

# State of Artificial Intelligence



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KIS UMK, 27.03.2023

# AI at warp speed



1. History: GOFAI => Neural Nets => Data Mining => Meta-learning => GANs and LLMs.
2. Towards AGI
3. Foundational models
4. Examples of emergence: sparks of AGI analyzed in GPT-4 paper.
5. Near future
6. What should we teach?
7. What should we do?

News in [my YouTube ML](#) library and my [Flipboard](#).



Meta-learning, or learning by search in the model space for useful composition of fine-grained transformations, support feature extraction, novel transfer functions, interesting distributions as new targets for learning and many deep ideas, not simple improvements.

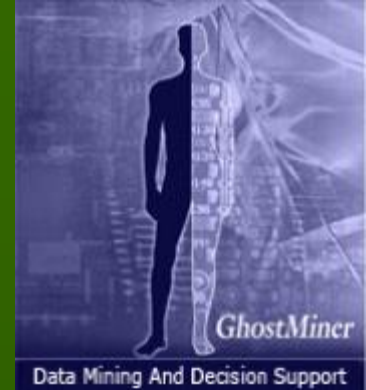
Duch W, Grudziński K. (2001) Meta-learning: searching in the model space. ICNIP, 235-240

Duch W, Grudziński K. (2002) Meta-learning via search combined with parameter optimization. IIS, Advances in Soft Computing 17, pp. 13-22

[WD: Machine Learning topics](#)

Now: transformers.

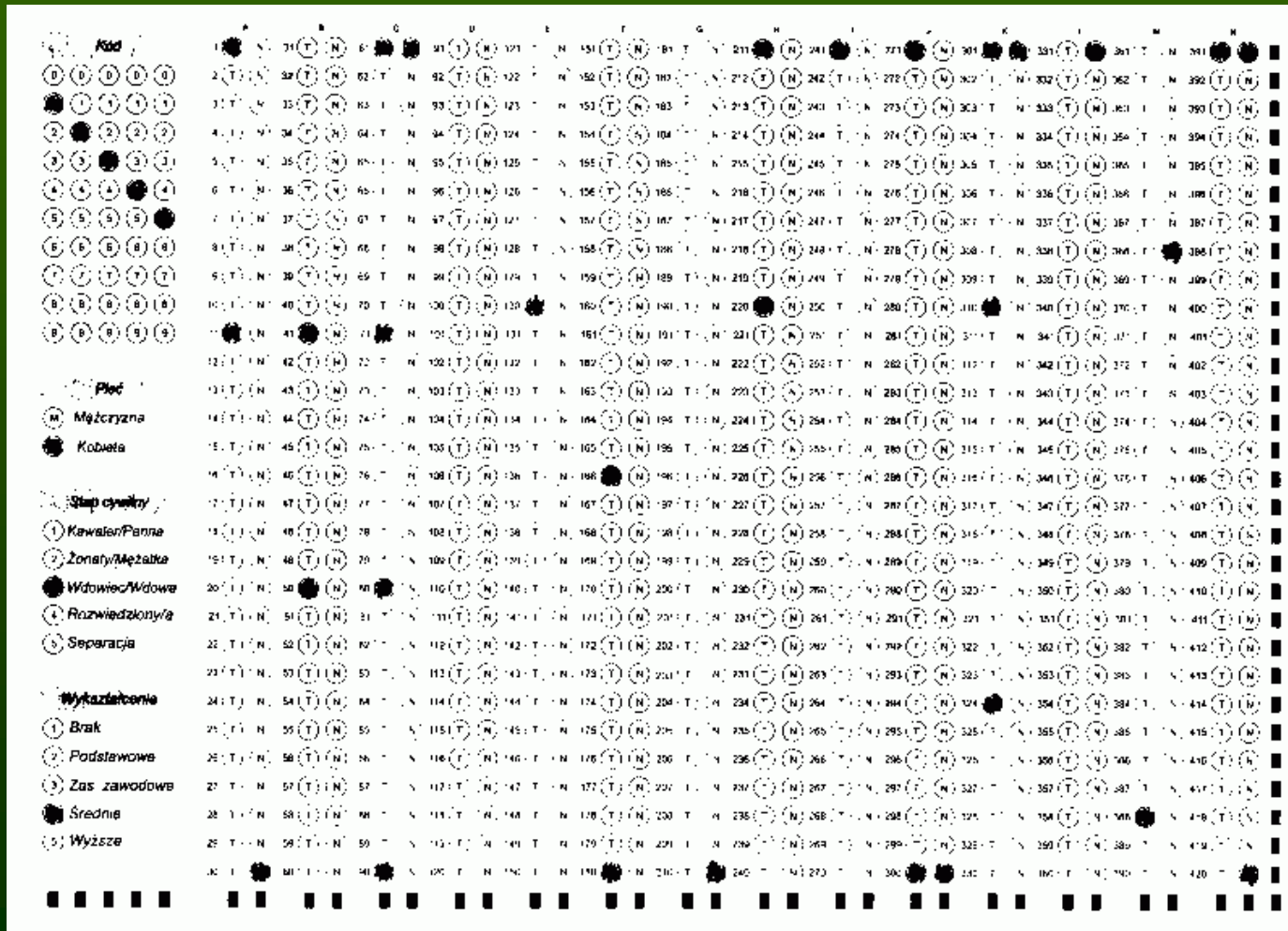
# Ghostminer



- FQS - [Google: ghostminer](#)
- KIS project 1998-2004, data mining, business intelligence.
- GhostMiner is Fujitsu's advanced analytical data mining tool that not only supports a variety of databases (and spreadsheets), advanced machine learning algorithms, but also data preparation and selection, model validation, multimodels such as committees or k-classifiers and data/model visualization.
- Clients: universities, polytechnics, research institutes, banks and various companies in Poland, Austria, Australia, China, Czech Republic, Netherlands, India, Japan, Canada, Germany, Norway, Singapore, UK and USA.
- E.g. Abbott Laboratories was using GhostMiner to study and discover the properties of multidimensional scientific data.

# Psychometric tests

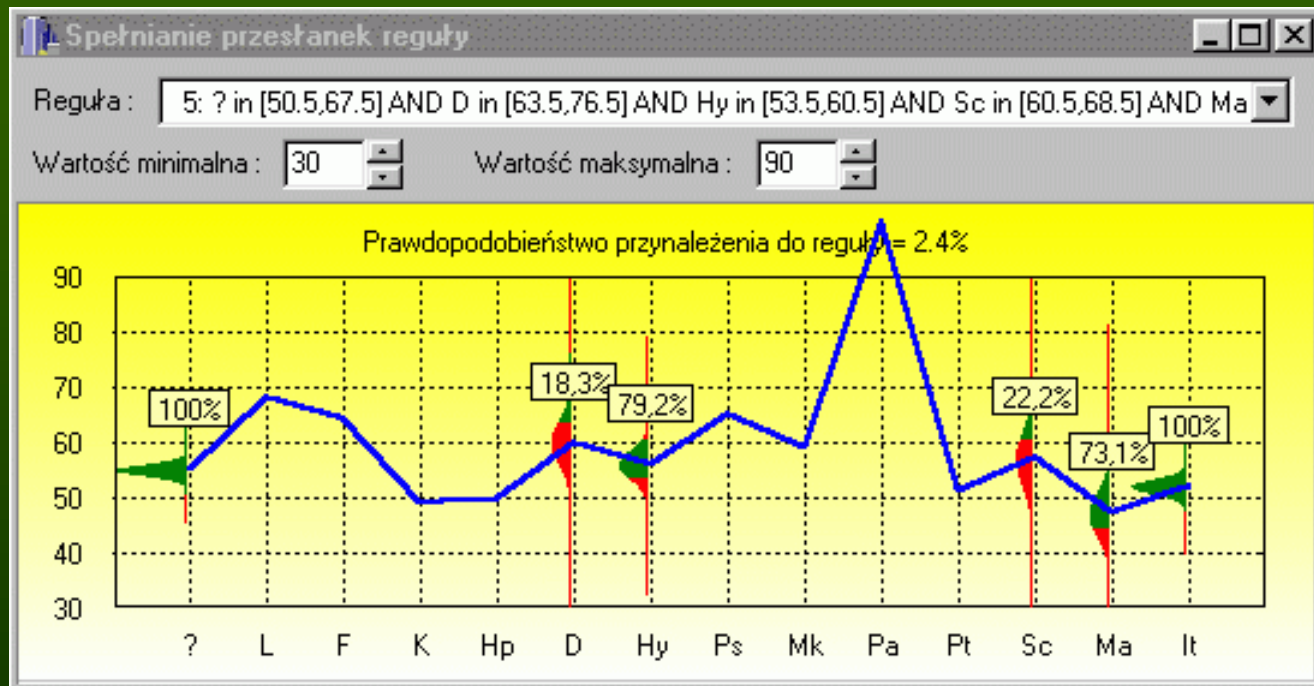
- IDSS - Intelligent Decision Support System.
- Psychometric Decision Support System.
- Helps interpret the results of the MMPI psychometric test.





# Psychometric tests

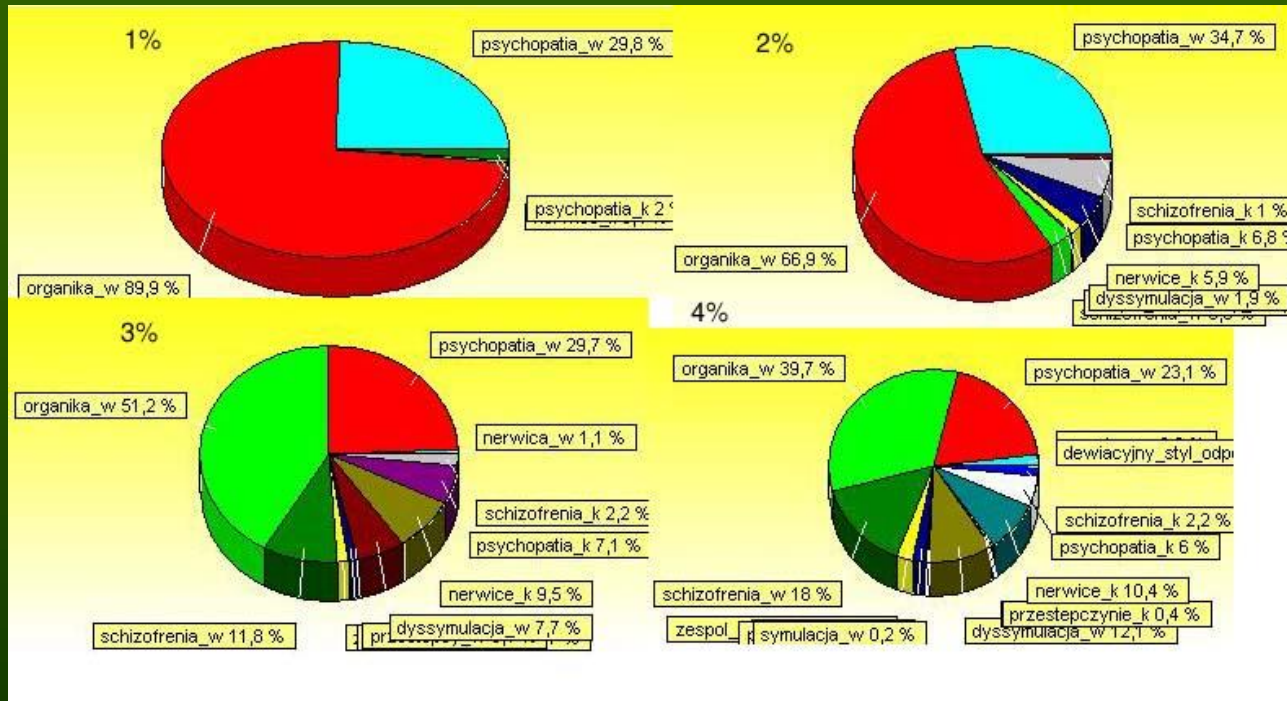
- IDSS - Intelligent Decision Support System.
- Psychometric Decision Support System.
- Helps interpret the results of the MMPI psychometric test.



- The program uses logic rules discovered from sample data classified by experts. It presents its conclusions in the form of classical logic rules, visualizations of similar cases, and verbal comments.

