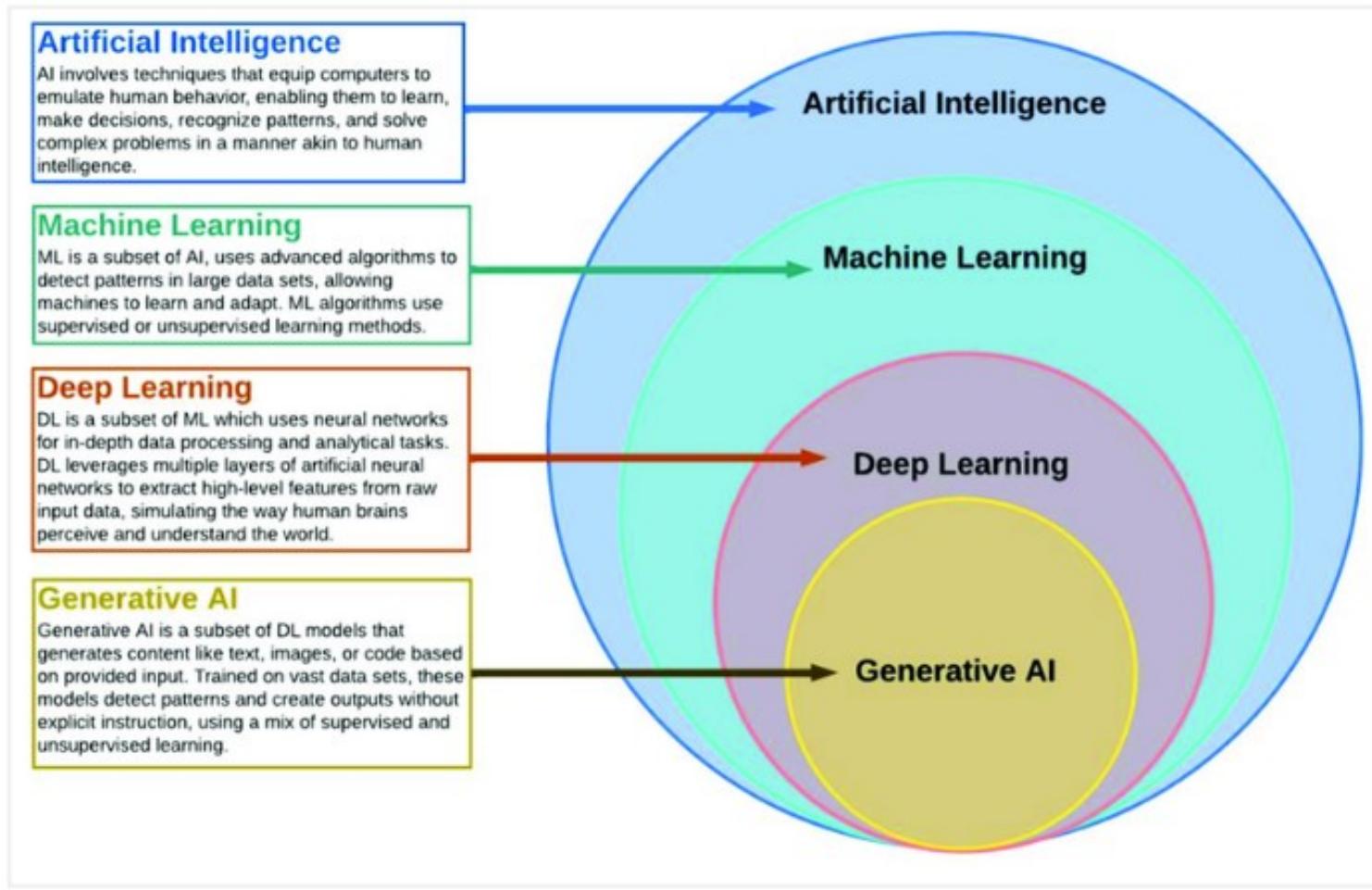


Introduction to GenAI

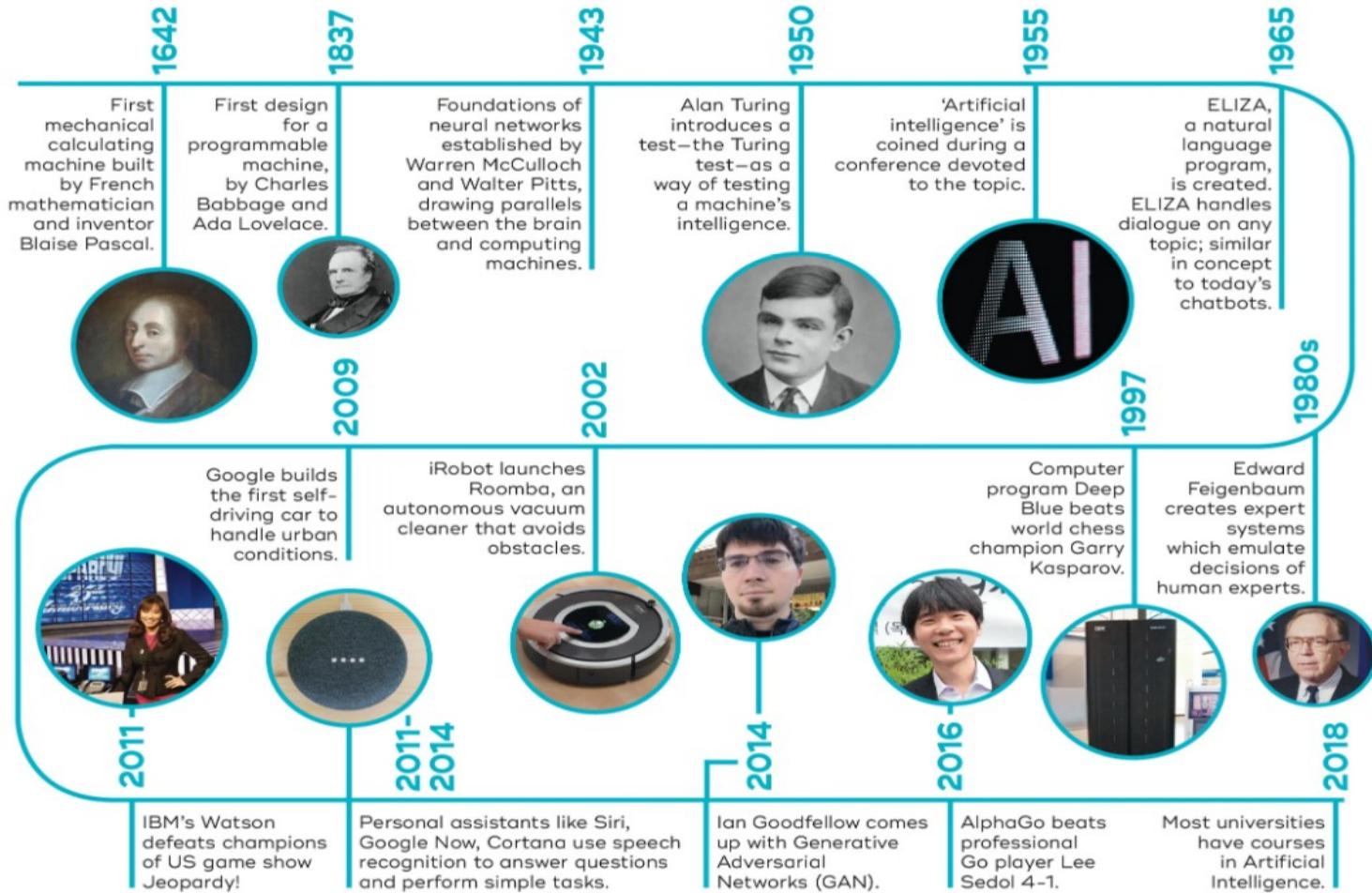
Past > Present > Future

wen.g.gong@gmail.com

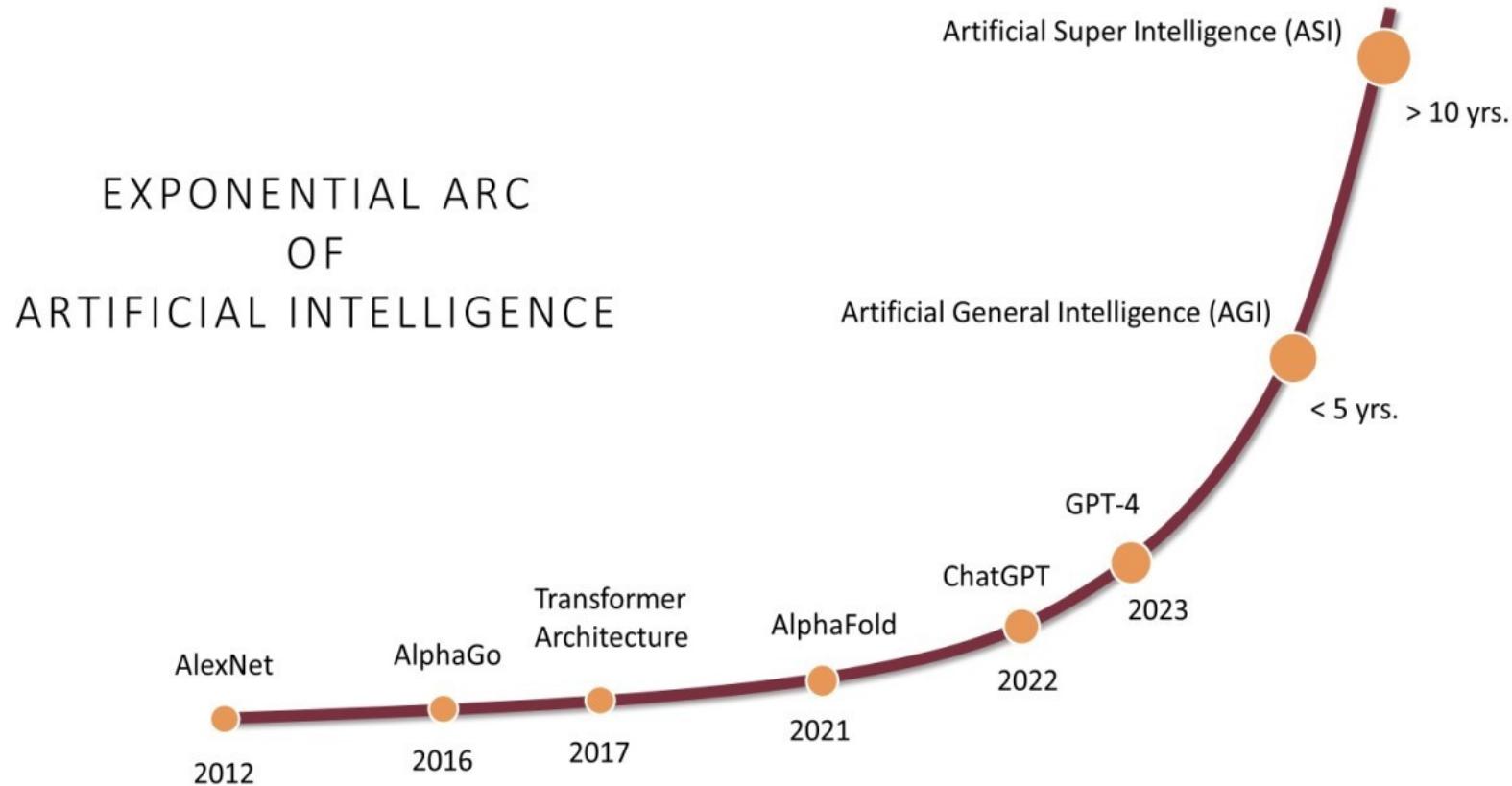
