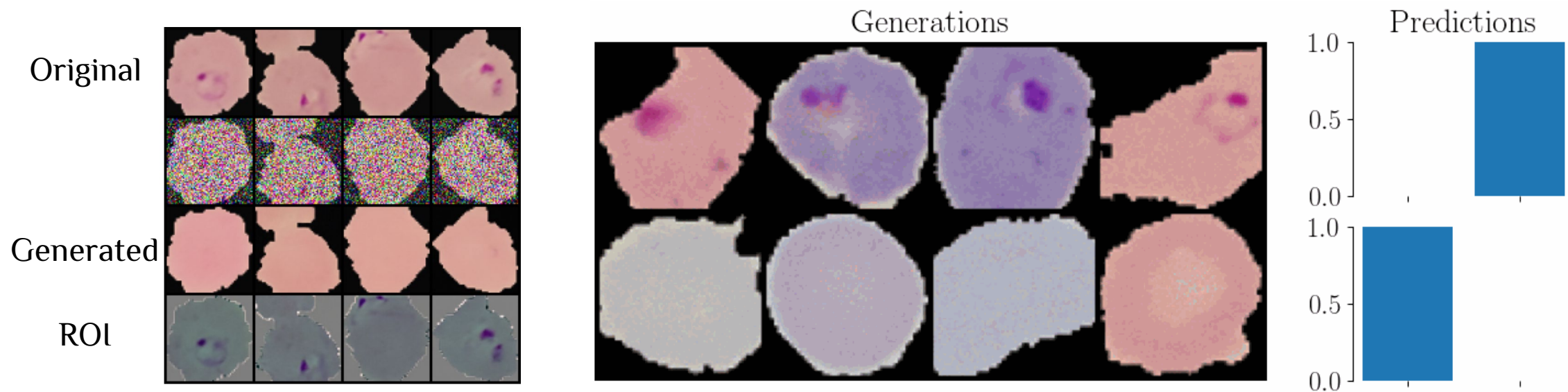
A single model that can GENERATE and PREDICT at the same time



Joint Diffusion Models for Medical Imaging

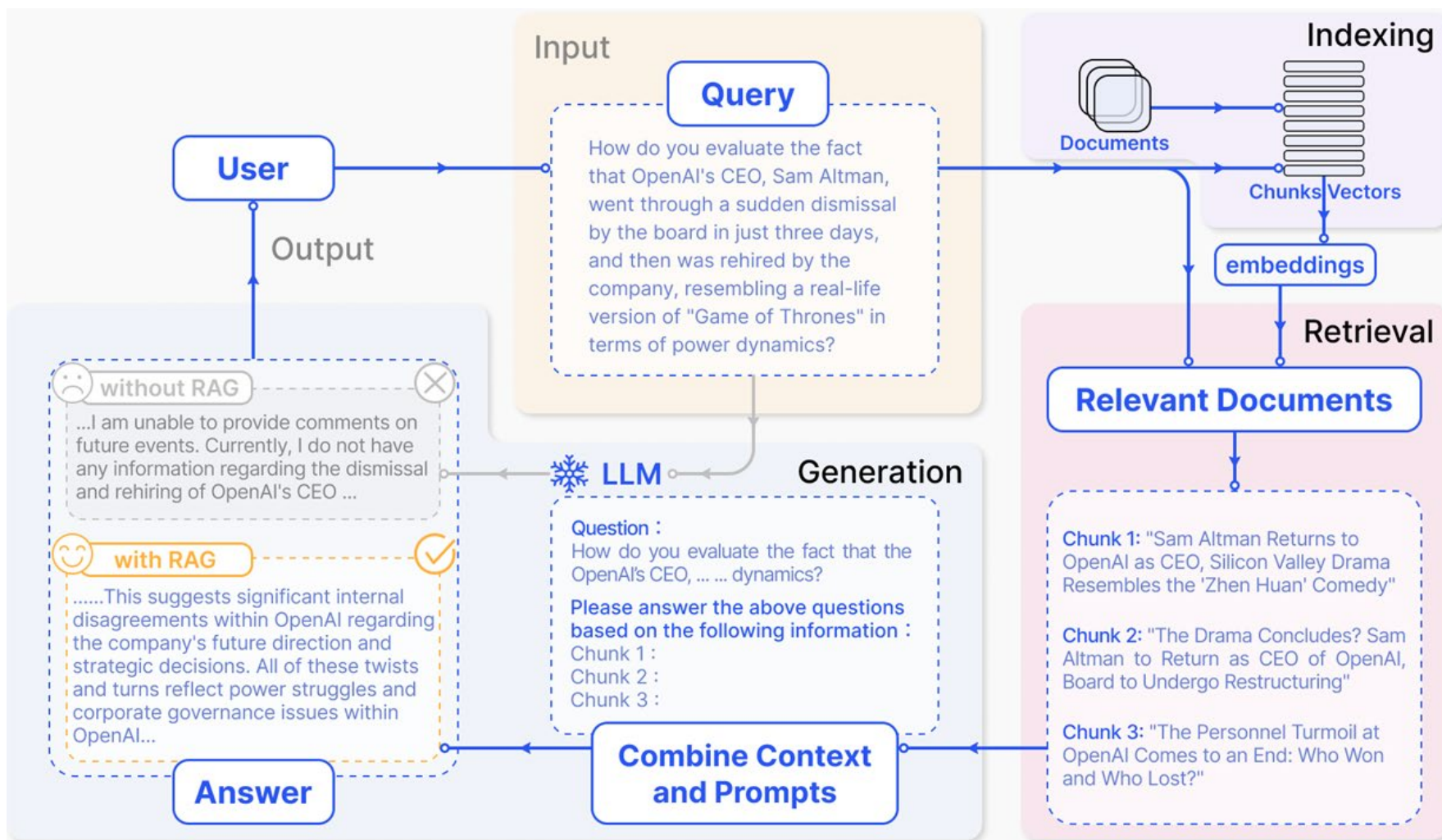
Generative AI with Decision Making:

A single model that can GENERATE and PREDICT at the same time



**What else can we do with
Generative AI in the future?**

LLMs for engineers



LLMs as manuals for engineers.

Examples:

- Diagnostics **ASML**
- Documentations
- Education
- System design

Generative AI for Chip Design

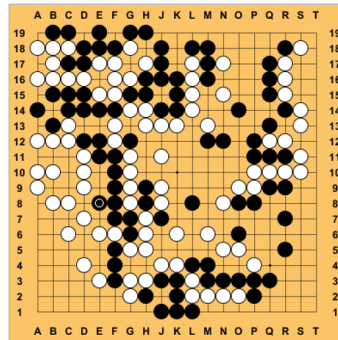
Complexity of Chip Design

Chess



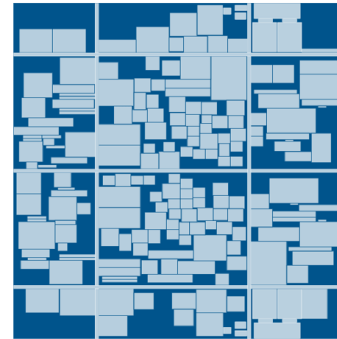
Number of states $\sim 10^{123}$
41 zeros

Go



Number of states $\sim 10^{360}$
120 zeros

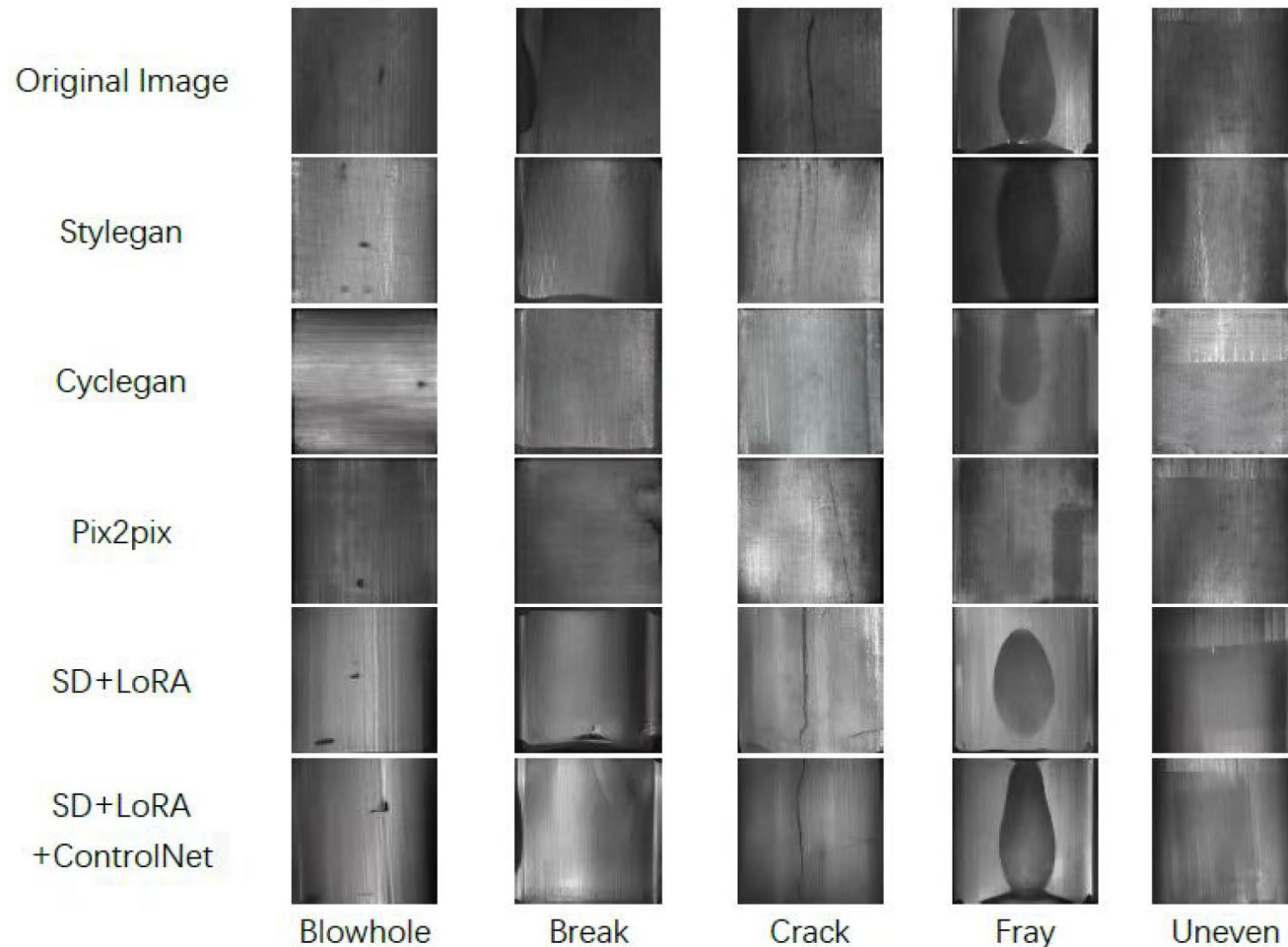
Placement



Number of states $> 10^{100,000}$
(way too many zeros)

"We're already seeing AI accelerate the design process by flattening learning curves, eliminating tedious work, and upleveling expertise, which expands skillsets" – *Erik Berg, Principal Engineer in the verification and validation team at Microsoft.*