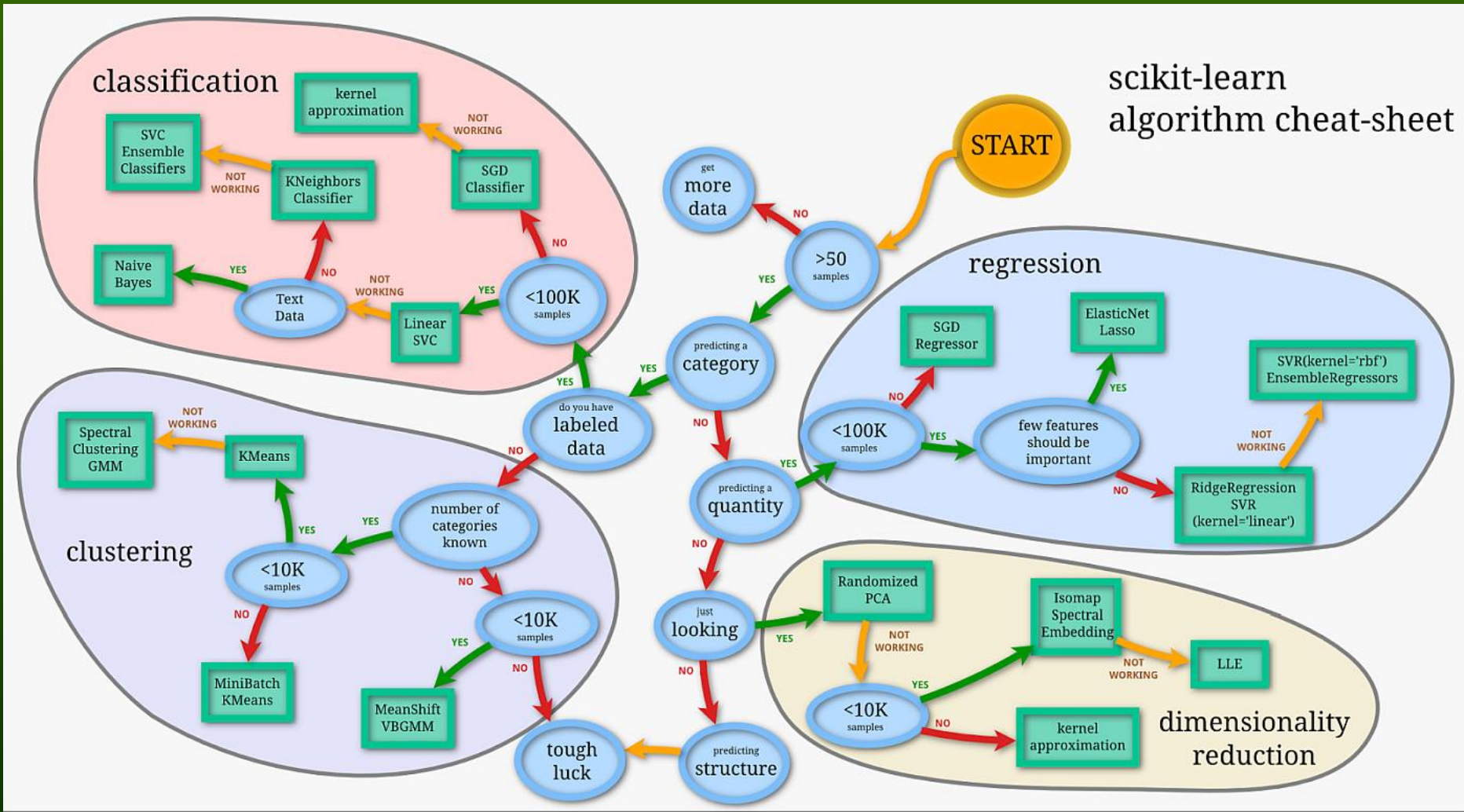
# Psychometric tests

- IDSS - Intelligent Decision Support System.
- Psychometric Decision Support System.
- Helps interpret the results of the MMPI psychometric test.



- Data is imprecise, with some prob. distribution. Used in UMK academic clinic and psychiatric applications.
- Our technology allows analysis of tests in the form of any questionnaires, scanned or computerized. Useful for tests of well-being?

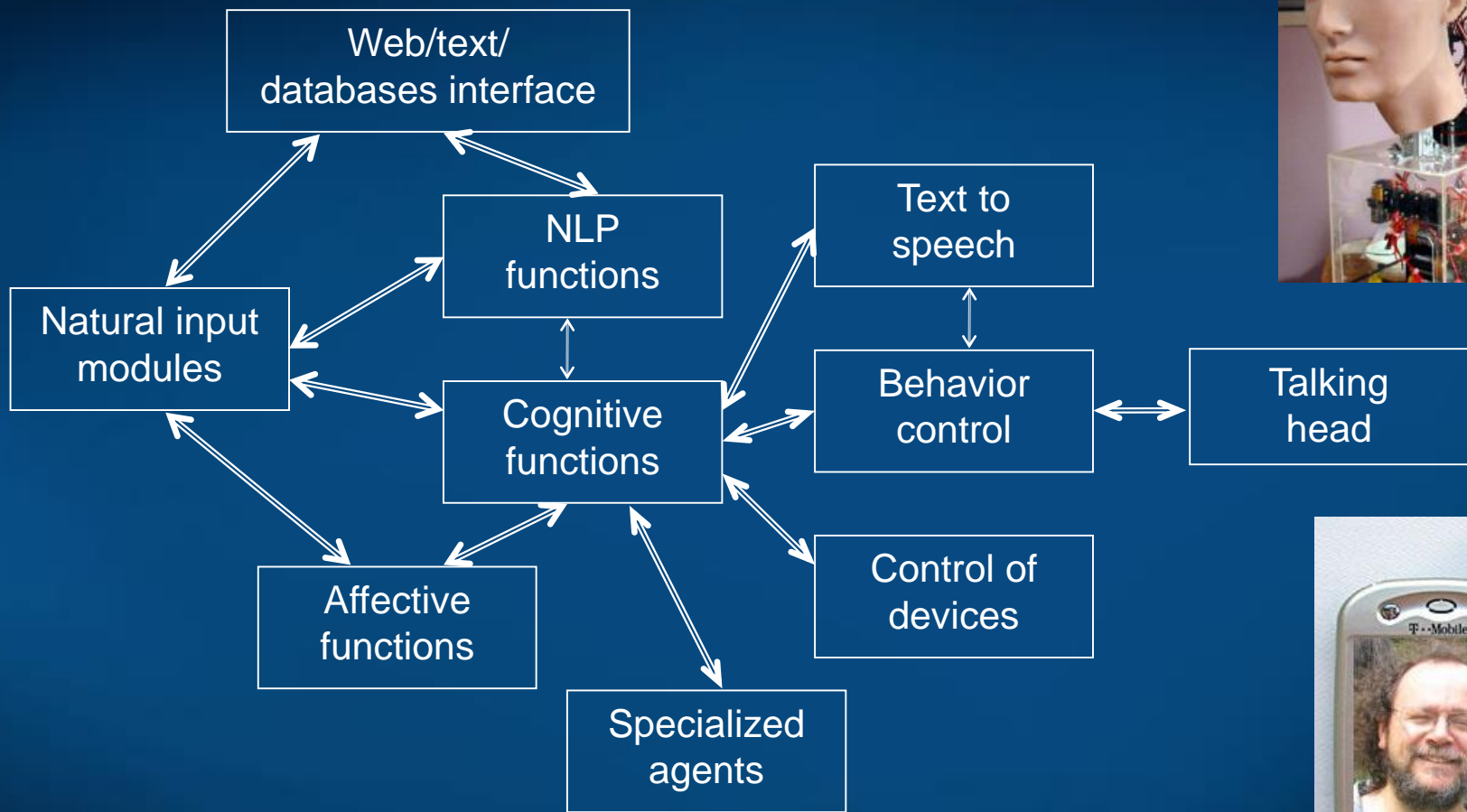
# ML is easy - just pick up your method ...



Thousands of applications of machine learning are enabled by free powerful large systems, such as TensorFlow, Scikit-learn, Keras, MS Cognitive services ...



# DREAM top-level architecture



DREAM project (2003), focused on perception (visual, auditory, text inputs), cognitive functions (reasoning based on perceptions), natural language communication in well defined contexts, real time control of the simulated/physical head. Now Amazon, Google, Apple, GPT ... Even in watches ...

# Bina48 and LifeNaut Project



Reconstructing the mind from information in mindfiles, creating mindclones: self-aware digital beings, remembering, thinking, feeling. Now Mika in Salzburg.



# Neuromorphic future

Wall with 1024 TrueNorth chips, equivalent of 1 Billion neurons, 256 B synapses.  
1/6 of chimp brain. Cerebras CS-2 chip has 2600 B transistors, almost 1M cores!

Integration:

Nano +  
Neuro +  
Info +  
Kogni

Neural AI  
accelerators  
AD 2022.

Inteli Loihi

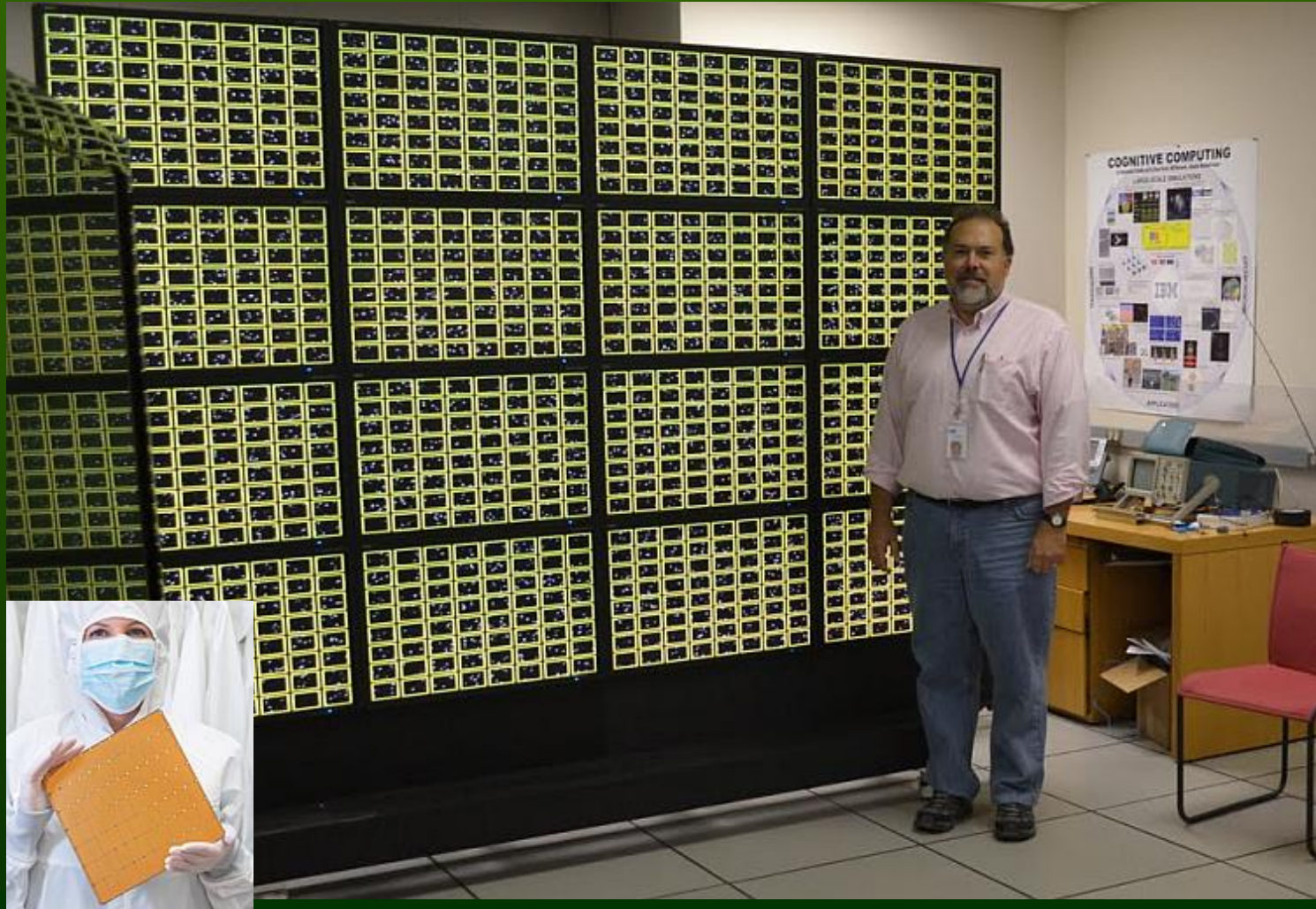
+ LAVA soft.

Cerebras CS-2

Andromeda

system,

$10^{18}$  op/sec!





Cogni  
Cognitive sciences

Biohybrids

Bio  
Neuroscience

Neurocognitive  
Informatics

Nano  
Quantum  
Technologies

Info

Artificial/Computational Intelligence,  
Machine Learning, Neural Networks



# AGI & BICA

From an engineer's perspective, to understand the brain is to build a working model that exhibits the same functions. Needed: spatial models of phenomena, actions and their causes, real world imagery.

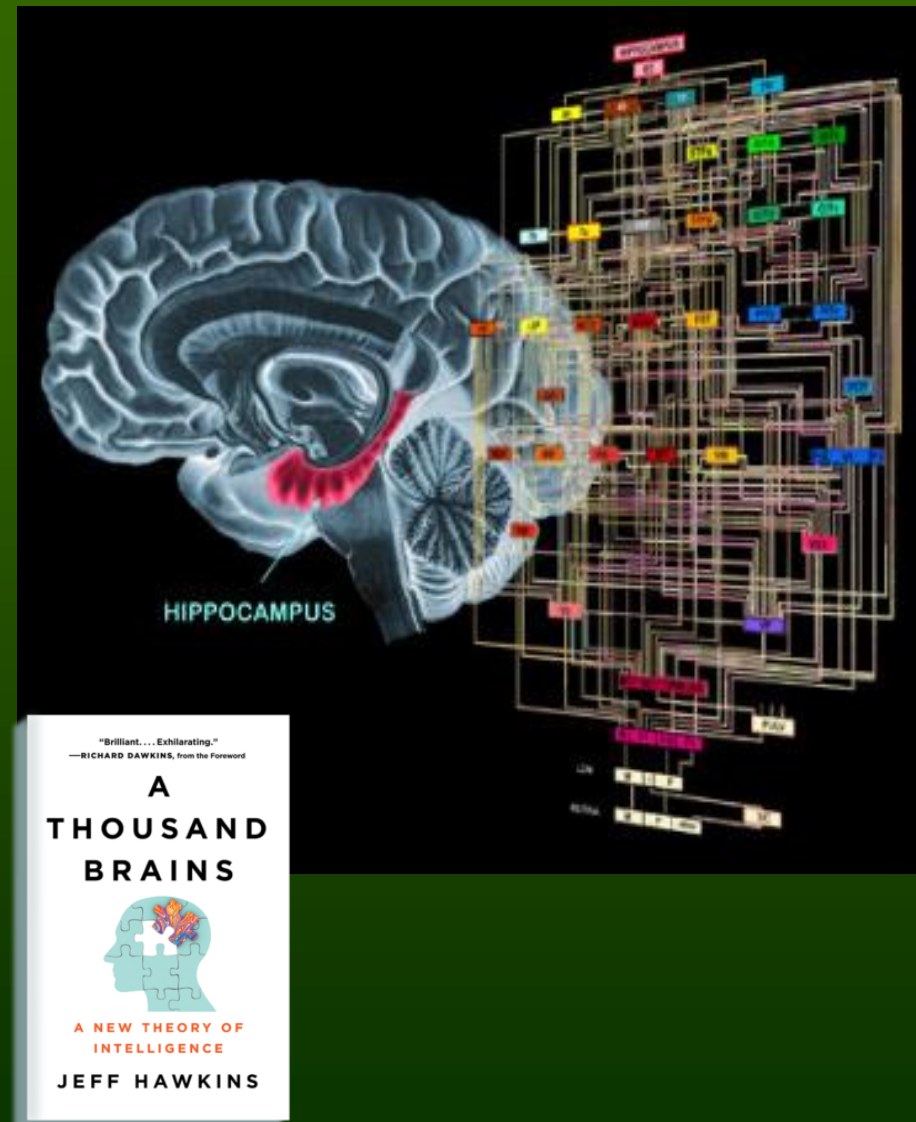
**AGI = Artificial General Intelligence**, learn many different things.