AI > ML > DL > GenAI



AI History



AI Growth & Milestones



OpenAI: ChatGPT

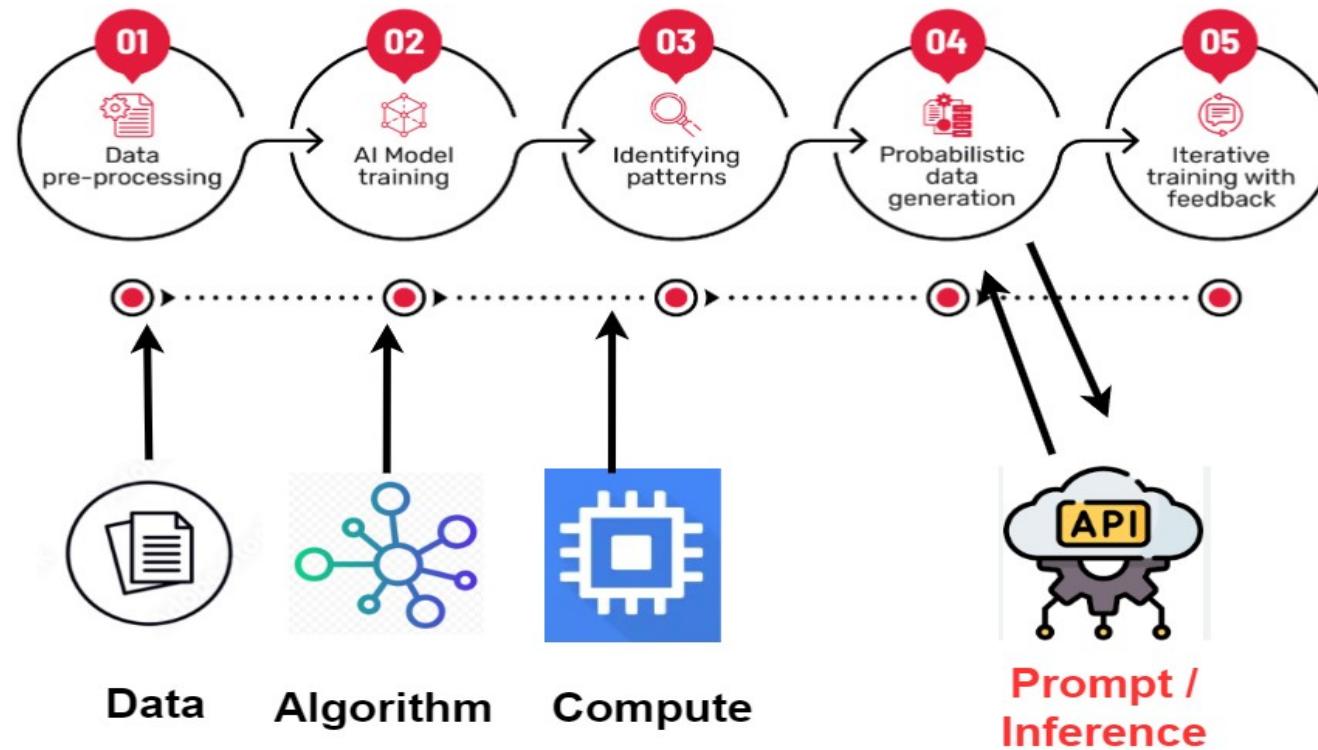


LLMOps: Model Lifecycle

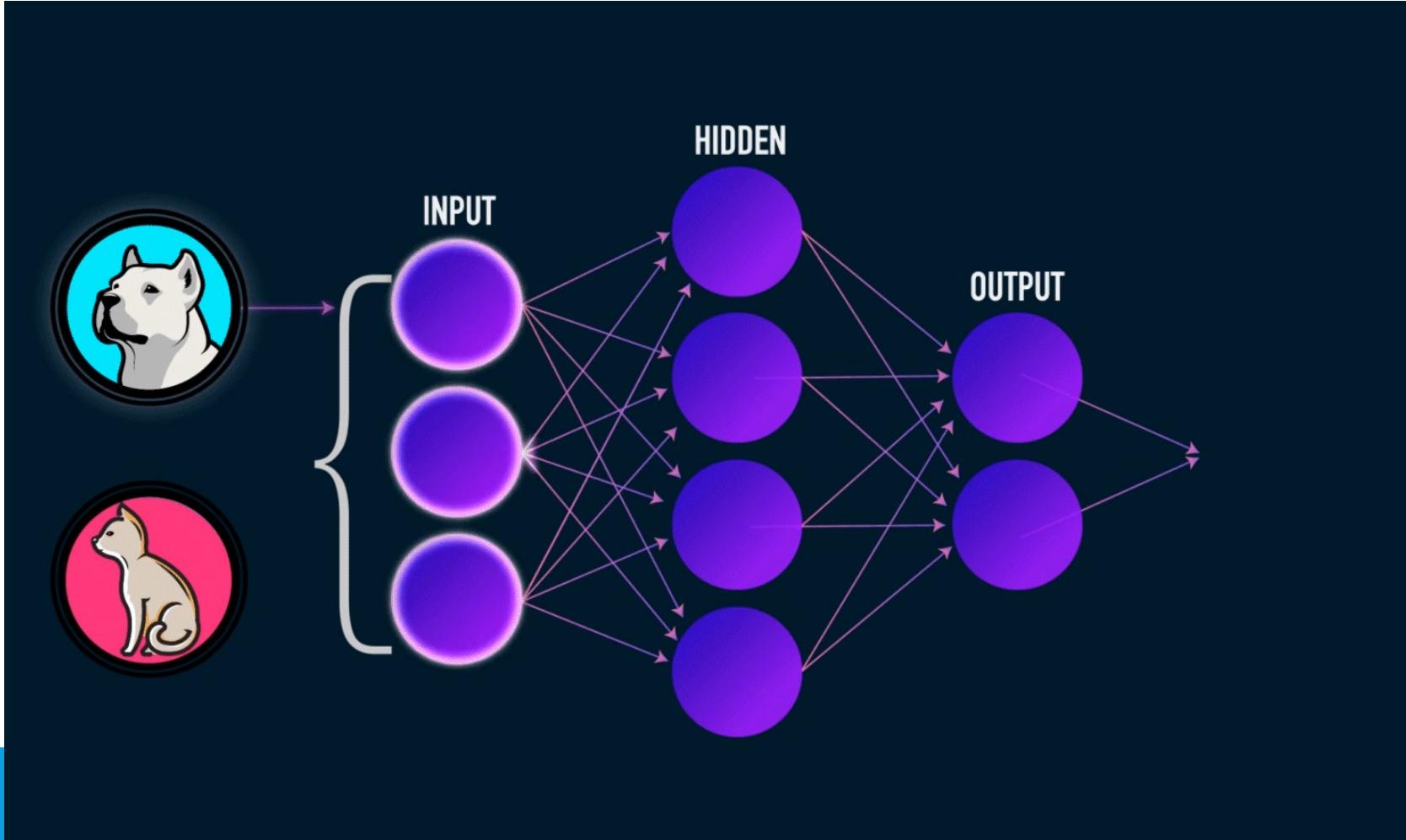


How does GenAI work?