Generative AI for Diagnostics



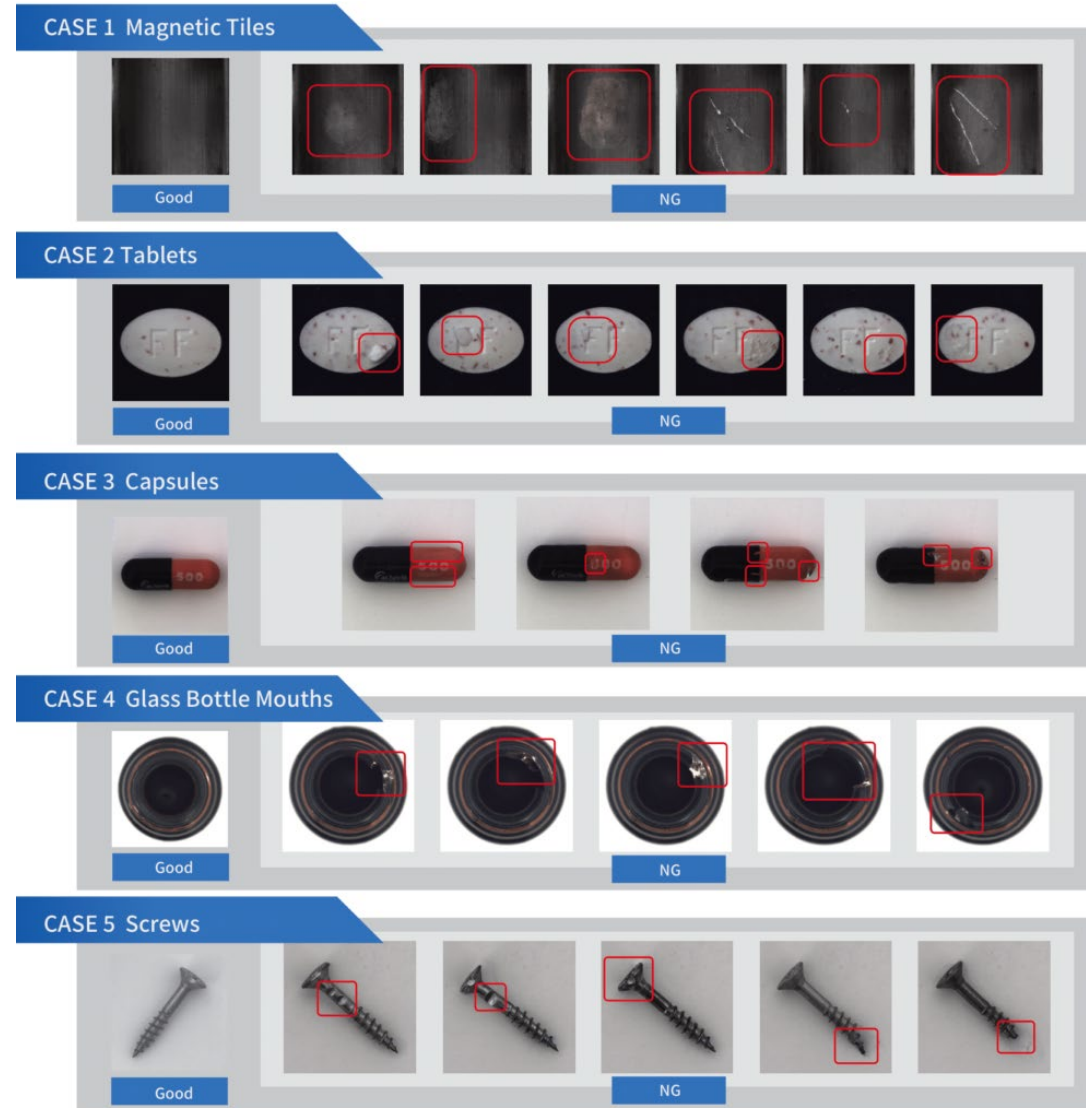
Typical situation (defect detection):