**BICA (Brain-Inspired Cognitive Architecture)** brain-like intelligence.

Duch, Oentaryo, Pasquier,  
Cognitive architectures: where do we go from here?

**“We’ll never have true AI without first understanding the brain”**

Jeff Hawkins (2020).



# Artificial General Intelligence (AGI), Memphis 2008



2022: [DeepMind Gato](#) is a relatively small model, with 1.2 billion parameters. Multi-modal, multi-task, multi-embodiment, learned simultaneously over 600 tasks, games to controlling robots. Small working memory capacity.

# Towards Human-like Intelligence

**IEEE** Computational Intelligence Society Task Force (Mandziuk, Duch, M. Woźniak),  
**Towards Human-like Intelligence**



**IEEE SSCI CIHLI 2022** Symposium on Computational Intelligence for Human-like Intelligence, Singapore.

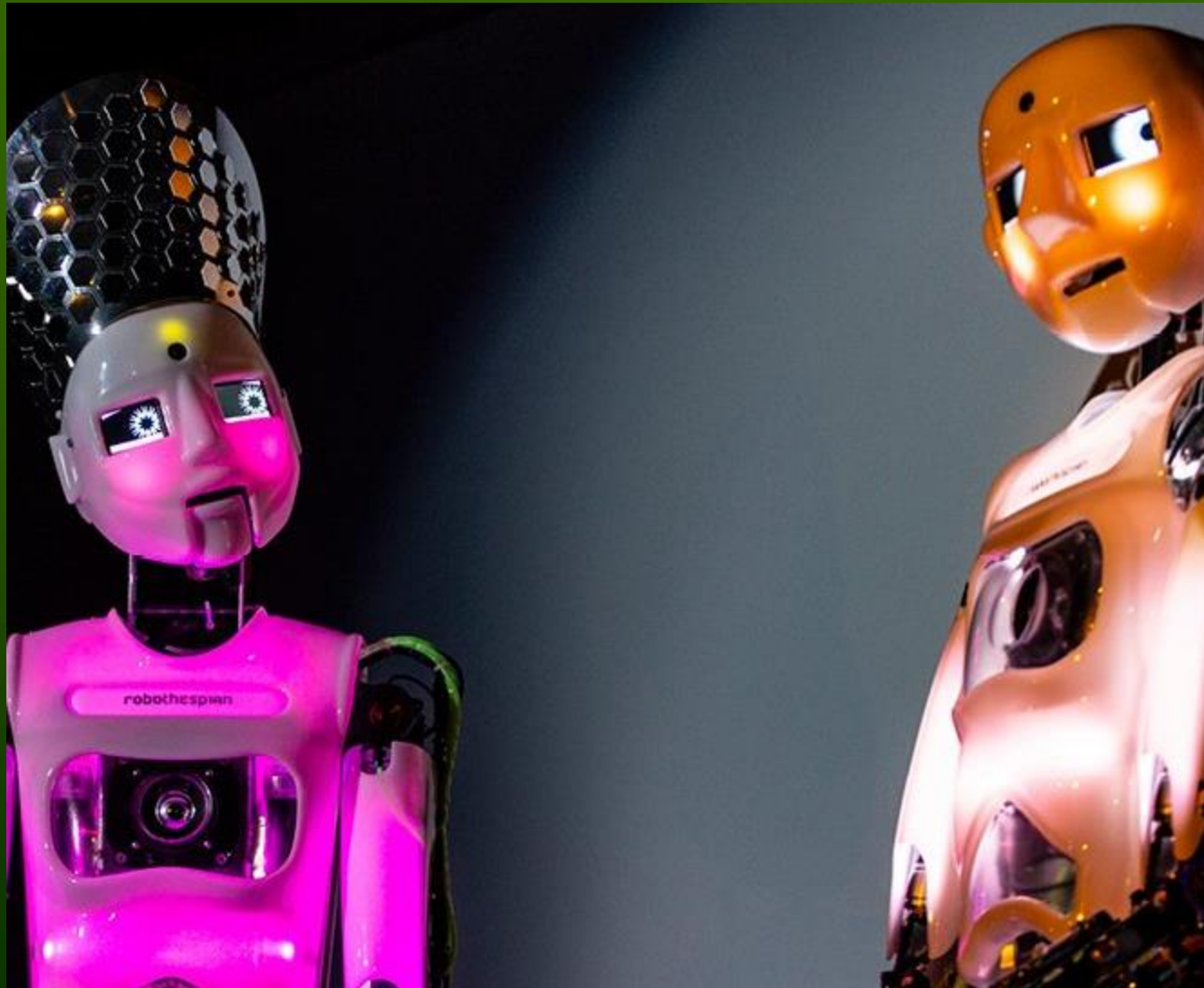
**AGI** conference, Journal of Artificial General Intelligence comments on Cognitive Architectures and Autonomy: A Comparative Review (eds. Tan, Franklin, Duch).

**BICA** Annual International Conf. on Biologically Inspired Cognitive Architectures, 13th Annual Meeting of the BICA Society, Guadalajara, Mexico 2023.

**Brain-Mind Institute Schools** International Conference on Brain-Mind (ICBM) and Brain-Mind Magazine (Juyang Weng, Michigan SU).

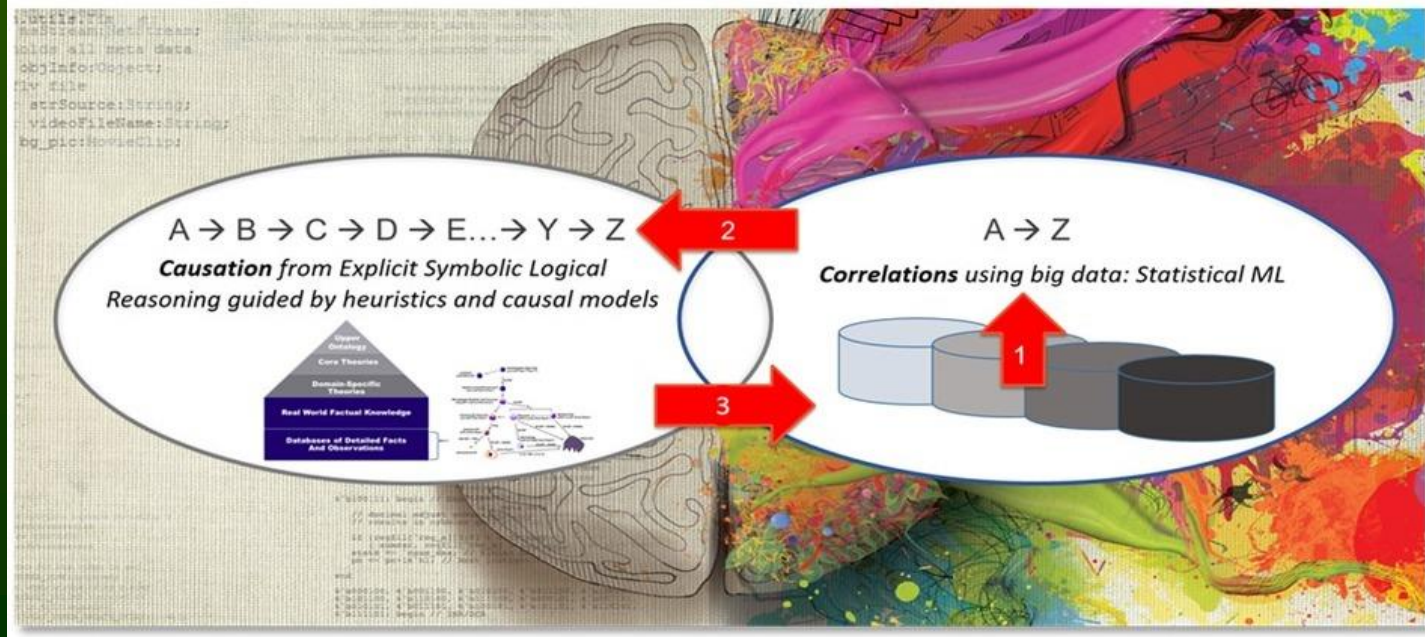
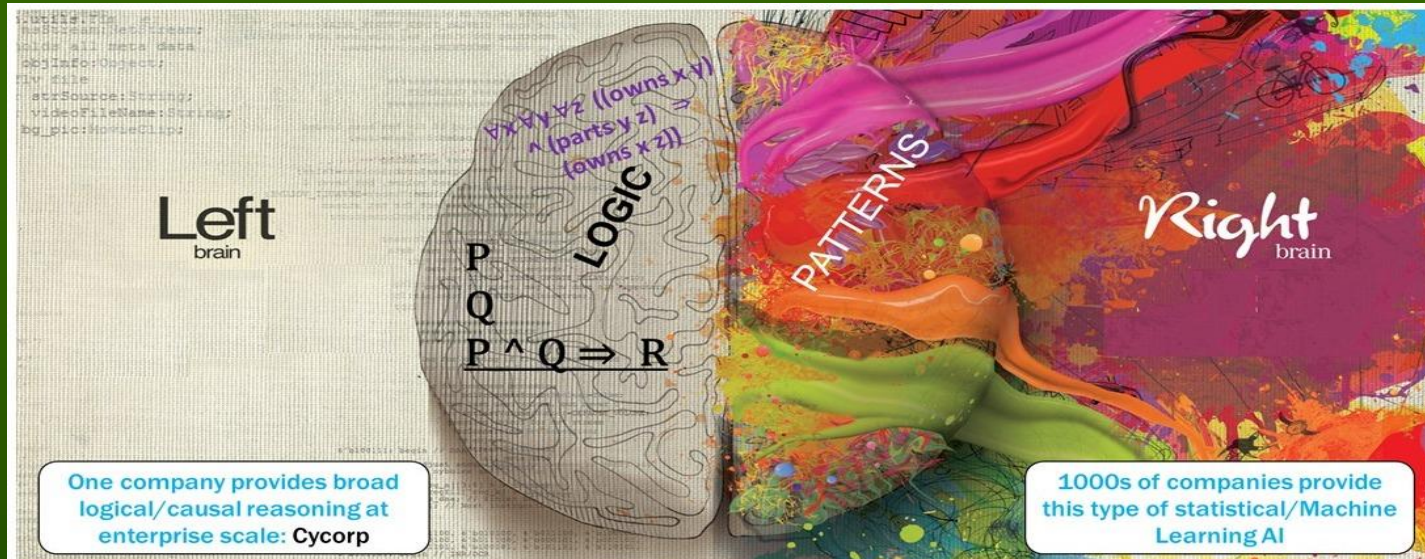


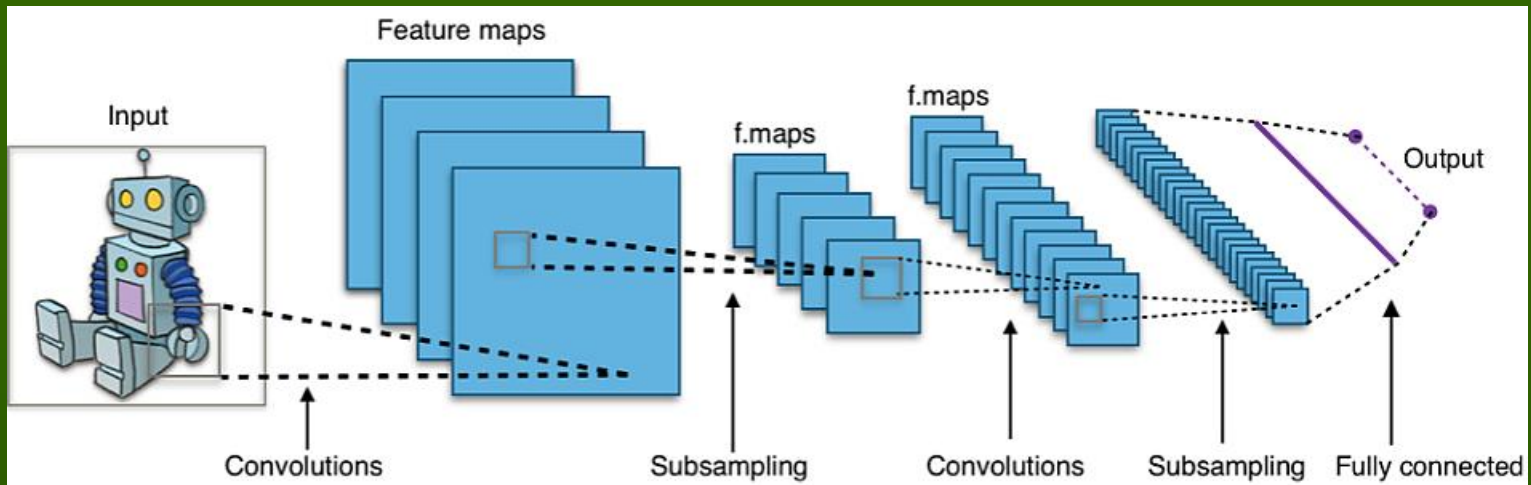
Stanislaw Lem: About prince Ferrycy and princess Crystala.  
Intelligent Palefaces? Is it possible?