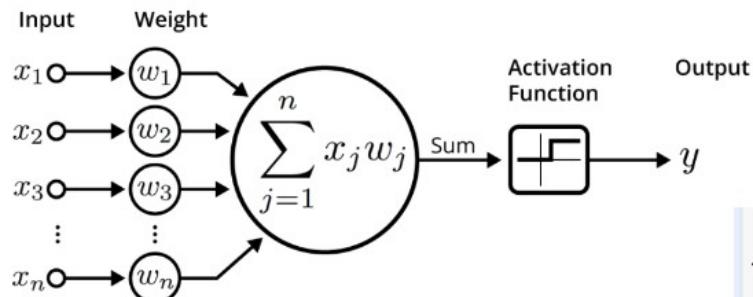
How Generative AI Works



GenAI: Neural Network

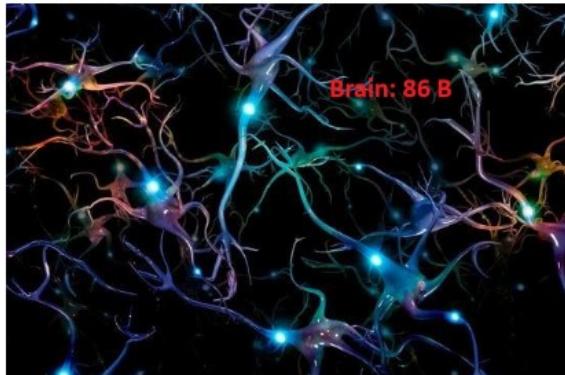


LLM: $y = f(x)$



An illustration of an artificial neuron. Source: Becoming Human.

$$y = f(x)$$

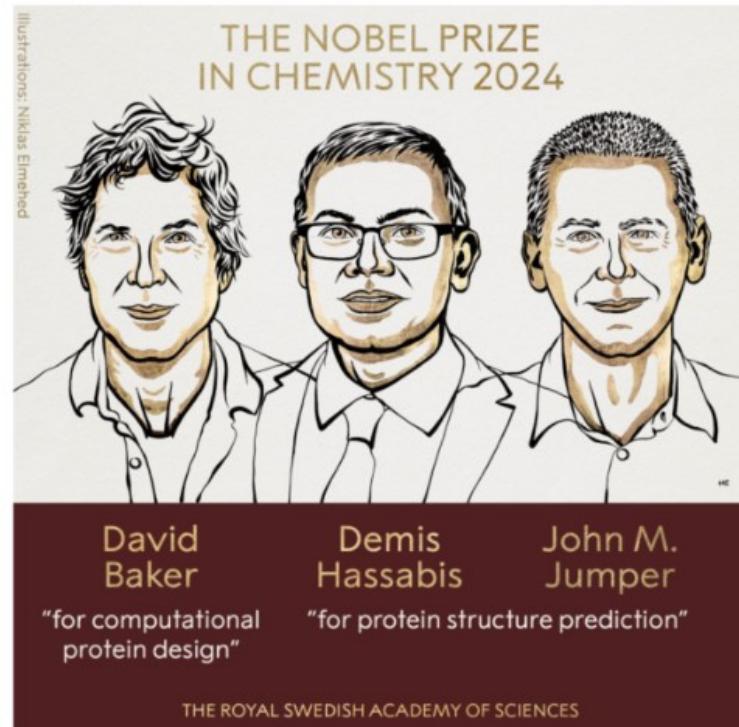
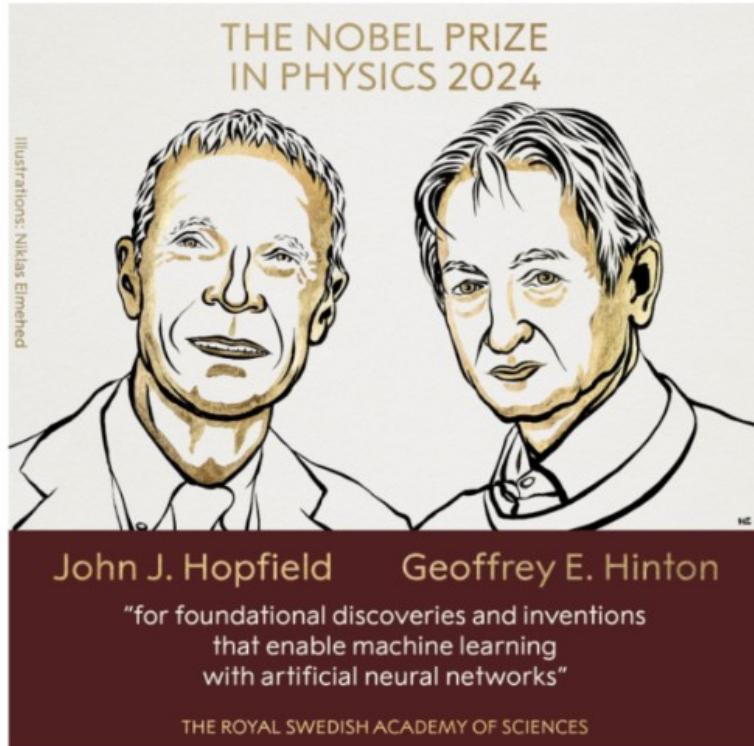


Parameters in Selected AI Models

Some of these figures are estimates. Newer models are many times larger than their predecessors.



2024 Nobel Prizes in Physics & Chemistry



State of AI - 2024

Research

- Frontier lab performance converges, but OpenAI maintains its edge following the launch of o1, as planning and reasoning emerge as a major frontier.
- Foundation models demonstrate their ability to break out of language as multimodal research drives into mathematics, biology, genomics, the physical sciences, and neuroscience.
- US sanctions fail to stop Chinese (V)LLMs rising up community leaderboards.

Industry

- NVIDIA remains the most powerful company in the world, enjoying a stint in the \$3T club, while regulators probe the concentrations of power within GenAI.
- More established GenAI companies bring in billions of dollars in revenue, while start-ups begin to gain traction in sectors like video and audio generation. Although companies begin to make the journey from model to product, long-term questions around pricing and sustainability remain unresolved.
- Driven by a bull run in public markets, AI companies reach \$9T in value, while investment levels grow healthily in private companies.

Politics

- While global governance efforts stall, national and regional AI regulation has continued to advance, with controversial legislation passing in the US and EU.
- The reality of compute requirements forces Big Tech companies to reckon with real-world physical constraints on scaling and their own emissions targets. Meanwhile, governments' own attempts to build capacity continue to lag.
- Anticipated AI effects on elections, employment and a range of other sensitive areas are yet to be realized at any scale.

Safety

- A vibe-shift from safety to acceleration takes place as companies that previously warned us about the pending extinction of humanity need to ramp up enterprise sales and usage of their consumer apps.
- Governments around the world emulate the UK in building up state capacity around AI safety, launching institutes and studying critical national infrastructure for potential vulnerabilities.
- Every proposed jailbreaking 'fix' has failed, but researchers are increasingly concerned with more sophisticated, long-term attacks.

LLM Model Types

Model types:

-  →  : LLMs
-  +  →  : Multimodal LLMs
-  +  +  →  : Multimodal LLMs for Robotics
-  → </> : Text to Code
-  →  : Text to Software tool use
-  →  : Text to Image
-  →  : Text to Video
-  →  : Text to Music
-  →  : Image to 3D
-  →  : Text to 3D
-  →  : Biological models

Input/Output types:

-  : Text
-  : Image
- </> : Code
-  : Software tool use
-  : Video
-  : Music
-  : 3D
-  : Robot state
-  : Biological modality

GenAI Leading Players

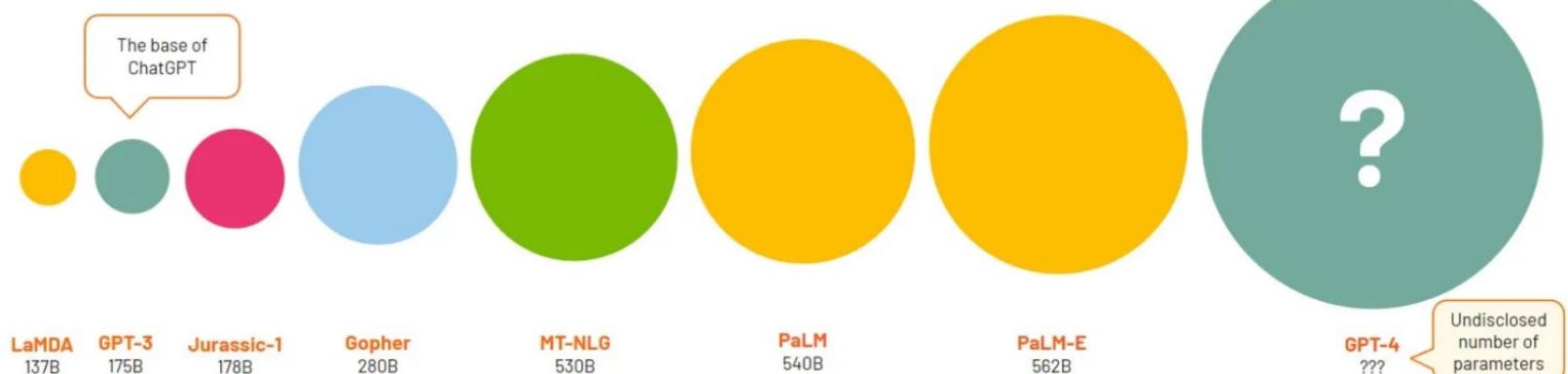
— Large Language Models are becoming very large indeed



Small models (<= 100b parameters)



Large models (>100b parameters)



Undisclosed
number of
parameters



HuggingFace – Open Source LLM Hub



And Chinese open source projects win fans around the world

► To drive international uptake and evaluation, Chinese labs have become enthusiastic open source contributors.
A few models have emerged as strong contenders in individual sub-domains.