- very few labeled data

- a need for transfer learning

- a lack of background knowledge

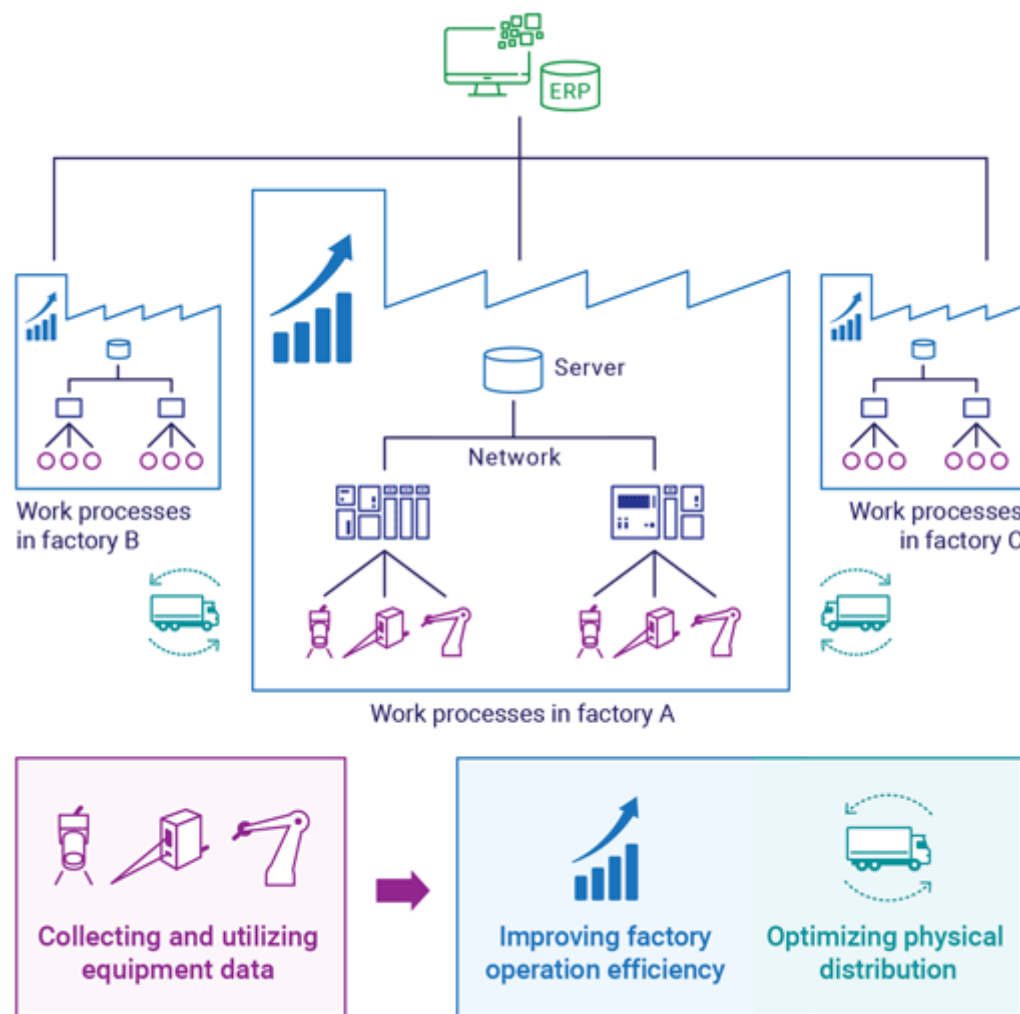
Generative AI for Diagnostics



Typical situation (inspections):

- very few labeled data
- a need for transfer learning
- a lack of background knowledge

Generative AI in Industry 4.0/5.0



Data from sensors:

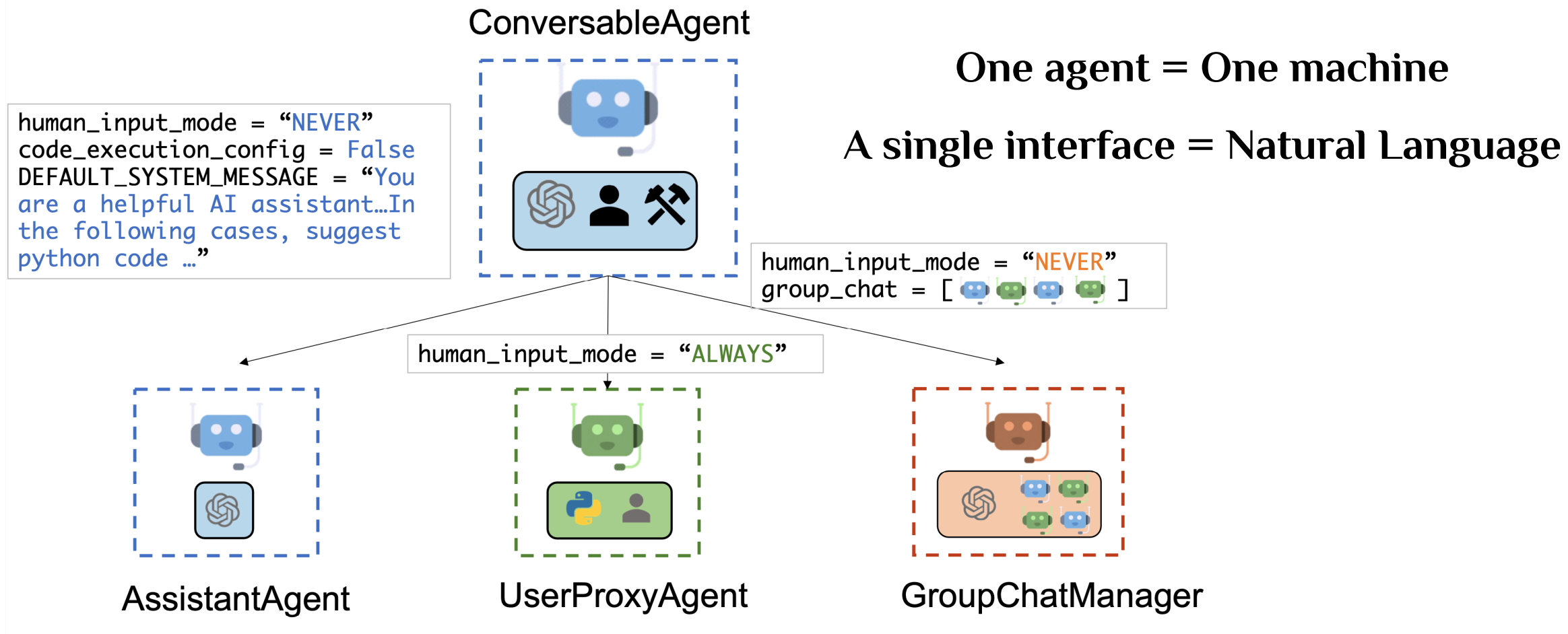
- Datastreams
- Event data

Labeled data < 1%

Multi-stage decision making

Network data

Generative Multi-Agent Systems



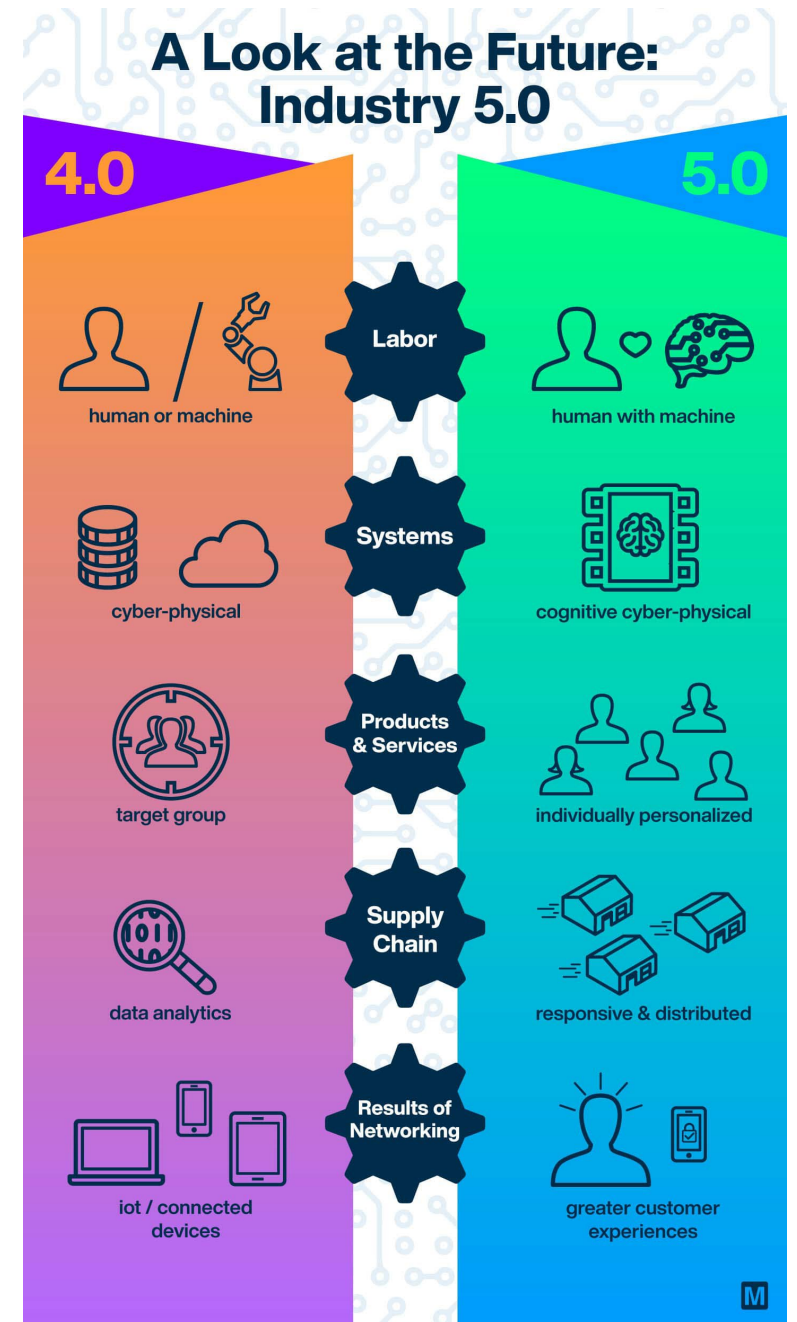
Conclusion

Generative AI is the key for Industry 5.0

Generative AI + Decision Making

Generative AI helps...

- designers
- engineers
- in diagnostics
- in communication
- machines to talk



Thank you!

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jmk.tomczak@gmail.com

Generativ/e

Generative AI Group: <https://generativeai-tue.github.io/>