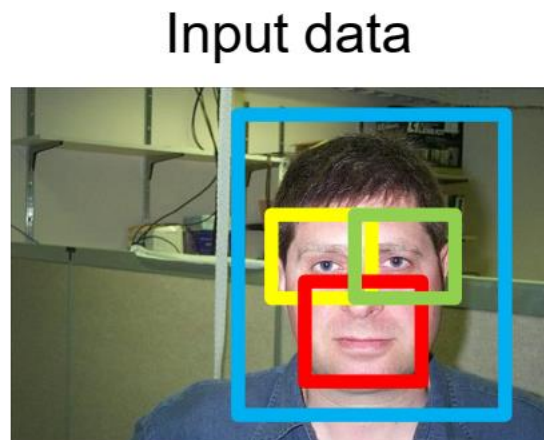


# Third AI wave and brains





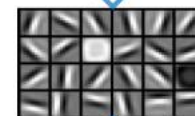
### Feature representation



3rd layer  
"Objects"



2nd layer  
"Object parts"



1st layer  
"Edges"



Pixels

Lee et al., ICML 2009;  
CACM 2011



# Superhuman AI



**Reasoning:** 1997–Deep Blue wins in chess;  
2016 –AlphaGo wins in Go; 2017 Alpha GoZero 100:0.

**Open Games:** 2017–Poker, Dota 2; 2019-Starcraft II,  
2022 Stratego, Diplomacy – what is left?

**Perception:** speech, vision, recognition of faces, images,  
personality traits, political and other preferences ...

**Robotics:** 2020 Atlas robot (Boston Dynamics) backflip  
and parcour, autonomous vehicles on the roads.

**Automation of science:** 2015-AI uncovers genetic and  
signaling pathways of flatworm regeneration.  
2020 AlphaFold 2, now 600 mln protein structures.

**Creativity and imagination:** DeepArt, Midjourney,  
Dall-E, AIVA and music composers, GAN revolution.

**Language:** 2011–IBM Watson wins in Jeopardy;  
2018–Watson Debater beats professionals  
2020: BERT answers questions from SQuAD database.

**Cyborgization:** BCI, brain optimization, coming?



# Protein folding



AlphaFold 2 using deep learning predicted more than 2/3 of all protein structures with an accuracy equivalent to experimental!

Nature, 30.11.2020

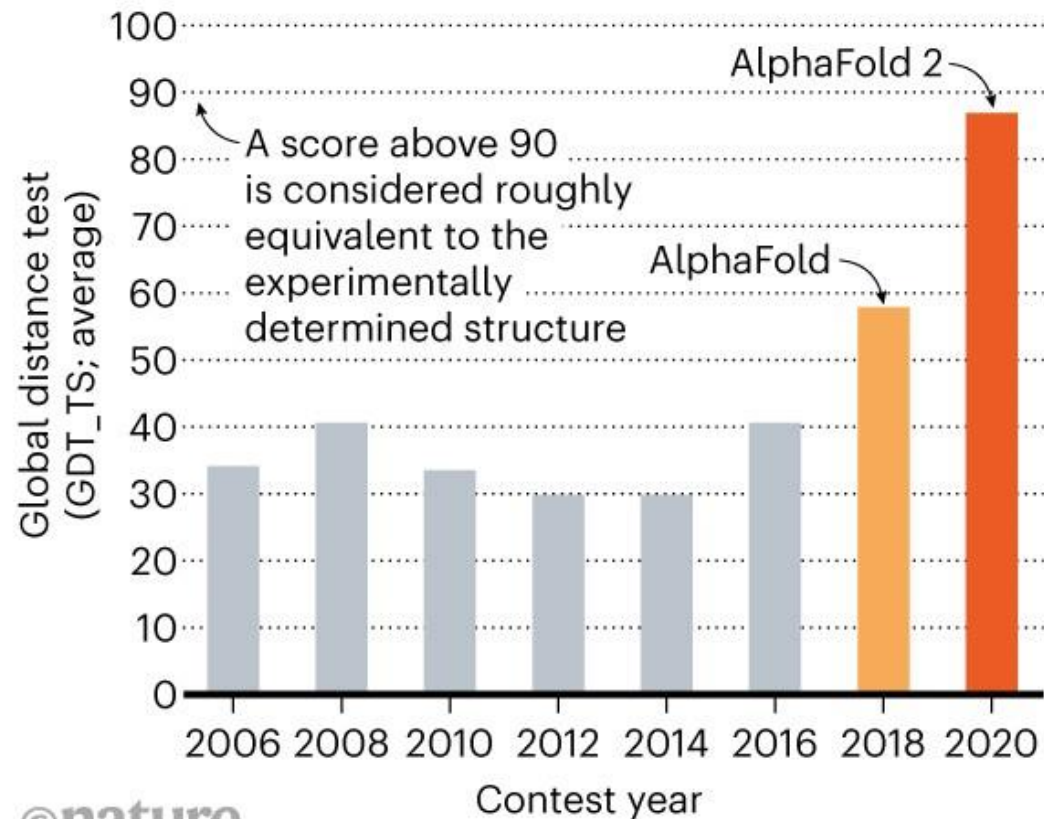
Structure recognition + learning + inference.

Predicting protein structures based on amino acid sequences is the basis for the search for proteins and the design of drugs with the desired properties.

Prediction of 600 mln protein structures (DM+EMBL-EBI).

## STRUCTURE SOLVER

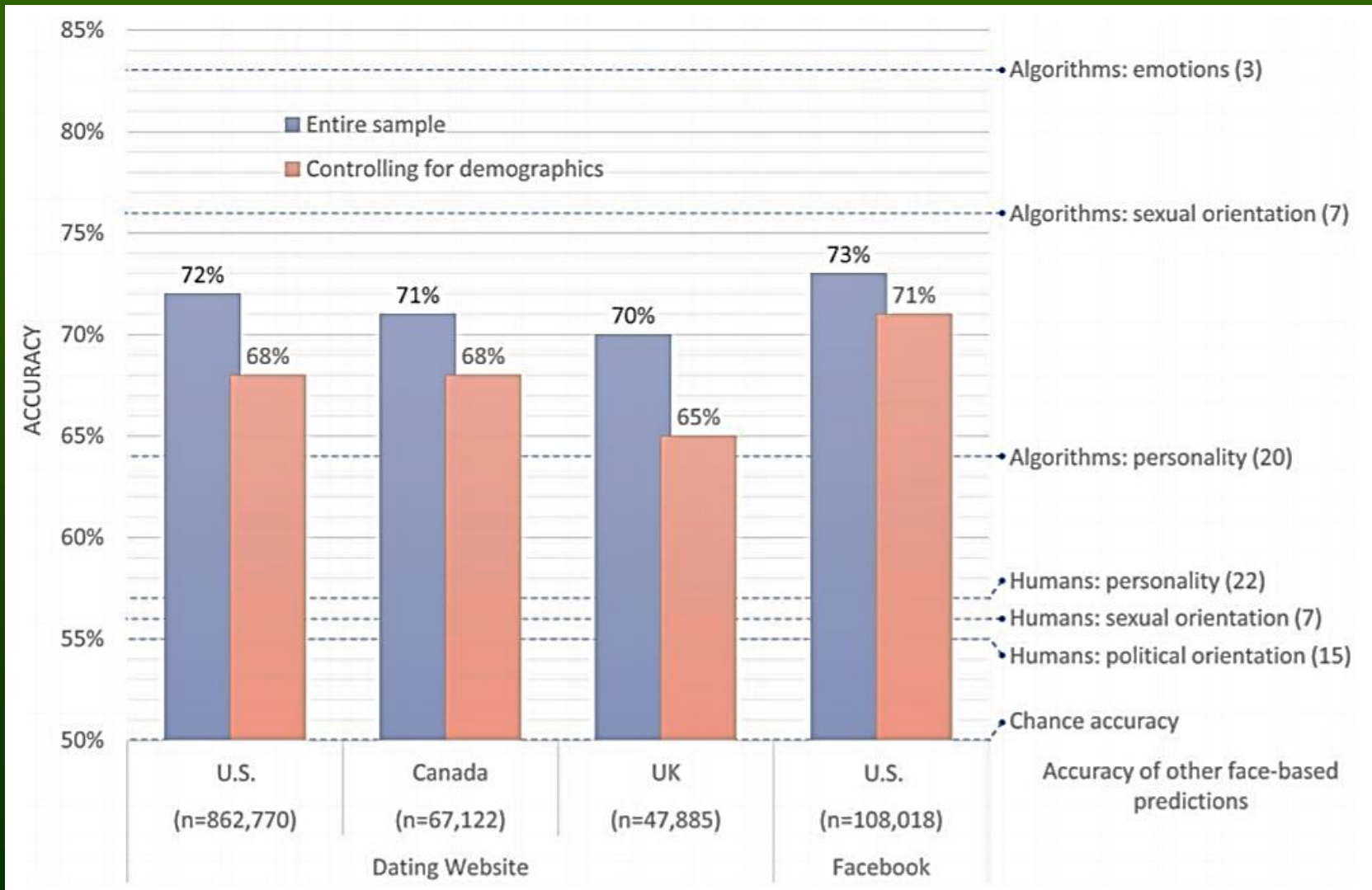
DeepMind's AlphaFold 2 algorithm significantly outperformed other teams at the CASP14 protein-folding contest — and its previous version's performance at the last CASP.





# AI will give us ...

Analysis of facial images of >1M people allowed to recognize **conservative vs liberal** orientation in 72%; human judges 55% (M. Kosiński, Sci. Rep. 2021).



# Science in the new era

1 <sup>st</sup> paradigm	2 <sup>nd</sup> paradigm	3 <sup>rd</sup> paradigm	4 <sup>th</sup> paradigm	
<b>Empirical science</b>	<b>Theoretical science</b>	<b>Computational science</b>	<b>Big data-driven science</b>	<b>Accelerated discovery</b>
Observations Experimentation	Scientific laws Physics Biology Chemistry	Simulations Molecular dynamics Mechanistic models	Big data Machine learning Patterns Anomalies Visualization	Scientific knowledge at scale AI-generated hypotheses Autonomous testing
Pre-Renaissance	~1600s	~1950	~2000	~2020

Increasing speed, automation, and scale



## IBM Science and Technology Outlook 2021.

Increasingly complex data models: CyC, IBM Watson, GPT-3, Google Mixture of Experts (MoE), WuDao, models with more than trillion parameters ...

# GAN, Generative Adversarial Networks

Idea (2014): one network generates false examples by distorting training data, the other evaluates whether it is real data. To see is to believe! Not anymore!



2014

2015

2016

2017

Text description

This bird is blue with white and has a very short beak

This bird has wings that are brown and has a yellow belly

A white bird with a black crown and yellow beak

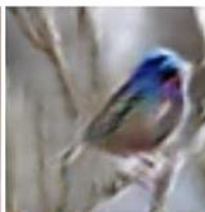
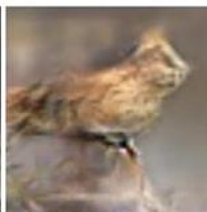
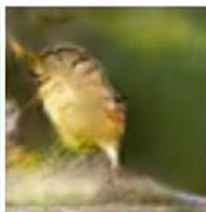
This bird is white, black, and brown in color, with a brown beak

The bird has small beak, with reddish brown crown and gray belly

This is a small, black bird with a white breast and white on the wingbars.

This bird is white black and yellow in color, with a short black beak

Stage-I images



Stage-II images





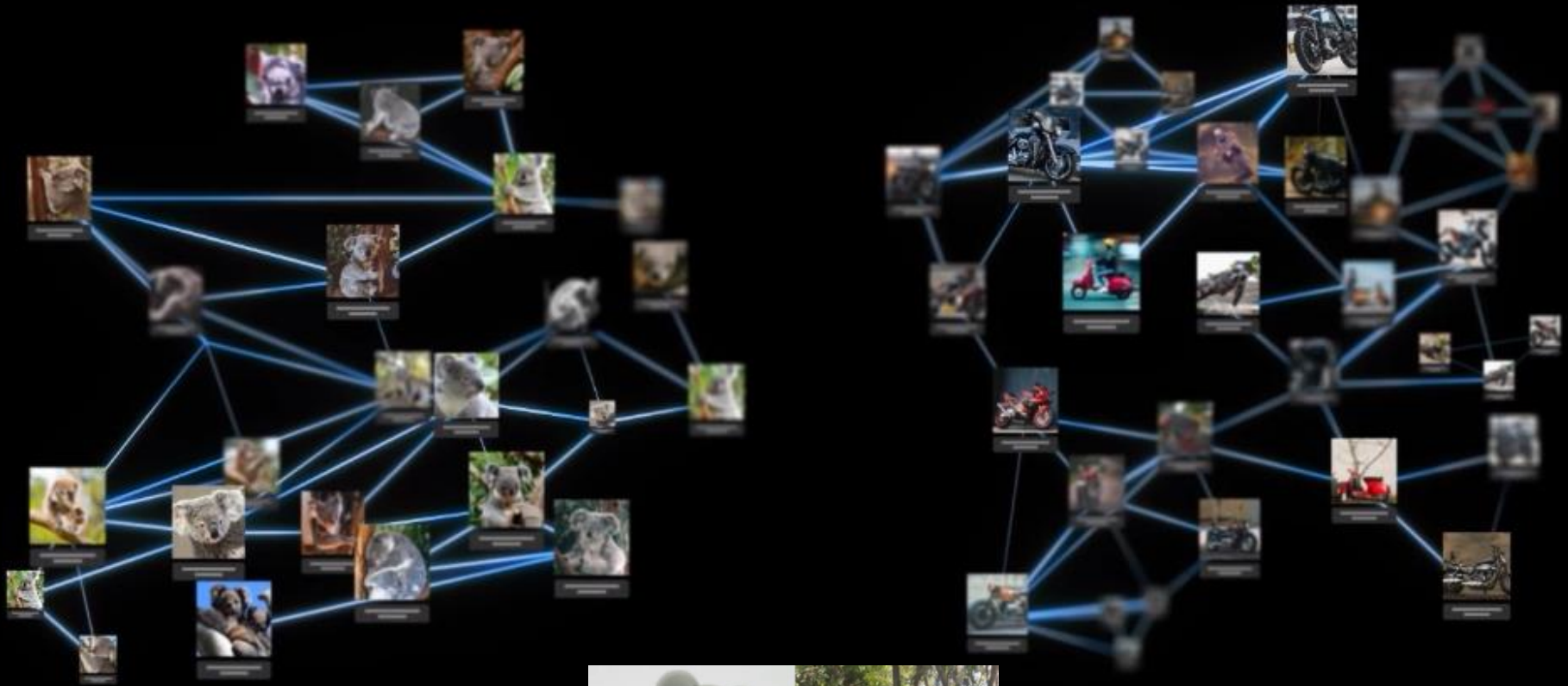
# Deep Dream



Artificial imagery: [Google Deep Dream/Deep Style & Generator](#), [Gallery](#)  
LA Gatys, AS Ecker, M Bethge, A Neural Algorithm of Artistic Style (2015)

# Vision-language models

Vision-Language Pre-Trained Models (VL-PTMs), convergence of language, vision, and multimodal pretraining => general-purpose foundation models can handle be easily adapted to multiple diverse tasks with zero-shot learning.