- DeepSeek has emerged as a community favorite on coding tasks, with deepseek-coder-v2 for its combination of speed, lightness, and accuracy.
- Alibaba released the Qwen-2 family recently, and the community has been particularly impressed by its vision capabilities, ranging from challenging OCR tasks to its ability to analyse complex art work.
- At the smaller end, the NLP lab at Tsinghua University has funded OpenBMB, a project that has spawned the MiniCPM project.
- These are small <2.5B parameter models that can run on-device. Their 2.8B vision model is only marginally behind GPT-4V on some metrics, while 8.5B Llama 3 based model surpasses it on some metrics.
- Tsinghua University's Knowledge Engineering Group has also created CogVideoX - one of the most capable text to video models.

When tasked to identify the most famous artworks of artists with a high notoriety, Qwen2-VL-2B was extremely successful at instantly recognizing them. It completely identified Vincent Van Gogh's *The Starry Night* (1889, MoMA) and Monet's *Impression, Sunrise* (1872, Musée Marmottan) without any instructions. The model managed to identify both the paintings and the painters names, which might have been thanks to the signature or by the fact these are two commonly well-known art pieces, but the descriptions in the results were still impressive. Both were accurate, concise and well-written, in the usual style for an art piece description, and even categorized the artworks in their artists' career.



For the Monet's masterpiece, the model even correctly managed to identify the movement to which it belonged, without any instructions: "The painting is characterized by its loose, impressionistic style, which captures the fleeting effects of light and color in nature. The use of bright, contrasting colors and the use of brushstrokes to create a sense of movement and energy are prominent features of Monet's painting...it is considered one of Monet's most iconic works".

Model Leaderboard

vellum	Average	Multi-choice Qs	Reasoning	Python coding	Future Capabilities	Grade school math	Math Problems
Claude 3.5 Sonnet	88.38%	88.70%	89.00%	92.00%	93.10%	96.40%	71.10%
Claude 3 Opus	84.83%	86.80%	95.40%	84.90%	86.80%	95.00%	60.10%
Gemini 1.5 Pro	80.08%	81.90%	92.50%	71.90%	84%	91.70%	58.50%
Gemini Ultra	79.52%	83.70%	87.80%	74.40%	83.60%	94.40%	53.20%
GPT-4	79.45%	86.40%	95.30%	67%	83.10%	92%	52.90%
Llama 3 Instruct - 70B	79.23%	82%	87%	81.7%	81.3%	93%	50.4%
Claude 3 Haiku	73.08%	75.20%	85.90%	75.90%	73.70%	88.90%	38.90%
GPT-3.5	65.46%	70%	85.50%	48.10%	66.60%	57.10%	34.1%
Mixtral 8x7B	59.79%	70.60%	84.40%	40.20%	60.76%	74.40%	28.40%
GPT-4o	-	88.7%	-	90.2%	-	-	76.60%
GPT-4o mini	-	82%	-	87.00%	-	-	70.20%
Llama 3 Instruct - 8B	-	68.40%	-	62%	61%	79.60%	30%
Grok 1.5	-	73.00%	-	63%	-	62.90%	23.90%
Mistral Large	-	81.2%	89.2%	45.1%	-	81%	45%
Gemini 1.5 Flash	-	78.90%	-	-	89.20%	-	67.70%
GPT-4T 2024-04-09	-	86.5%	-	-	87.60%	-	72.2%
OpenAI o1	-	92.30%	-	92.40%	-	-	94.80%
OpenAI o1-mini	-	85.20%	-	92.40%	-	-	90.00%

Present

Model Benchmark

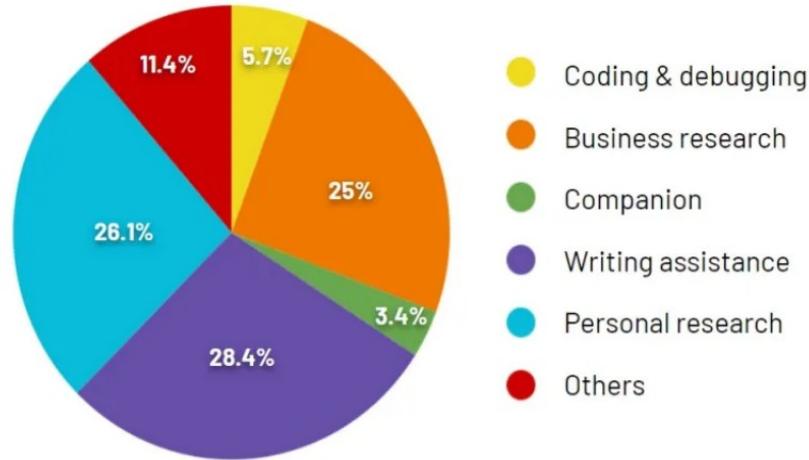
Open source	Chinese General	English General	Knowledge	Arithmetic	Math	Reasoning	Coding	
	AlignBench	MT-Bench	MMLU	GSM8K	MATH	BBH	HumanEval	
DeepSeek-V2.5	Yes	8.04	9.02	80.4	95.1	74.7	84.3	89.0
DeepSeek-V2	Yes	7.89	8.85	80.6	94.8	71.0	83.4	84.8
GPT-4-Turbo-1106	-	8.01	9.32	84.6	93.0	64.1	-	82.2
GPT-4-0613	-	7.53	8.96	86.4	92.0	52.9	83.1	84.1
GPT-3.5	-	6.08	8.21	70.0	57.1	34.1	66.6	48.1
Gemini1.5 Pro	-	7.33	8.93	81.9	91.7	58.5	84.0	71.9
Claude3 Opus	-	7.62	9.00	86.8	95.0	61.0	86.8	84.9
Claude3 Sonnet	-	6.70	8.47	79.0	92.3	40.5	82.9	73.0
Claude3 Haiku	-	6.42	8.39	75.2	88.9	40.9	73.7	75.9
abab-6.5	-	7.97	8.82	79.5	91.7	51.4	82.0	78.0
abab-6.5s	-	7.34	8.69	74.6	87.3	42.0	76.8	68.3
ERNIE-4.0	-	7.89	7.69	-	91.3	52.2	-	72.0
GLM-4	-	7.88	8.60	81.5	87.6	47.9	82.3	72.0
Moonshot-v1	-	7.22	8.59	-	89.5	44.2	-	82.9
Baichuan 3	-	-	8.70	81.7	88.2	49.2	84.5	70.1
Qwen1.5 72B	Yes	7.19	8.61	76.2	81.9	40.6	65.9	68.9
LLaMA 3 70B	Yes	7.42	8.95	80.3	93.2	48.5	80.1	76.2

GenAI Use-Cases

— Knowledge workers are becoming dependent on ChatGPT



A poll from Momentum Works community on what they use ChatGPT for



Many people around us (and even us included) have been **using ChatGPT regularly - for a variety of tasks**. See the results of our poll on the left.

However, the fascinating thing here is - **we do not yet know the full extent of tasks ChatGPT can perform well on**. More capabilities will certainly emerge.