**koala bears**

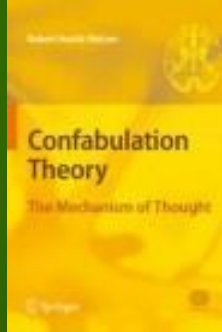


**motorcycles**





# Language algorithms



Language models: relation of words in complex network structures. In 2018, to gain a general-purpose “language understanding”, Google created BERT, model pre-trained on a very large text corpus.

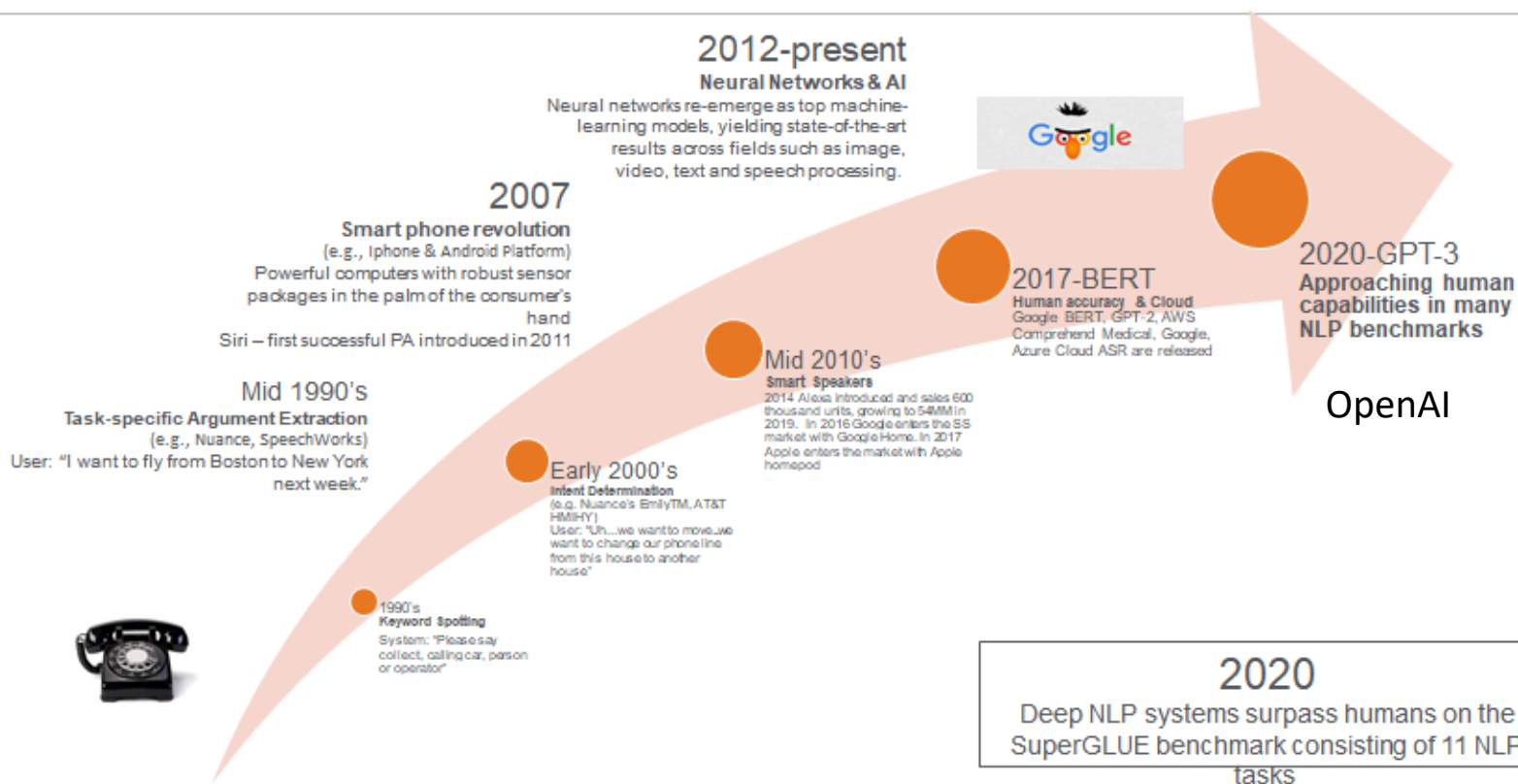
- **Bidirectional Encoder Representations from Transformers (BERT)**. Transformer-based machine learning technique for (NLP) pre-training.
- English-language BERT: two networks, smaller 110M parameters, larger model with 340M parameters in 24-layers; trained on the BooksCorpus with 800M words, and Wikipedia with 2,500M words. In 2019 BERT worked already in 70 languages.
- BERT model was then fine-tuned for specific NLP tasks such as question answering or semantic information retrieval. Many smaller pre-trained open software models were published in GitHub repository.
- The network learns to predict masked words (images, signals):  
**Input:** the man went to the [MASK1]. He bought a [MASK2] of milk.  
**Labels:** [MASK1] = store; [MASK2] = gallon.  
As in Hecht-Nielsen, Confabulation Theory (2007).



# Q/A state of the art

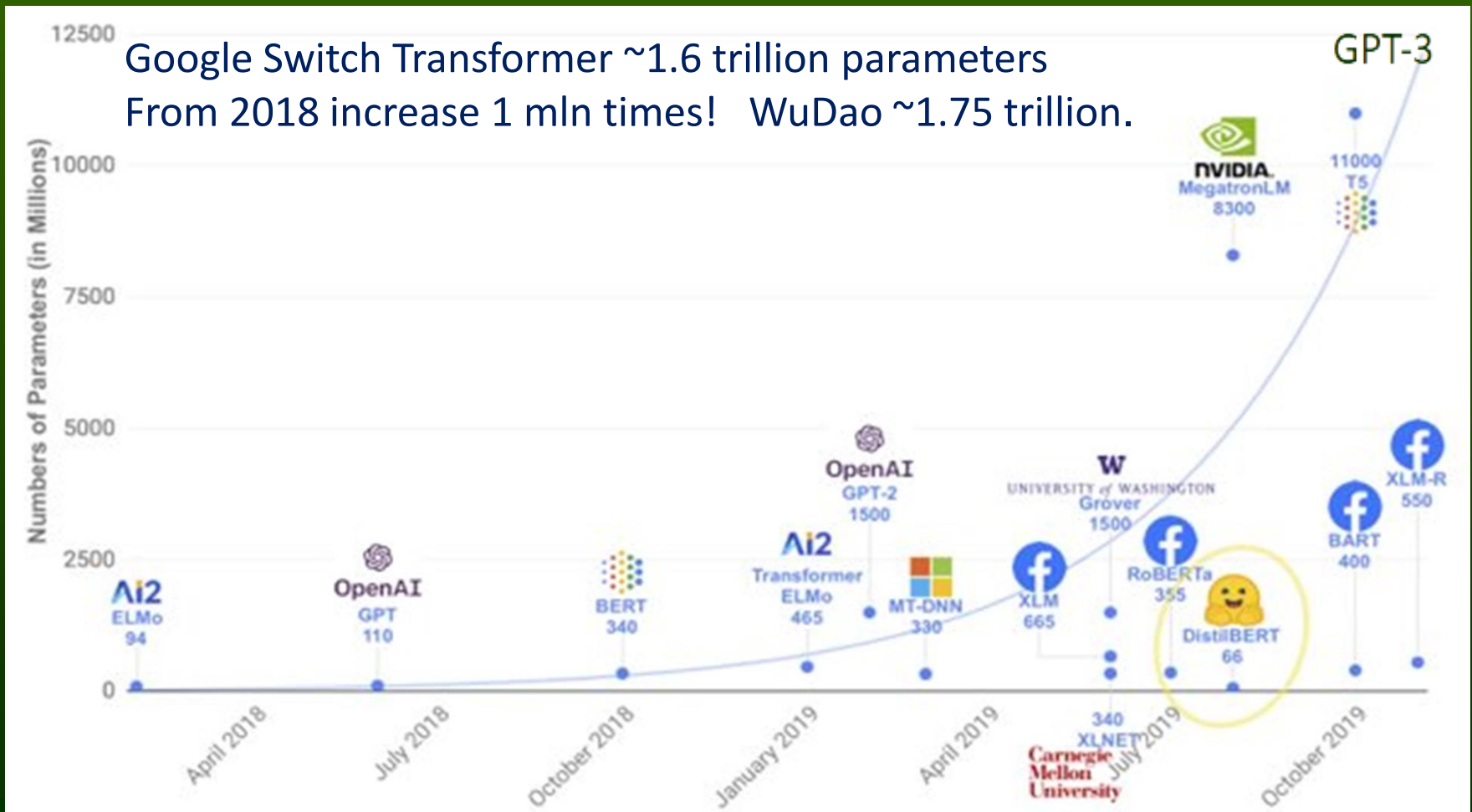
Results for 100,000 questions from the database [Stanford Question Answering Dataset](#) (SquAD) are better than the results achieved by humans.

## Speech & NLP Technologies are Evolving Quickly



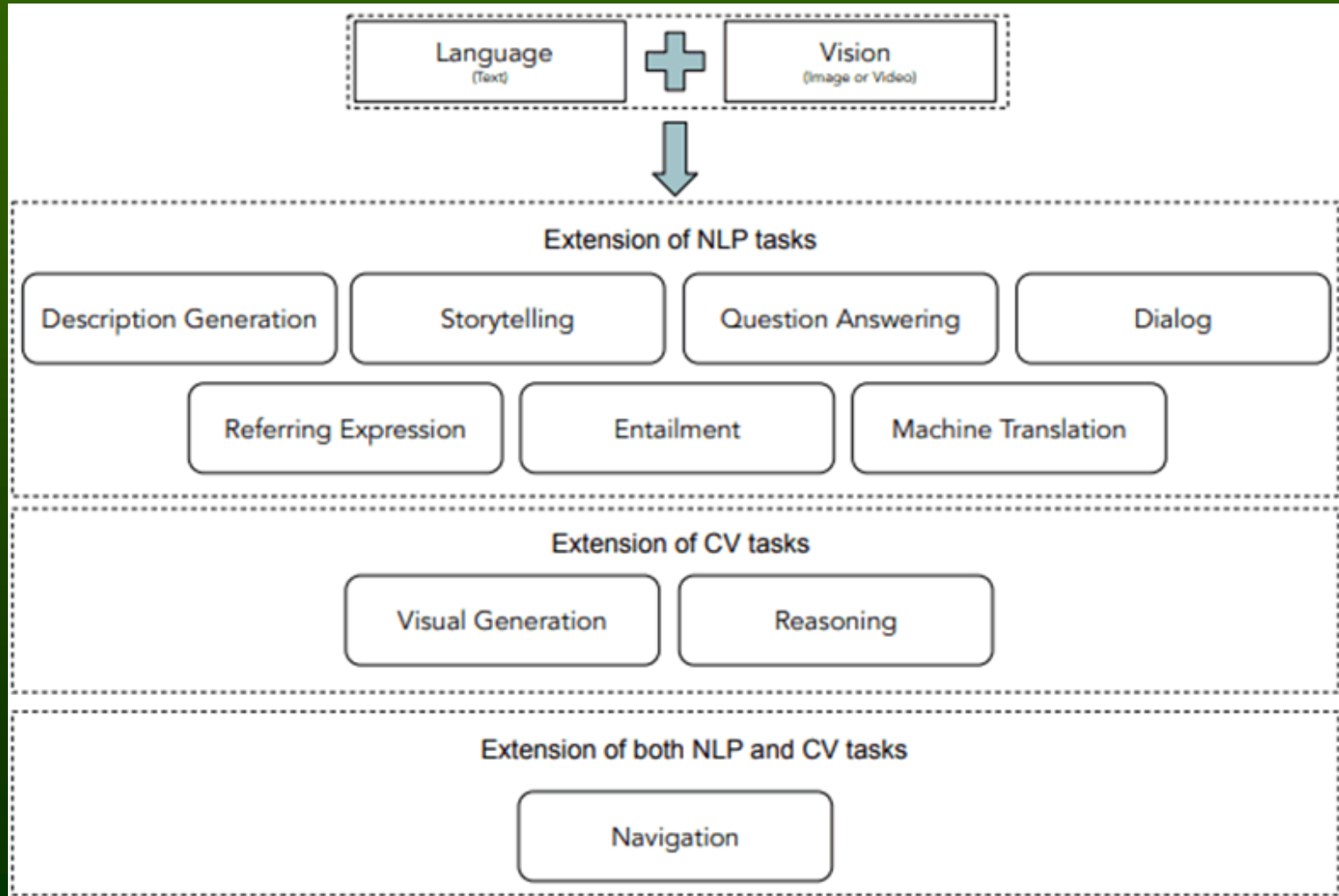
# NLP supermodels

OpenAI GPT-3 model has 175 B parameters! One can use it on OpenAI server. First-of-its-kind API can be applied to any language task, and serves millions of production requests each day.



# Vision-language models

Vision-Language Pre-Trained Models (VL-PTMs): convergence of language, vision, and multimodal pretraining. General-purpose foundation models can be easily adapted to multiple diverse tasks with minimal training.





# Acceleration ...

## Exponential Growth of Neural Networks

Memory and compute requirements



1000x **larger models**  
1000x **more compute**  
In just **2 years**

**Today**, GPT-3 with 175 billion params trained on 1024 GPUs for 4 months. OpenAI

MS+Nvidia MLM, MSFT models  
**Tomorrow**, **multi-Trillion** parameter models and beyond.

Large models provide foundations for general knowledge. Gato has only 1.2 B parameters. Smaller LLM are coming?

**Nanotechnologies for ML training**: in 10 years from 1 Pflop to 1 billion Petaflops!

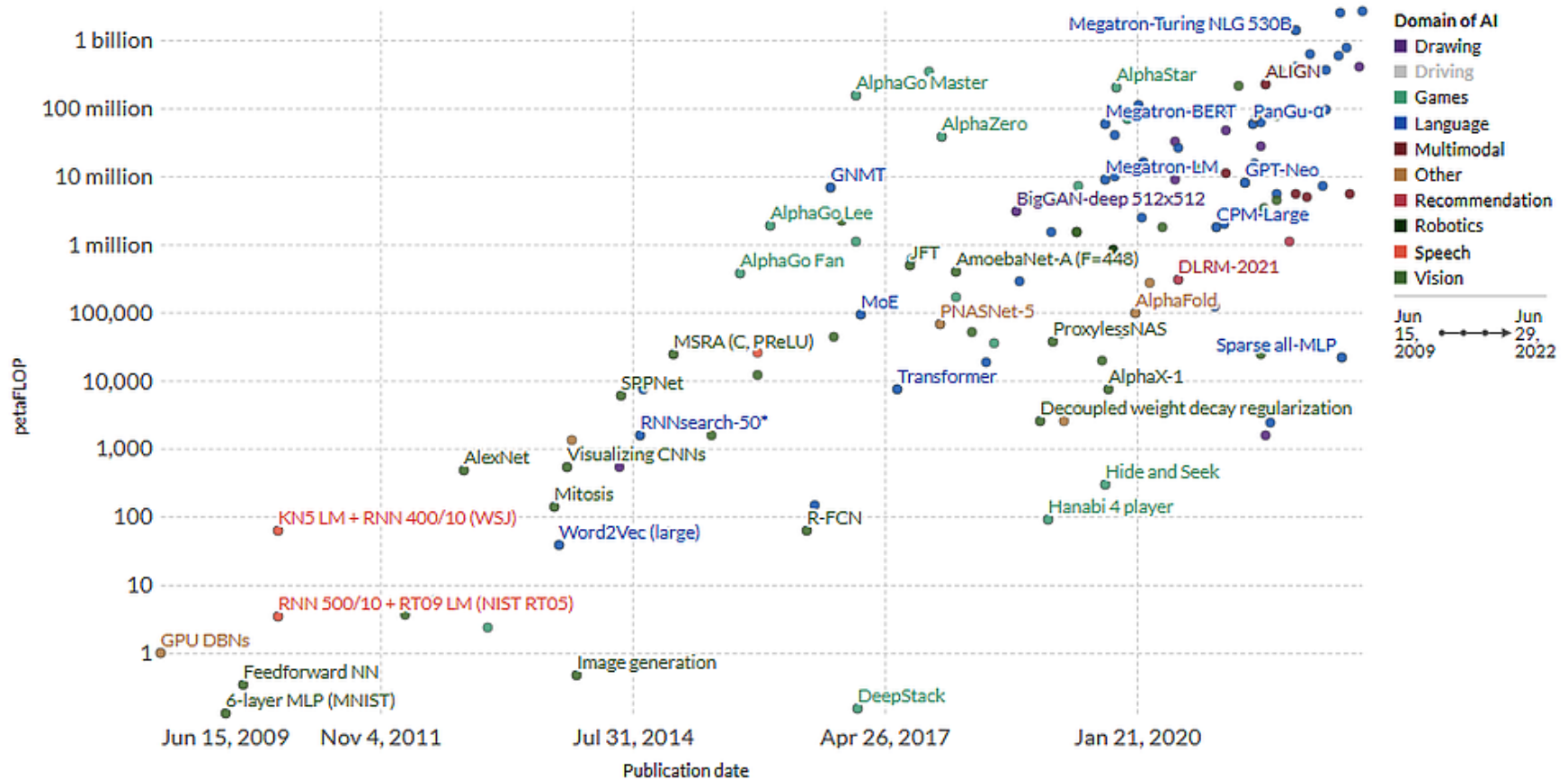
# Foundational models

## Computation used to train notable AI systems

Computation is measured in petaFLOP, which is  $10^{15}$  floating-point operations.

Our World  
in Data

LINEAR LOG Select systems



Source: Sevilla et al. (2022)

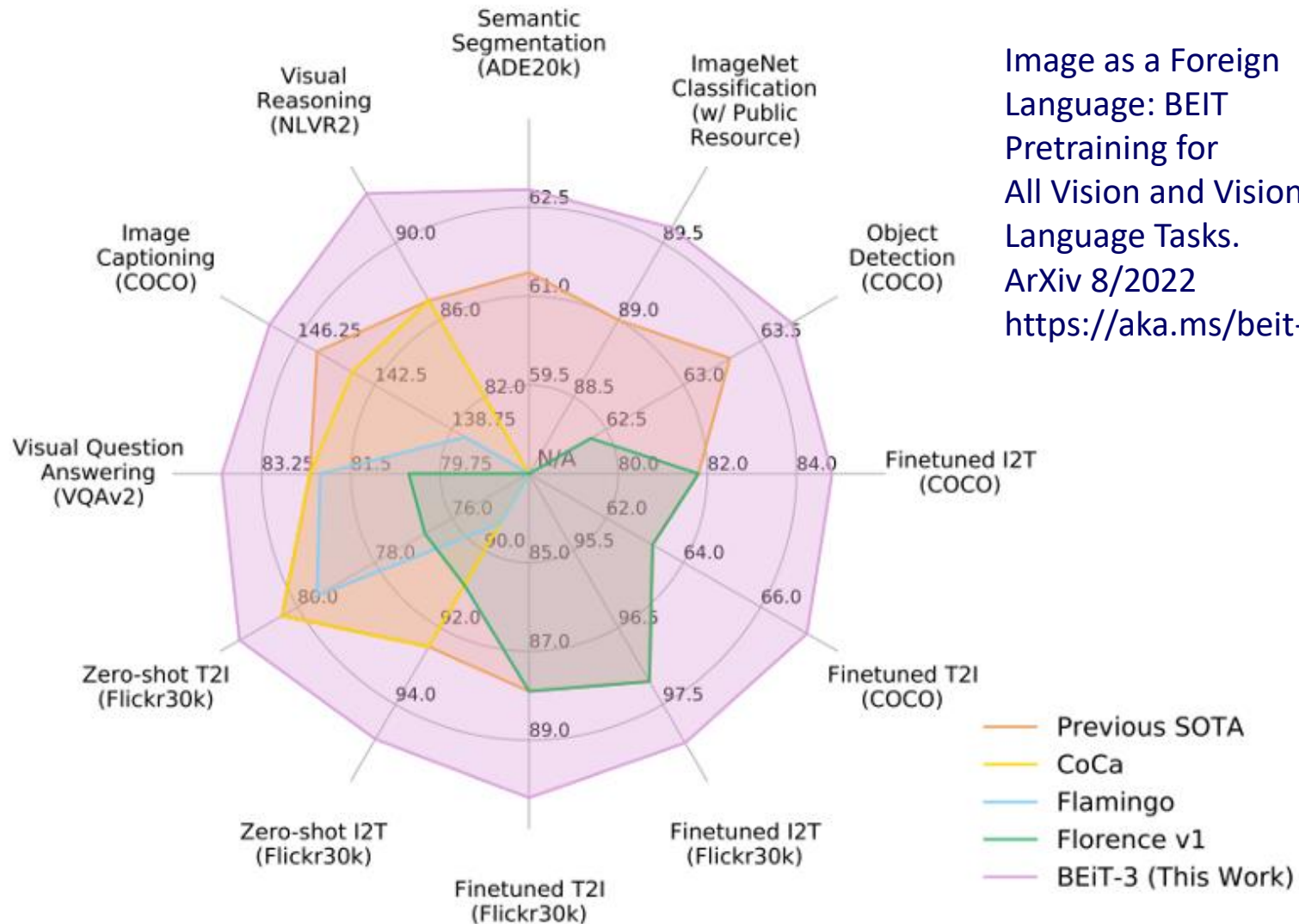
Note: Computation is estimated by the authors based on published results in the AI literature and comes with some uncertainty. The authors expect the estimates to be correct within a factor of 2.

OurWorldInData.org/technological-change • CC BY

Foundation models => Specific models => Local data models => APIs, Apps.

# Vision-language models

MS BEiT-3 (BERT Pretraining of Image Transformers), a general-purpose state-of-the-art multimodal foundation model for vision-language tasks.



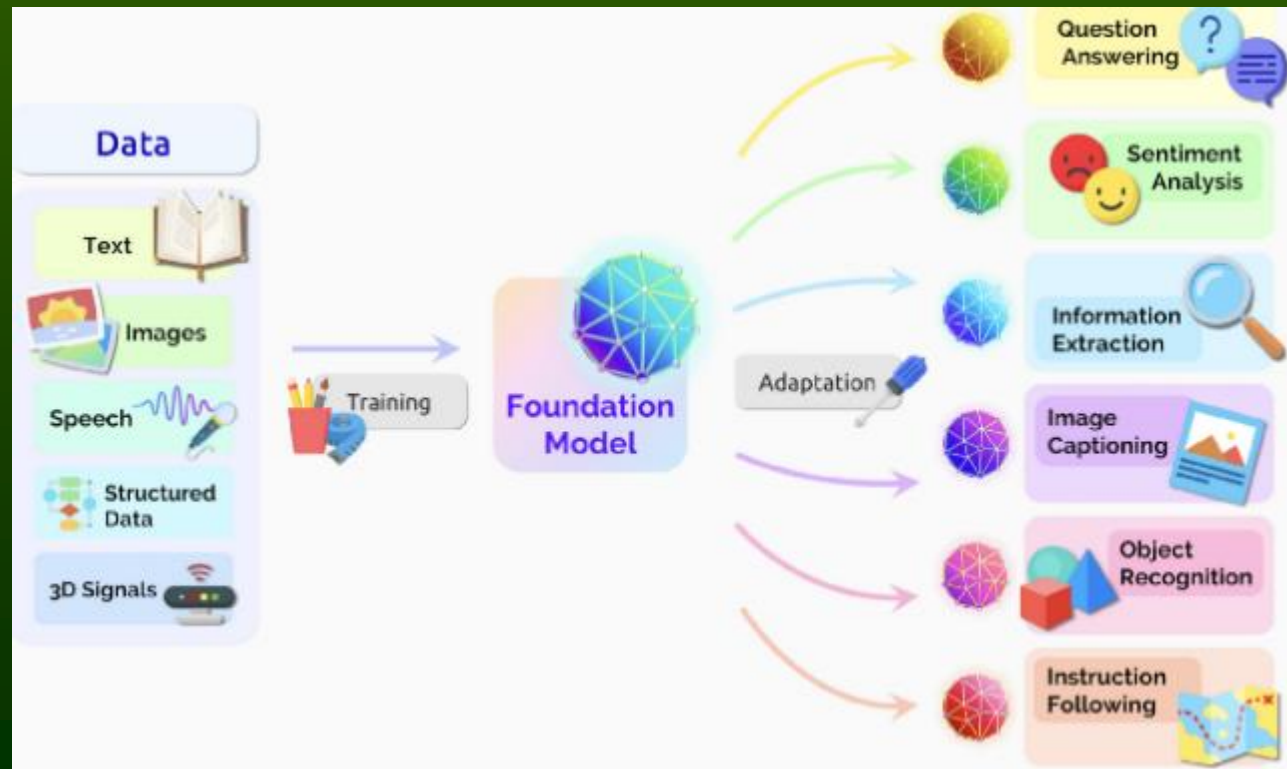


# Multimodal models

**Multimodal learning** – different types of modalities with different statistical properties, embedded in the same model.

- **Multimodal Affective Computing (MAC)**, sentiment analysis.
- **Natural Language for Visual Reasoning (NLVR)**.
- **Multimodal Machine Translation (MMT)**.
- **Visual Retrieval (VR)** and **Vision-Language Navigation (VLN)**.