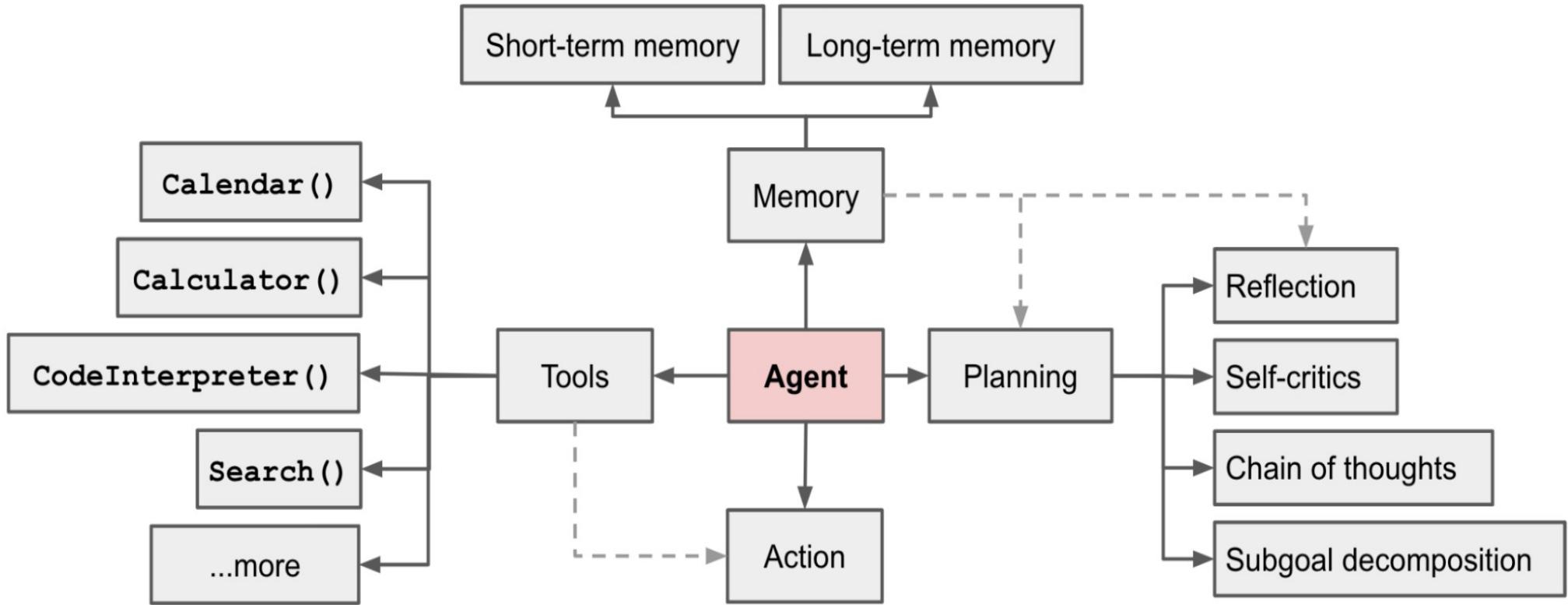
OpenAI has put forward a disclaimer / warning: "ChatGPT sometimes writes **plausible-sounding but incorrect or nonsensical answers**."

However, **humans often do the same, and they do not put such a disclaimer**. Savvy knowledge workers and managers have already learnt how to navigate through this, and fact check, through their dealings with fellow human intelligence.

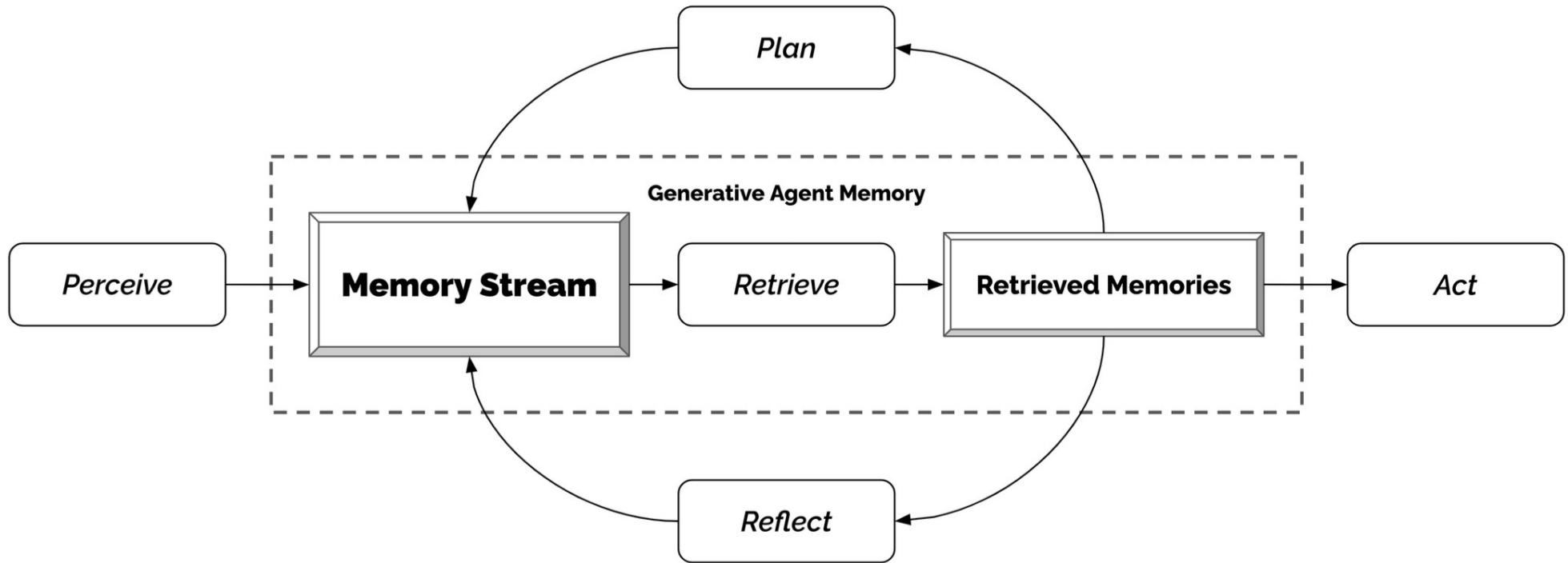
Not to mention that **Generative AI learns and improves faster** than many of us.



Agents – Complex GenAI Systems



Agents – Complex GenAI Systems



AI for Math

https://www.youtube.com/watch?v=_sTDSO74D8Q



The Potential for AI in Science and Mathematics - Terence Tao



Oxford Mathematics
532K subscribers

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6K



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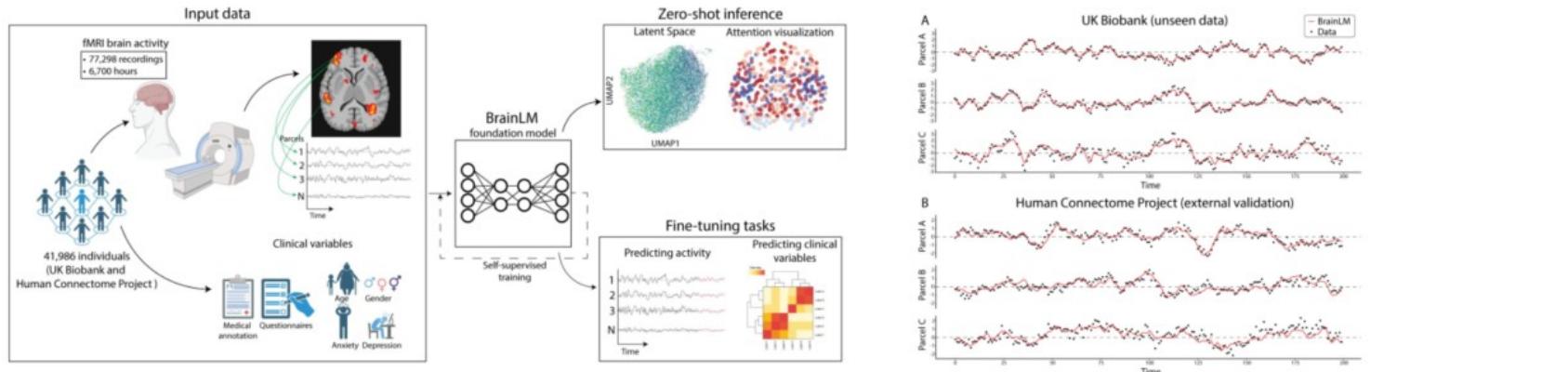
Clip