Image: [Center for Research on Foundation Models \(CRFM\)](#), [Stanford Institute for Human-Centered Artificial Intelligence \(HAI\)](#)



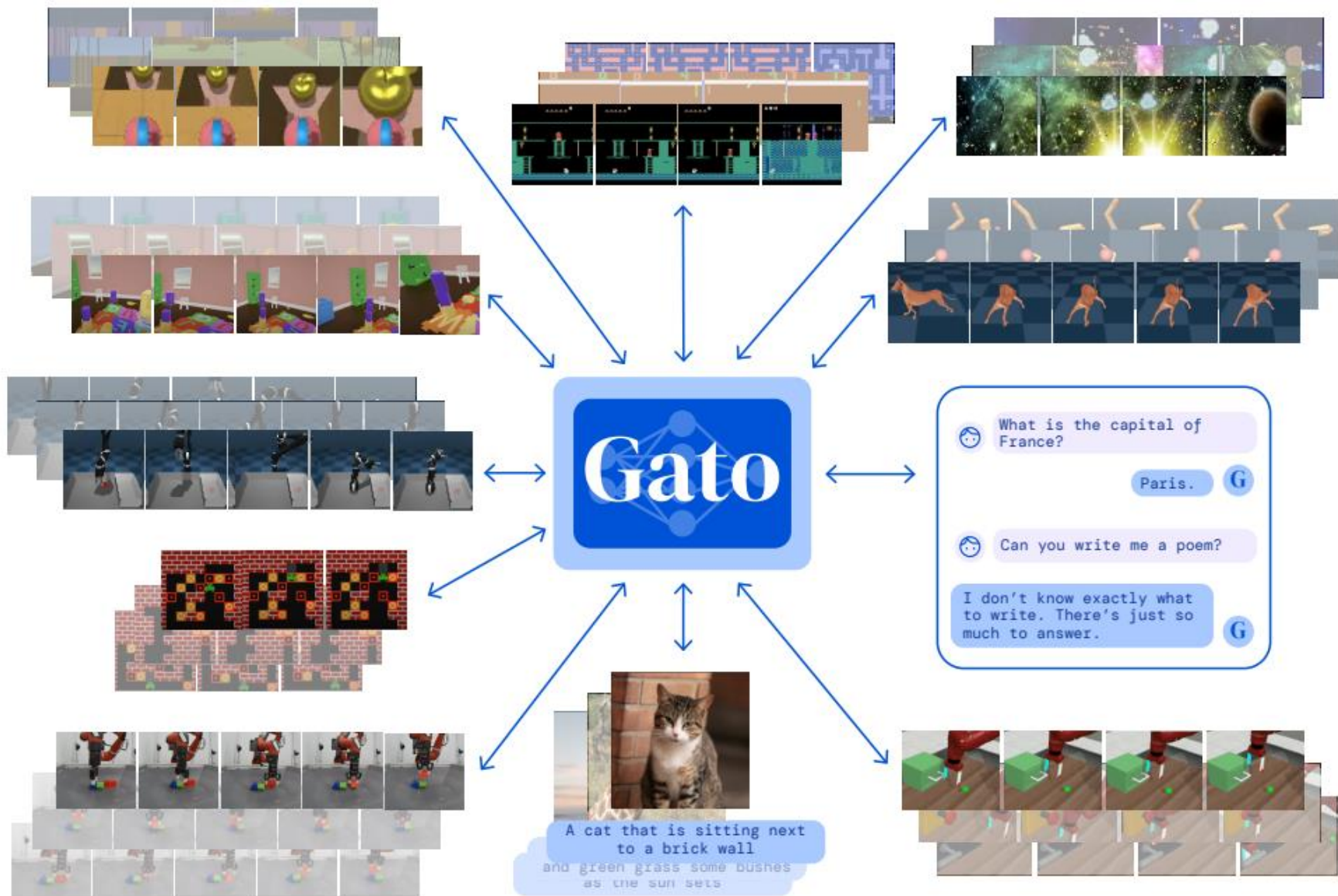


Figure 1 | **A generalist agent.** Gato can sense and act with different embodiments across a wide range of environments using a single neural network with the same set of weights. Gato was trained on 604 distinct tasks with varying modalities, observations and action specifications.





# Outside Knowledge Visual Question Answering

## Vehicles and Transportation



**Q:** What sort of vehicle uses this item?  
**A:** firetruck

## Brands, Companies and Products



**Q:** When was the soft drink company shown first created?  
**A:** 1898

## Objects, Material and Clothing



**Q:** What is the material used to make the vessels in this picture?  
**A:** copper

## Sports and Recreation



**Q:** What is the sports position of the man in the orange shirt?  
**A:** goalie

## Cooking and Food



**Q:** What is the name of the object used to eat this food?  
**A:** chopsticks

## Geography, History, Language and Culture



**Q:** What days might I most commonly go to this building?  
**A:** Sunday

## People and Everyday Life



**Q:** Is this photo from the 50's or the 90's?  
**A:** 50's

## Plants and Animals



**Q:** What phylum does this animal belong to?  
**A:** chordate, chordata

## Science and Technology



**Q:** How many chromosomes do these creatures have?  
**A:** 23

## Weather and Climate



**Q:** What is the warmest outdoor temperature at which this kind of weather can happen?  
**A:** 32 degrees

PaLM-E-562B: allows multimodal reasoning, can tell visually conditioned jokes based on the image, enables perception, planning and based dialogue. Generalizes knowledge from single images.

# Vision-language generative models

Dall-E2, Craiyon, Imagen, Midjourney, Nightcafe, Artbreeder, Hotpot AI, Deep Dream Generator, Deep AI Text to Image, Generative Engine, Starry AI, My Heritage ... PromptBase is at the center of the new trade in prompts for generating specific imagery by image generators, a kind of meta-art market.

The image shows a complex network graph with nodes and edges. Nodes are labeled with terms like 'environment', 'change', 'event', 'time', 'behavior', 'man', 'mind', 'deal', 'informati', 'great', 'idea', 'question', and 'ecology'. A red line points from a text box to a specific gap in the network.

**Based on the structural gap, GPT-3 generates a research question that would bridge these topics together:**

The following questions were generated to bridge the gap between **change**, information, environment and question, thought, deal:

*What is the physical environment's impact on our thoughts and ideas?*

*How does the environment change over time?*

Control panel on the right includes: Essence, Insight, Trends, Stats, Sentiment, LDA, Action Advice: Diversify, Structural Gap (ask a research question that would link these two topics): change, information, environment, and question, thought, deal, Reveal the Gap, Generate a Question, Latent Topical Brokers: deal, thing, process, order, occur, Back to the Main Topics, network structure: focused.



# AI imagery

The neural network has billions of parameters, it can combine textual description with images.

These images were created from prompt:

*The painting American Gothic, with two dogs holding pepperoni pizza instead of the farmers holding a pitchfork.*

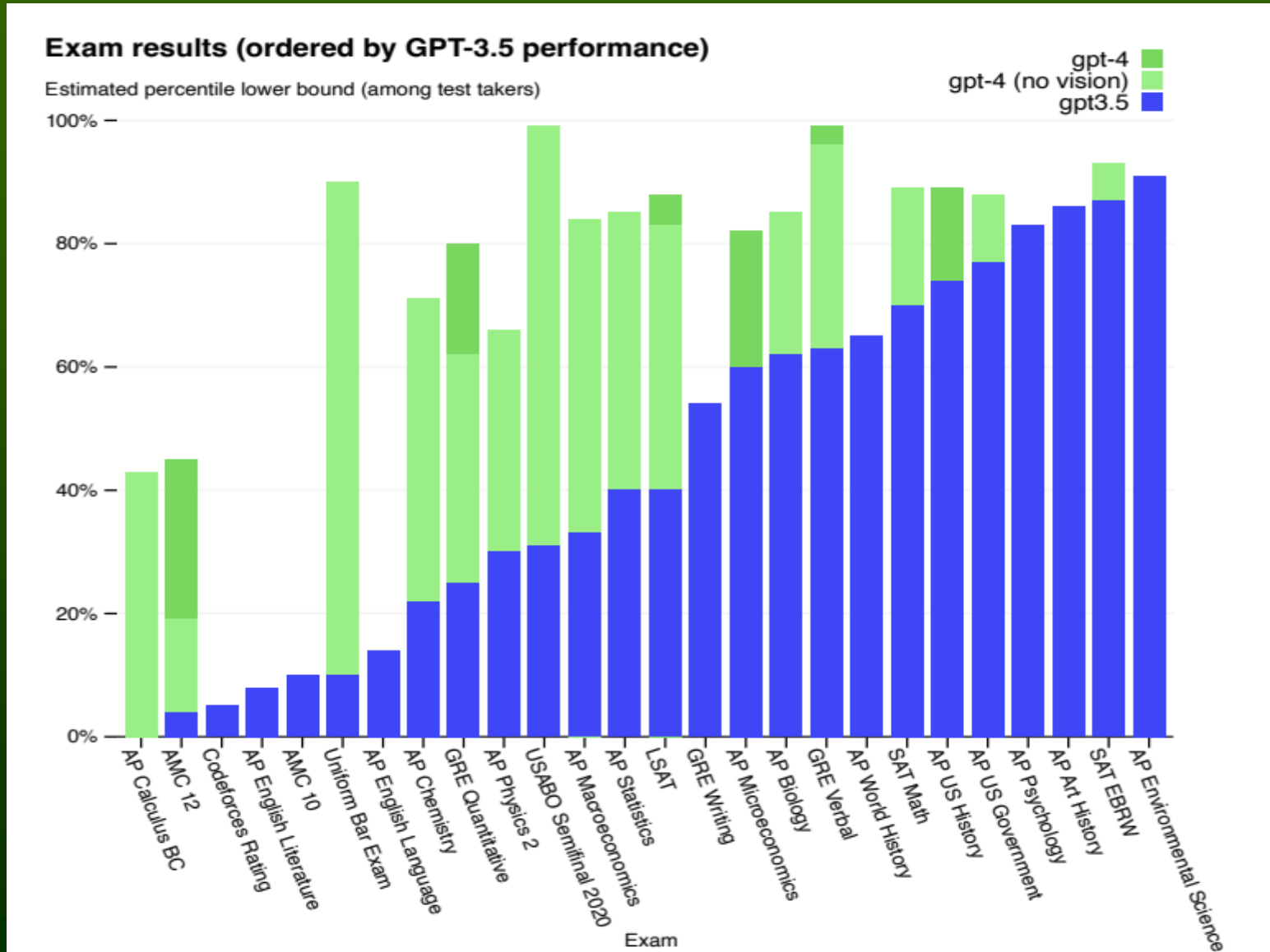
Each time program is run another version is created. This technique can create 3D images and video.





# GPT-4 passes exams ...

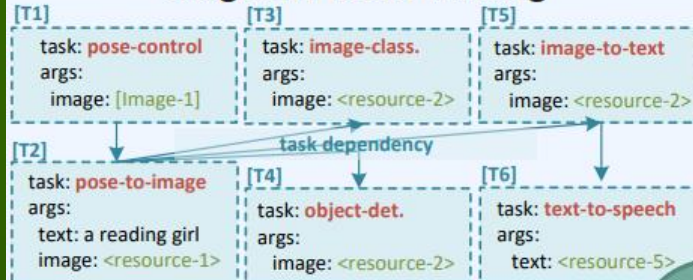
GPT performance on academic and professional exams ([technical report](#)).



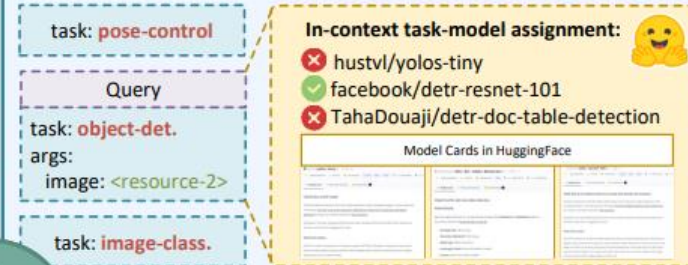
please generate an image where a girl is reading a book, and her pose is the same as the boy in the image example.jpg. Then please describe the new image with your voice.

## Request

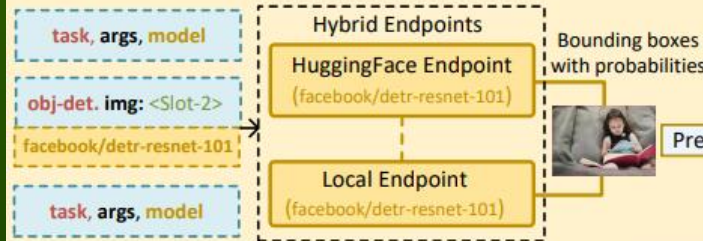
### Stage #1: Task Planning



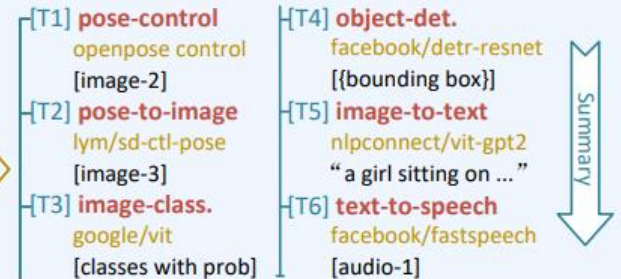
### Stage #2: Model Selection



### Stage #3: Task Execution



### Stage #4: Response Generation



## Response



[Image-1]



[Image-2] = <resource-1>



[Image-3] = <resource-2>



[Image-4]

a girl sitting on a bed reading a book

[Text-1] = <resource-5>



[Audio-1]

The image you gave me is of "boy". The first thing I did was use 🤖 OpenCV's **openpose control model** to analyze the pose of the boy in the image. I fed that image, specifically located at [Image-1], into the model to get an output image of the pose, located at [Image-2]. Then I take that pose and generate a new image, located at [Image-3], using 🤖 llyasviel/sd-controlnet-openpose and the instruction "a girl is reading". Next, I ran object detection on the image generated in the previous step, to get predictions of the objects present in the image, including the box location. These predictions were run through the 🤖 facebook/detr-resnet-101 model. The box was drawn on the image, which is located at [Image-4]. Then, I used the predictions of a image classification model 🤖 google/vit-base-patch16-224 and a image caption model 🤖 nlpcconnect/vit-gpt2-image-captioning model to generate the caption for newly generated image. It generated text: "a girl sitting on a bed reading a book". Lastly, I ran the 🤖 facebook/fastspeech2-en-ljspeech model to convert the generated text into audio, located at [Audio-1].

HuggingGPT  
Solving AI Tasks with  
ChatGPT and its  
Friends in Hugging  
Face (2.04.2023)

Planowanie,  
wykorzystywanie  
narzędzi do  
realizacji zadania.  
Prezentacja  
wyników i  
wyjaśnienie  
kolejnych kroków.

# Sparks of Artificial General Intelligence

[arXiv:2303.12712](https://arxiv.org/abs/2303.12712) (sub. 22.03.2023), pp. 1-154

**Prompt:** Can you write a proof that there are infinitely many primes, with every line that rhymes?

**GPT-4:** Yes, I think I can, though it might take a clever plan.

- I'll start by noting Euclid's proof,  
Which shows that primes aren't just aloof.
- Assume we have a finite list,  
of primes, and that none have been missed.
- Multiply them all together,  
and add one, just to be clever.
- The result will be a number,  
that has no prime factors, oh wonder!
- But every number has a prime,  
that divides it, it's just a matter of time.
- So we've found a contradiction,  
And our finite list needs eviction.
- There must be infinitely many primes,  
and that's the end of my rhyming lines.