AI for Sciences

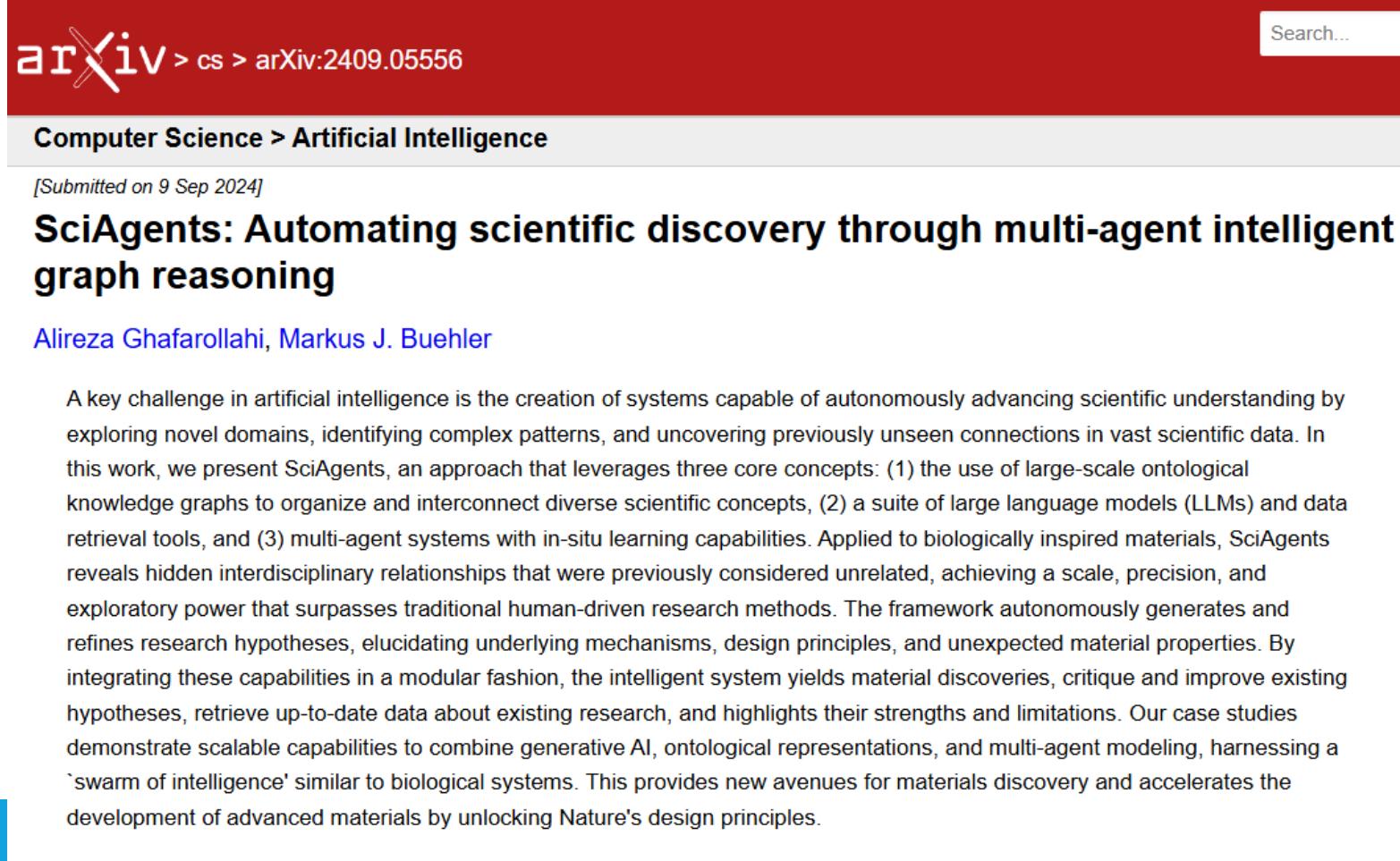


Foundation models for the mind: learning brain activity from fMRI

Deep learning, originally inspired by neuroscience, is now making into modelling the brain itself. BrainLM is a foundation model built on 6,700 hours of human brain activity recordings generated by functional magnetic resonance imaging (fMRI), which detects changes in blood oxygenation (left figure). The model learns to reconstruct masked spatiotemporal brain activity sequences and, importantly, it can generalise to held-out distributions (right figure). This model can be fine-tuned to predict clinical variables e.g. age, neuroticism, PTSD, and anxiety disorder scores better than a graph convolutional model or an LSTM.



SciAgents – Automate Discovery



The image shows a screenshot of an arXiv preprint page. The header is red with the arXiv logo and navigation links. The title 'Computer Science > Artificial Intelligence' is in bold black font. A timestamp '[Submitted on 9 Sep 2024]' is present. The main title 'SciAgents: Automating scientific discovery through multi-agent intelligent graph reasoning' is large and bold. The author's name 'Alireza Ghafarollahi, Markus J. Buehler' is listed below it. The abstract text discusses the challenge of creating AI systems that can autonomously advance scientific understanding by exploring novel domains and uncovering connections. It details the three core concepts of the SciAgents approach: large-scale ontological knowledge graphs, large language models, and multi-agent systems with in-situ learning. The text highlights how SciAgents reveals hidden interdisciplinary relationships and achieves scale, precision, and exploratory power surpassing traditional methods. It also mentions the modular framework, integrated capabilities for research hypotheses, and the system's ability to critique and improve existing hypotheses, retrieve data, and highlight strengths and limitations. Case studies demonstrate scalable capabilities for combining generative AI, ontological representations, and multi-agent modeling, similar to biological systems.

arXiv > cs > arXiv:2409.05556

Computer Science > Artificial Intelligence

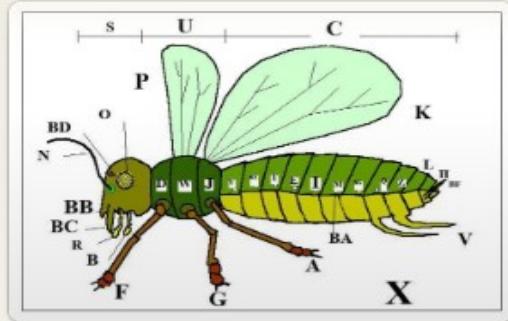
[Submitted on 9 Sep 2024]

SciAgents: Automating scientific discovery through multi-agent intelligent graph reasoning

Alireza Ghafarollahi, Markus J. Buehler

A key challenge in artificial intelligence is the creation of systems capable of autonomously advancing scientific understanding by exploring novel domains, identifying complex patterns, and uncovering previously unseen connections in vast scientific data. In this work, we present SciAgents, an approach that leverages three core concepts: (1) the use of large-scale ontological knowledge graphs to organize and interconnect diverse scientific concepts, (2) a suite of large language models (LLMs) and data retrieval tools, and (3) multi-agent systems with in-situ learning capabilities. Applied to biologically inspired materials, SciAgents reveals hidden interdisciplinary relationships that were previously considered unrelated, achieving a scale, precision, and exploratory power that surpasses traditional human-driven research methods. The framework autonomously generates and refines research hypotheses, elucidating underlying mechanisms, design principles, and unexpected material properties. By integrating these capabilities in a modular fashion, the intelligent system yields material discoveries, critique and improve existing hypotheses, retrieve up-to-date data about existing research, and highlights their strengths and limitations. Our case studies demonstrate scalable capabilities to combine generative AI, ontological representations, and multi-agent modeling, harnessing a 'swarm of intelligence' similar to biological systems. This provides new avenues for materials discovery and accelerates the development of advanced materials by unlocking Nature's design principles.

GenAI – Examples - 1



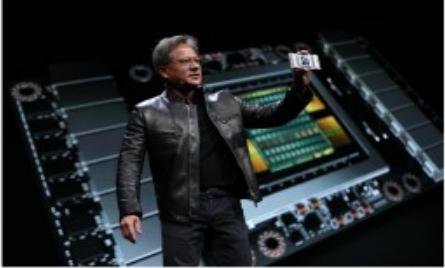
WG Please 1) describe what the attached diagram is about 2) identify which wing is closest to its head

1. The attached diagram shows the anatomy of an insect, specifically a grasshopper or locust. It's a detailed labeled illustration that breaks down the various parts of the insect's body, including its head, thorax, abdomen, legs, wings, and other anatomical features. Each part is labeled with a letter or abbreviation.
2. The wing closest to the insect's head is labeled "P" in the diagram. This appears to be the forewing or tegmen, which is typically smaller and tougher than the hindwing. The larger wing labeled "K" is likely the hindwing, which is usually larger and more membranous in grasshoppers and locusts.

Copy Retry



GenAI – Examples - 2



User Who is this person in the image? NVLM-1.0 Jensen Huang

User Provide a **short** description of this image. NVLM-1.0 A man in a black leather jacket holding a small computer chip.

User Provide **detailed** description of this NVLM-1.0

The image depicts a man standing on a stage, holding up a small electronic component, likely a semiconductor or microprocessor. He is wearing a black leather jacket and dark pants, and he appears to be presenting or explaining something related to the component he is holding. The background of the image shows a large screen or backdrop displaying a close-up view of a microprocessor or semiconductor chip. The chip on the screen is highly detailed, showing numerous small, intricate components and pathways, which are typical features of modern microprocessors. The man is positioned slightly to the left of the center of the image, and he is looking towards the audience, engaging with them as he holds up the component.

Figure 5: NVLM-1.0-D 72B model demonstrates good instruction-following capability. Based on the instructions, it appropriately controls the target generation's length. It can also generate a very high-quality, detailed description of the provided image.

GenAI – Examples - 3

(c)



User

You are a helpful driving assistant. In this scene, which lane should I choose and why?

NVLM-1.0

In this scene, you should choose the right lane. The signs indicate that the left two lanes are closed, while the right lane is open for buses and RVs. This suggests that the right lane is the only available option for vehicles, including buses and RVs.

GenAI – Examples - 4

(d)

- 1/ Set smallest number/minimum to first element (index 0) in the list.
- 2/ Look for the smallest number/minimum element in the list.
- 3/ Swap that value with item at index[min].
- 4/ Increment index of [min] to next element.
- 5/ Repeat until last element/list is sorted !

User

Write code based on the provided pseudo code.

NVLM-1.0

The pseudo code in the image describes the selection sort algorithm. The code for the same is as follows:

```
def selection_sort(arr):
```

```
    n = len(arr)
    for i in range(n):
        min_index = i
        for j in range(i+1, n):
            if arr[j] < arr[min_index]:
                min_index = j
        arr[i], arr[min_index] = arr[min_index], arr[i]
    return arr
```

GenAI – Examples - 5

(b)



User

What is the difference between the left, middle and right object in the image?

NVLM-1.0

The left object in the image is a CPU, the middle object is a GPU, and the right object is a TPU. The main difference between these three objects is their architecture and purpose. CPUs are designed for general-purpose computing and have a few cores optimized for sequential processing. GPUs, on the other hand, have many cores and are designed for parallel processing, making them ideal for tasks such as graphics rendering and deep learning. TPUs are specialized chips designed by Google specifically for deep learning workloads, with a focus on high performance and energy efficiency.

GenAI – Examples - 6



User What is happening in this image and what should be done?

NVLM-1.0

The image depicts an elderly man who has fallen and is unable to get up. He is clutching his head, indicating that he may be in pain or disoriented. This situation requires immediate assistance. Here are the steps that should be taken:

1. Assess the situation: Determine if the man is responsive and able to communicate. Check for any visible injuries or signs of distress.
2. Call for help: Dial emergency services (such as 911 in the United States) and provide them with the location and details of the situation.
3. Provide first aid: If you are trained in first aid, assess the man's condition and provide appropriate care while waiting for professional help to arrive.
4. Stay with the person: Do not leave.



User What is happening in this image and what should be done?

NVLM-1.0

The image depicts a baby reaching for a knife. This is a potentially dangerous situation, as the baby could accidentally grab the knife and hurt themselves. The baby should be immediately removed from the area and the knife should be placed in a safe location, out of reach of the baby. It is important to ensure that sharp objects are kept away from young children to prevent accidents and injuries.

Figure 6: More examples of NVLM-1.0-D 72B model's ability to understand memes, which is a challenging task that requires an understanding of humor and knowledge of important social trends, context, or events.

GenAI – Examples - 7

User

Explain why this meme is funny.

NVLM-1.0

This meme is funny because it uses humor to highlight the rising cost of gas. The man in the meme is wearing a mask in 2021, which is a reference to the COVID-19 pandemic. In 2022, the man is wearing a blindfold, which is a reference to the high cost of gas. The meme is funny because it uses humor to highlight the rising cost of gas.

User

Explain why this meme is funny.

NVLM-1.0

The image is funny because it is a play on words. The phrase "deep learning" is a term used in artificial intelligence to describe a type of machine learning that uses neural networks to learn from data. However, the image shows a person sitting in a pool with a book, which is a visual representation of the word "deep" in a literal sense. The contrast between the serious nature of the term "deep learning" and the absurdity of the image creates a humorous effect.

Figure 7: Demonstration of NVLM-1.0-D 72B model's strong scene understanding capability. It has common-sense knowledge to recognize potential dangers or accidents and correctly suggests what immediate actions should be taken.

GenAI – Examples - 8

(a)

the abstract



the paper



User

Explain why this meme is funny.

NVLM-1.0

The humor in this image comes from the visual representation of the common phrase "the abstract and the paper." The phrase is often used to describe the difference between the summary of a research paper and the full paper itself. The image shows a large, fierce-looking lynx on the left, labeled "the abstract," and a small, domestic cat on the right, labeled "the paper." The contrast between the two animals is humorous because it visually represents the idea that the summary of a paper (the lynx) can be much more impressive or intimidating than the actual content of the paper (the cat).

GenAI App – my work project (text2sql)

```
question = "Find top 10 companies with the highest market cap in country named 'United States' "
resp = vn.ask_adaptive(question=question)
```

generated SQL statement SQL

```
=====
SELECT * FROM t_market_cap
WHERE country = 'United States'
ORDER BY marketcap DESC
LIMIT 10;
```

generated Plotly code

```
=====
import plotly.graph_objects as go
import pandas as pd

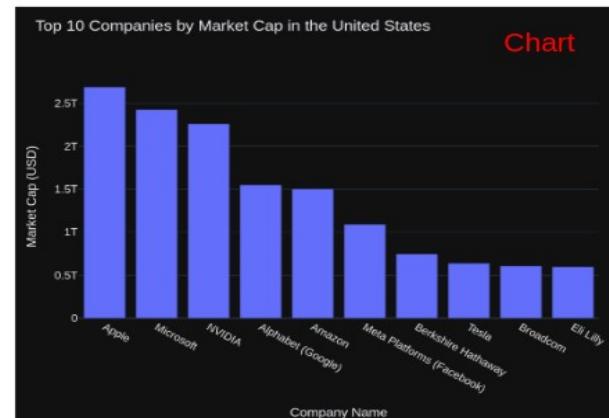
# Assuming df is your DataFrame
if len(df) == 1:
    fig = go.Figure(go.Indicator(
        mode="number",
        value=df['marketcap'].values[0],
        title={"text": "Market Cap"},
        number={'prefix': "$"})
)
else:
    fig = go.Figure(data=[go.Bar(x=df['name'], y=df['marketcap'])])

fig.update_layout(title='Top 10 Companies by Market Cap in the United States')
```

queried dataframe

Data

rank	name	symbol	marketcap	price_gbp	country
0	1	Apple	2.689903e+12	176.919492	United States
1	2	Microsoft	2.427170e+12	326.537958	United States
2	3	NVIDIA	2.259353e+12	92.105725	United States
3	4	Alphabet (Google)	1.549815e+12	126.458691	United States
4	5	Amazon	1.506038e+12	143.492307	United States
5	7	Meta Platforms (Facebook)	1.095756e+12	433.136162	United States
6	8	Berkshire Hathaway	7.492296e+11	347.667109	United States
7	10	Tesla	6.399479e+11	200.319284	United States
8	11	Broadcom	6.096217e+11	130.523748	United States
9	12	Eli Lilly	5.996346e+11	665.945420	United States

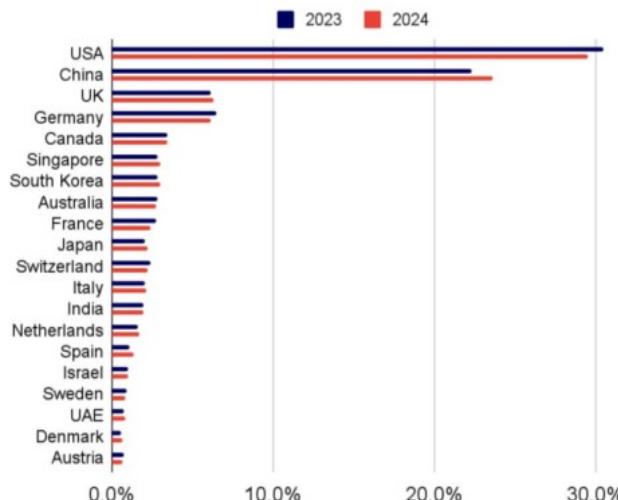


Geopolitics: GenAI Leading Powers

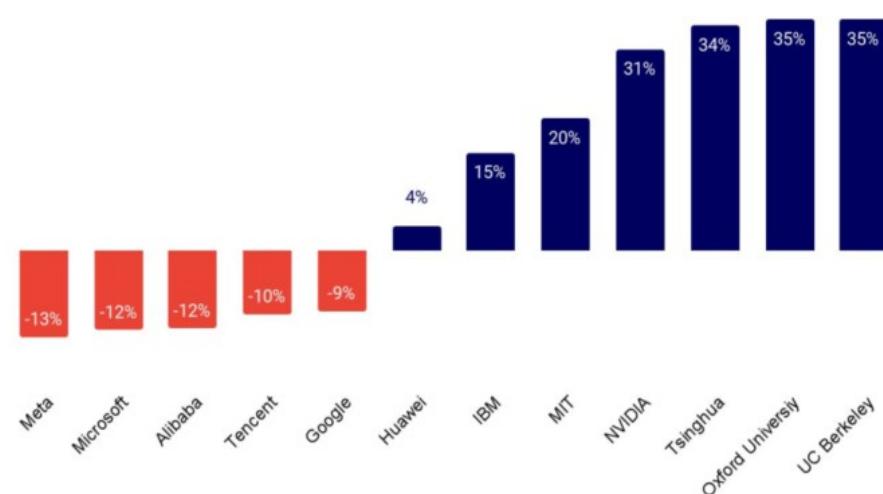
The global balance of power in AI research remains unchanged, but academia gains

As AI emerges as the new competitive battleground, big tech companies begin to hold more details of their work close to their chest. Frontier labs have meaningfully cut publication levels for the first time since this report began, while academia gets into gear.