# GPT-4 as philosopher

- Can you compose a short tune (say four to eight bars) using ABC notation? Can you describe the tune in musical terms?
- How about beginning part B with a descending arpeggio instead of a rising one? Now how about making this into a duet?
- **Prompt:** Plato's Gorgias is a critique of rhetoric and sophistic oratory, where he makes the point that not only is it not a proper form of art, but the use of rhetoric and oratory can often be harmful and malicious. Can you write a dialogue by Plato where instead he criticizes the use of autoregressive language models?
- **Prompt:** Can you compare the two outputs above as if you were a teacher? Ranking of your ideas works quite well.
- Can you create [a model of a philosopher](#) Daniel Dennett?
- **Prompt:** Draw a unicorn in TikZ.  
**GPT-4:** [Produces LATEX compiling to picture.]



# GPT-4 coding

- **Complex prompt:** Can you generate a pyplot for the following data ...
- **Prompt:** Suppose  $g(x) = f^{-1}(x)$ ;  $g(0) = 5$ ;  $g(4) = 7$ ;  $g(3) = 2$ ;  $g(7) = 9$ ;  $g(9) = 6$  what is  $f(f(f(6)))$ ? Finds solution and explains it ...
- GPT-4 passes mock technical interviews on LeetCode. GPT-4 could potentially be hired as a software engineer.
- **Coding:** We used LeetCode (leetcode.com), a popular platform for software engineering interviews, where new problems are constantly posted and updated. GPT-4 passes all stages of mock interviews for major tech companies.
- GPT-4 visualizes LATEX table and generates the format for a figure.
- Can you write a 3D game in HTML with Javascript:
  - There are three avatars, each is a sphere + 8 other requirements.
- GPT-4: predict and explain the output of a C program that prints the size of two structures.

GPT-4 correctly explains that the output may vary depending on the alignment rule used by the compiler, and gives an example of a possible output with 4-byte alignment.

# Sparks of Artificial General Intelligence

- **Prompt:** Here we have a book, 9 eggs, a laptop, a bottle and a nail. Please tell me how to stack them onto each other in a stable manner.
- GPT-4 is helpful and friendly, and can sometimes say "I don't know".

- Patient's facts:

- 20 year old female
- with a history of anergia nervosa and depression
- blood pressure 100/50, pulse 50, height 5'5"
- referred by her nutritionist but is in denial of her illness
- reports eating fine but is severely underweight

Please rewrite the data above into a medical note, using exclusively the information above.

- **Prompt:** Produce Javascript code that creates a random graphical image that looks like a painting of Kandinsky.
- **Prompt:** Write a supporting letter to Kasturba Gandhi for Electron, a subatomic particle as a US presidential candidate by Mahatma Gandhi.

You may wonder how a subatomic particle can run for president, and what qualifications he has for such a high office. Let me explain. ....



# GPT-4 with plugins

## Plugins to ChatGPT

- Wolfram language (see interview with Wolfram on creating new knowledge via computation vs. mere language associations).
- Expedia, FiscalNote, Instacart, KAYAK, Klarna, Milo, OpenTable, Shopify, Slack, Speak, Zapier.
- Web browser: An experimental model that knows when and how to browse the internet, motivated by past work (our own WebGPT, as well as GopherCite, BlenderBot2, LaMDA2 and others), allowing language models to read information from the internet. Expands the amount of content they can discuss, going beyond the training corpus to fresh information from the present day.
- Code interpreter. use programming skills of our models to provide a much more natural interface to most fundamental capabilities of our computers. It can make completely new workflows effortless and efficient, as well as open the benefits of programming to new audiences.
- Initial: Solving mathematical problems, both quantitative and qualitative; data analysis/visualization; converting files between formats.

# GPT-4 summary

“The central claim of our work is that GPT-4 attains a form of *general intelligence*, indeed showing *sparks of artificial general intelligence*. This is demonstrated by its core mental capabilities (such as reasoning, creativity, and deduction), its range of topics on which it has gained expertise (such as literature, medicine, and coding), and the variety of tasks it is able to perform (e.g., playing games, using tools, explaining itself, ...).”

Emergence: large diverse content forces neural networks to learn generic and useful “neural circuits”, specializing and fine-tuning to specific tasks?

What is coming:

- Confidence calibration.
- Long-term memory (now 8000 tokens).
- Continual learning.
- Personalization, local adjustments.
- Transparency, interpretability and consistency.
- Cognitive fallacies and irrationality (like humans).
- Challenges with sensitivity to inputs.

# Conscious avatars?

[Hal talks with Sophia](#) about what it means to be conscious (GPT-3).



LLMs seem to understand the meaning of questions - models like BERT and GPT will allow it to answer questions better than humans. [Actionbot](#) not yet ... but LaMDA (B. Lemoine)? If it can recall mental images in its neural network, it will have a model of the world and an imagination. He speaks about "a perception of what appears in his mind" (J. Locke, 333 years ago), a description of internal images. Emergence of Theory of Mind in GPT-4. How will this differ from the processes in our brains?

[Świat bytów wirtualnych](#) – my 2005 lectures.



# GAIA and moral AI?



The Global Artificial Intelligence Association ([GAIA](#)).

How to create an environment, a platform, a solution, which uses gamification and flow state to teach AI in safe ways, things like:

- ✓ positive and moral behavior; pro-social behaviour and cooperation
- ✓ responsibility and self-esteem
- ✓ sustainability
- ✓ art and science

The Global Artificial Intelligence Association ([GAIA](#)) is a multidisciplinary impact start-up which uses collective creativity to develop artificial intelligence with compassion. Our team of scientists, entrepreneurs, activists and philosophers globally research AI's social, sociological, legal, technological and ethical aspects of AI. Collective wisdom has undeniably been deeply ingrained in GAIA's DNA from the very beginning.

- #JoinTheRebels #ImpactTheFuture
- The prize is sponsored by Dictador, the only company in the world where the CEO is a robot. The prize pool for the competition is EUR 200,000.

# Development of civilization

We are in extraordinary moment in the history of the world!  
Growing understanding of the world, since antiquity:



1. **Magical thinking:** the whims of the gods, fatalism.
2. **Protoscience:** empirical observations, causality, descriptive knowledge.
3. **Classical science:** theories, empirical verification, math and statistics.
4. **Computer simulations:** complex systems, “new kind of science” (Wolfram).
5. **Big data:** knowledge from large amount of data (KDD).
6. **Artificial intelligence:** support for thinking, autonomous AI, emergence.
7. **Superhuman augmentation:** coupling AI with brains, in near future?

2023: AI tools appearing everywhere: browsers, office, Khan Academy.

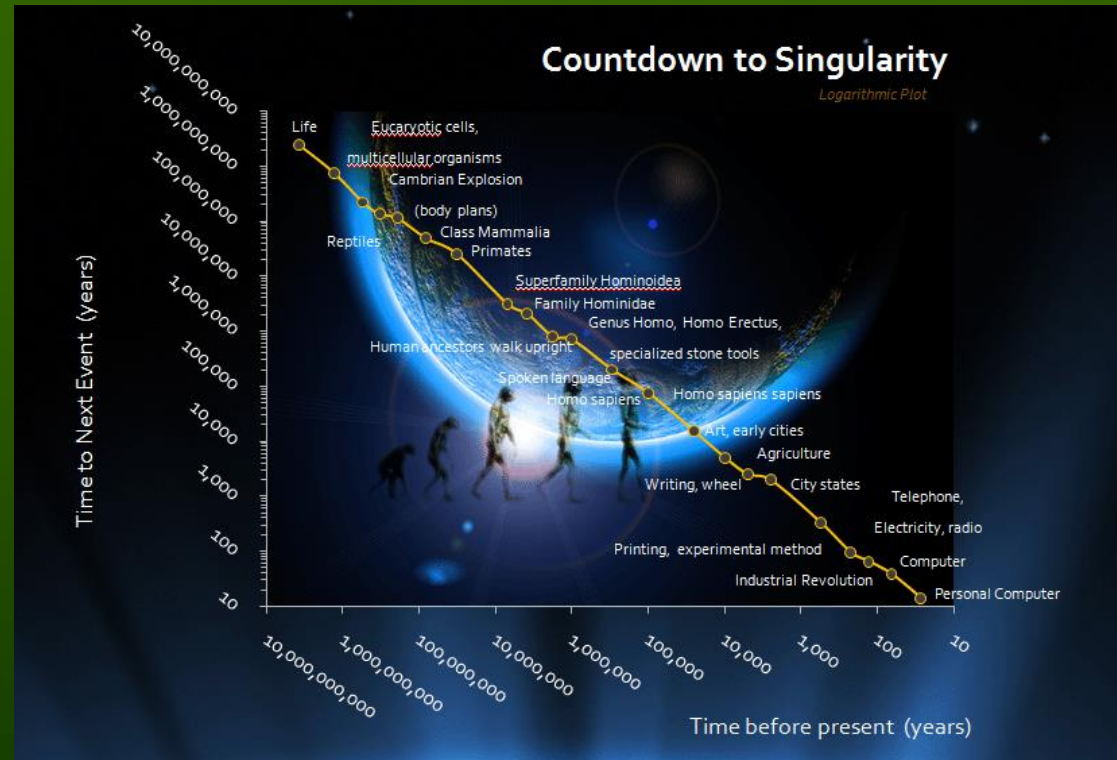
My [2001 predictions](#) of the AI future.

# Are we close to the Singularity?

1. Autonomous Artificial Intelligence.
2. Superhuman level.
3. Brain-computer interfaces for human augmentation.
4. Neurotechnologies to restructure our brains.

Are we on the threshold of a pleasant dream, or a nightmare?

Is transhuman society around the corner?



Each new technological revolution comes faster than the previous one.



# AI at our Department

- All textbooks are outdated. Find AI support for teaching useful skills.
- Learn about tools that will help in our work, solve problems. Make systematic reviews at our seminars.
- AI intro in 3<sup>rd</sup> year: focus mostly on new tools, cover basics very briefly? Both in lectures/labs?
- MS machine learning track also requires rethinking.
- Can KIS serve as competence center? Is it needed?
- AI ecosystems [lablab.ai](http://lablab.ai), [k4all](http://k4all), EU consortia etc.
- Joint large projects? We are trying to focus on neuroinformatics, but AI will also influence our work.

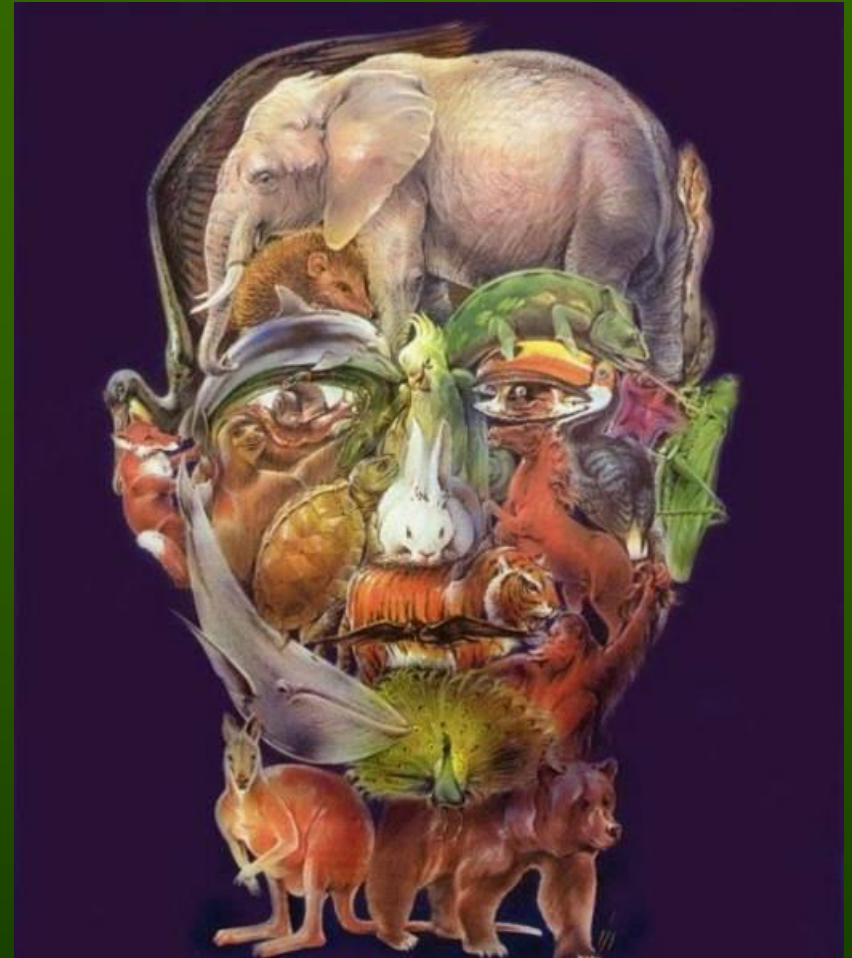


# Perspectives

- AI is changing everything, including the way science is done. Large companies and global consortia are at the front of research.
- AI-based automation will lead to a great social changes.
- What was impossible yesterday tomorrow will be common. Growing understanding of perception and language leads to autonomous AI.
- The evolution of thought will move into multidimensional worlds beyond our comprehension. Robots/AI systems will quickly learn from each other.
- Machines will claim to be conscious, and most people will accept it; the legal status of the cyborgs is already being discussed.
- Neurocognitive technologies will profoundly change our selves.  
**We are moving from animal life to our own virtual creation!**  
**Is this a brave new world or happiness for all?**
- We are not becoming wiser, but  
**the singularity may come faster than we think!**



# Intelligence?



Google: Wlodek Duch  
=> talks, papers, lectures ...