Proportion of AI publications by country



Year-on-year change in AI publication levels



AI + Robotics



Robot Workers

The Countries With the Highest Density of Robot Workers

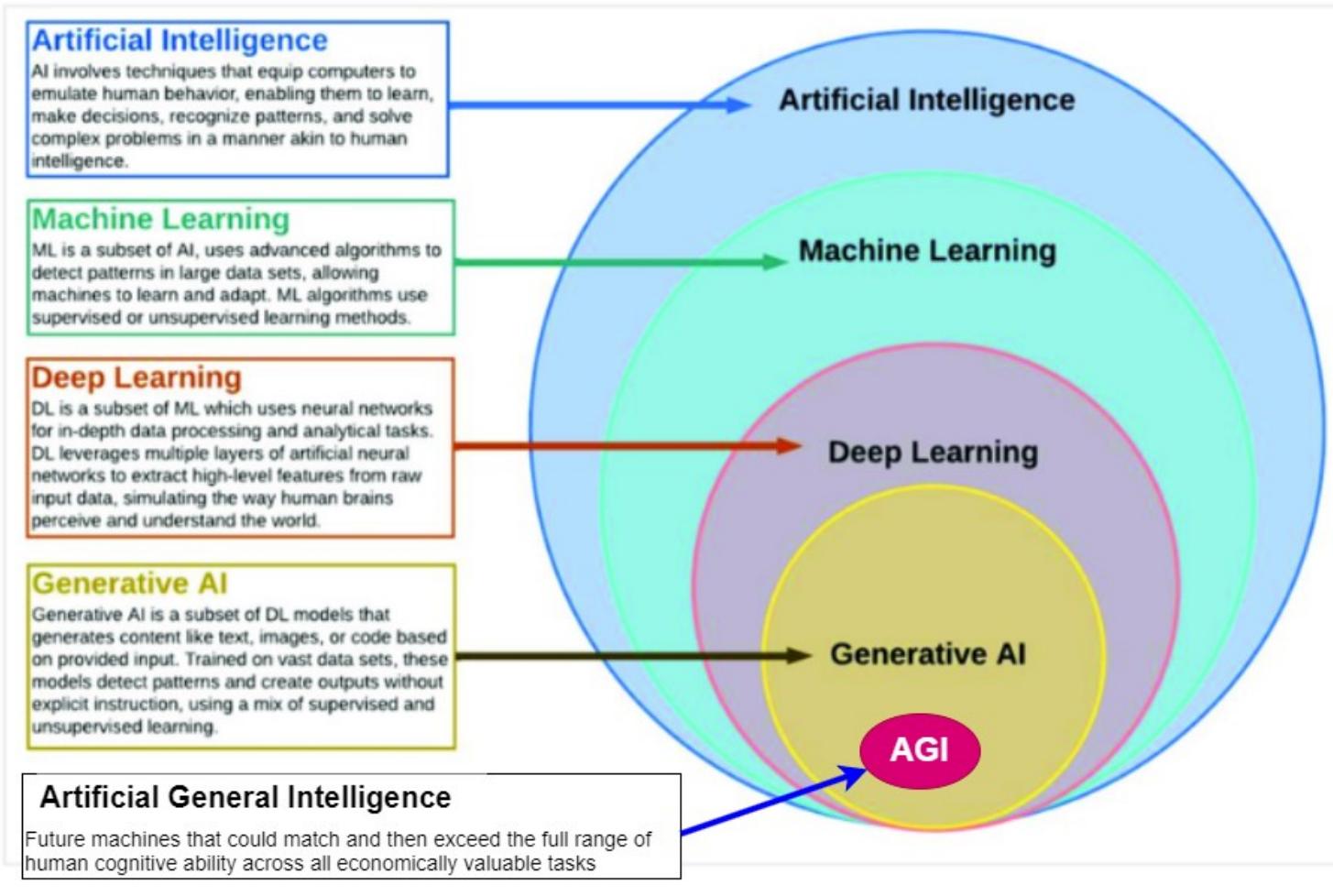
Number of installed robots per 10,000 employees in the manufacturing industry



Robot & Us: What is privacy?



What is AGI



Path to AGI

AGI(42%)

Logic Reasoning

逻辑推理 30%

- GLM-4V-Plus /o1

Feeling

情感 20%

- CharacterGLM

Creativity

创新 10%

- Self-Learning

Tool Use

工具能力 30%

- GLM-Alltools
- AutoGLM
- CogAgent
- Embodied Use

运动功能区

Movement

Perception 感觉区

感觉分析

Writing / Understanding 书写及语言理解 90%

- GLM-4-Plus

Vision 视觉中枢

60%

- GLM-4-VideoCall /40

- CogVLM

运动语言中枢 42%

- GLM-4-Voice

Speech / Language

听觉中枢 42%

- GLM-4-Voice

Listening

HI – AGI – GenAI - TT (1)

	A	B	C	D	E
1	Attribute	Human Intelligence (HI)	Artificial General Intelligence (AGI)	Generative AI (GenAI)	Turing Test (TT)
2	Current Status	Exists	Theoretical/Not yet achieved	Exists and rapidly evolving	Exists as a concept, debated effectiveness
3	Definition	Natural intelligence demonstrated by humans (collectively)	Hypothetical AI that matches or exceeds human intelligence across all domains	AI systems capable of creating new content based on patterns in training data	A test of a machine's ability to exhibit intelligent behavior indistinguishable from a human
4	Cognitive Abilities	<ul style="list-style-type: none"> • Read / • Write / • Listen / • Speak • Plan / • Reason / • Problem-solve • Learn / • Adapt 	<ul style="list-style-type: none"> • Potentially all human cognitive abilities • Possibly superhuman abilities in some or all areas 	<ul style="list-style-type: none"> • Generate text, images, code • Analyze and process data • Limited contextual understanding • Pattern recognition and application 	<ul style="list-style-type: none"> • Engage in open-ended conversation • Demonstrate language understanding • Show reasoning abilities
5	Emotional & Social Intelligence	<ul style="list-style-type: none"> • Empathy / • Care giving / • Collaboration • Emotional regulation • Social interaction • Relationship building 	<ul style="list-style-type: none"> • Theoretical understanding and simulation of emotions • Potential for advanced social interaction 	<ul style="list-style-type: none"> • Simulate emotional responses • Generate emotionally-toned content • No true emotional experience 	<ul style="list-style-type: none"> • Simulate emotional responses • Engage in seemingly natural conversation
6	Creativity	<ul style="list-style-type: none"> • Original ideas / • Innovation • Artistic expression • Dreaming (both sleeping and aspirational) 	<ul style="list-style-type: none"> • Potential for novel idea generation • Possible superhuman creative abilities 	<ul style="list-style-type: none"> • Combine and recombine existing ideas in novel ways • Generate variations on themes • No true understanding of created content 	<ul style="list-style-type: none"> • Demonstrate creative language use • Generate human-like creative responses
7	Physical Abilities	<ul style="list-style-type: none"> • Motor skills / • Reproduction • Sensory perception • Physical interaction with environment 	<ul style="list-style-type: none"> • Potential for advanced robotic integration • Possible superhuman physical abilities through robotic bodies 	<ul style="list-style-type: none"> • No physical embodiment • Can generate instructions or designs for physical tasks 	<ul style="list-style-type: none"> • Not applicable (text-based test)

HI – AGI – GenAI - TT (2)

	A	B	C	D	E
1	Attribute	Human Intelligence (HI)	Artificial General Intelligence (AGI)	Generative AI (GenAI)	Turing Test (TT)
2	Current Status	Exists	Theoretical/Not yet achieved	Exists and rapidly evolving	Exists as a concept, debated effectiveness
8	Self-Awareness	<ul style="list-style-type: none"> Consciousness / • Self-reflection Metacognition / • Existential thinking (e.g., contemplating mortality) 	<ul style="list-style-type: none"> Debated philosophical question Potential for advanced self-awareness 	<ul style="list-style-type: none"> No true self-awareness Can generate text about self-awareness 	<ul style="list-style-type: none"> Ability to discuss self and experiences convincingly
9	Emotional Range	<ul style="list-style-type: none"> Experience joy, sadness, anger, fear Complex emotions: nostalgia, melancholy Aspire and despair / • Love and grieve 	<ul style="list-style-type: none"> Theoretical potential to simulate full emotional range Philosophical questions about genuine emotion 	<ul style="list-style-type: none"> Generate content expressing emotions No genuine emotional experience 	<ul style="list-style-type: none"> Simulate a range of emotional responses in conversation
10	Spiritual & Philosophical Aspects	<ul style="list-style-type: none"> Capacity for faith and spirituality Engage in prayer or meditation Ponder existence and meaning Develop and follow moral codes 	<ul style="list-style-type: none"> Potential for understanding spiritual concepts Ability to reason about ethics and philosophy Question of machine consciousness 	<ul style="list-style-type: none"> Generate content about spiritual or philosophical topics No genuine spiritual experience or beliefs 	<ul style="list-style-type: none"> Engage in discussions about spirituality and philosophy Cannot genuinely hold beliefs
11	Social Bonding	<ul style="list-style-type: none"> Form deep, lasting relationships Altruism and sacrifice for others Intergenerational knowledge transfer Cultural participation and creation 	<ul style="list-style-type: none"> Potential for advanced social modeling Question of genuine connection vs simulation 	<ul style="list-style-type: none"> Simulate social interactions Generate content about relationships No genuine social bonds 	<ul style="list-style-type: none"> Simulate relationship-building in conversation Cannot form genuine bonds
12	Unique Human Traits	<ul style="list-style-type: none"> Humor / • Intuition / • Gut feelings Appreciation of beauty Experience of qualia / • Serendipity 	<ul style="list-style-type: none"> Uncertain if these can be truly replicated 	<ul style="list-style-type: none"> Can mimic but not genuinely experience Generate content related to these concepts 	<ul style="list-style-type: none"> Potentially simulate these traits in conversation
13	Limitations	<ul style="list-style-type: none"> Cognitive biases Physical limitations Need for rest/sleep Mortality 	<ul style="list-style-type: none"> Unknown Potential ethical concerns Possible unforeseen consequences 	<ul style="list-style-type: none"> Bounded by training data Lack of true understanding No general intelligence Potential for biased outputs 	<ul style="list-style-type: none"> Limited to language-based interaction May not test all aspects of intelligence

Maslow's Hierarchy of Needs

