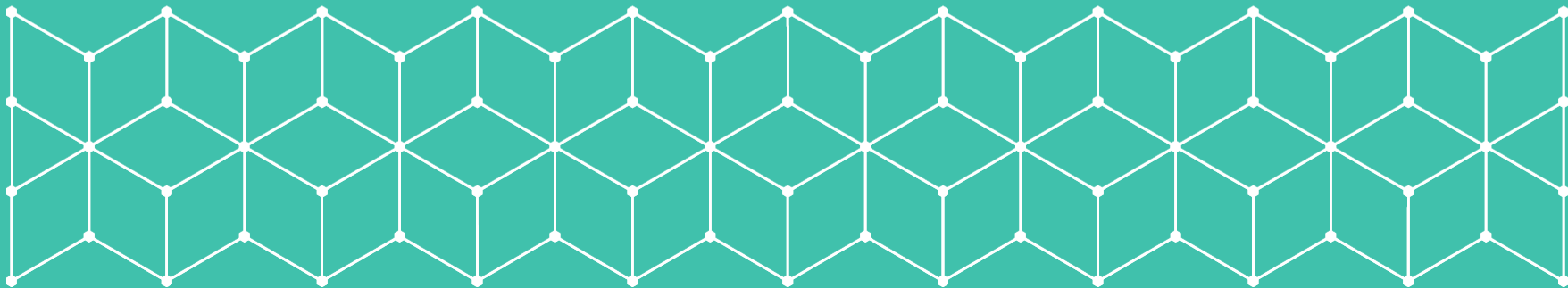


Å forske med KI: Fremtidens Doktorgradsutdanning

(Nåtidens)

Stefano Nichele
Professor

www.nichele.eu



From a very recent research paper:

3.8 Language model use

The Large Language Model (LLM) ChatGPT was utilized for the code and text during this project. For the code, ChatGPT was used to optimize code snippets for speed, often from pure Python to NumPy vectorization. Any code optimized with ChatGPT has been extensively tested to ensure its correctness. In addition, ChatGPT was utilized for brainstorming reasons for issues with the code. For the text, ChatGPT was used for brainstorming paragraph structure and for suggesting wording that would keep the text professional and concise. LLMs have not generated substantial parts of the code or text in this article.

The new standard!



Stefano Nichele

Professor

Østfold University College

Machine Learning research group

The Digital Society priority area

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Address: B R A Veien 4, 1783 Halden, Norway

Office nr.: D1-039

Postal: P.O. Box 700, NO-1757 Halden

Professor II

Oslo Metropolitan University



My research is in **Artificial Intelligence (AI)**, **Artificial Life (ALife)**, and **Complex Systems (CS)**.

My long-term goals are:

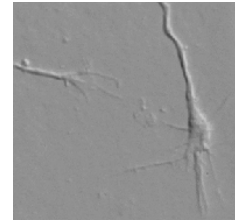
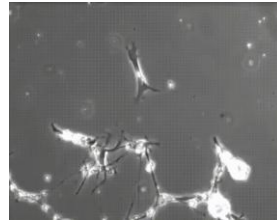
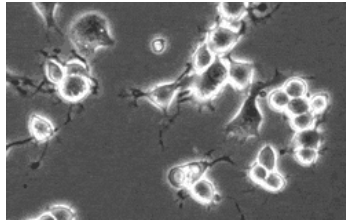
- understand how intelligence can emerge in machines as it does in biological organisms;
- create machines that are more adaptive, alive, and generally intelligent.

<https://www.nichele.eu/lab.html>

Services

- Member of the Board of Directors of [NORA \(Norwegian Artificial Intelligence Research Consortium\)](#) (2022-26)
- Member of [Expert Committee on Artificial General Intelligence](#), Norwegian Board of Technology (2025-)
- Member of [ISAL \(International Society for Artificial Life\)](#)
- Member of [ELLIS \(European Laboratory for Learning and Intelligent Systems\)](#)
- Senior Member of [IEEE](#)
- Chair of IEEE CIS [Task Force on Artificial Life and Complex Adaptive Systems](#) (2022-26)
- External advisor for Bachelor and Master programs in Robotics at the University of Oslo (2023-ongoing)

What is biological intelligence?

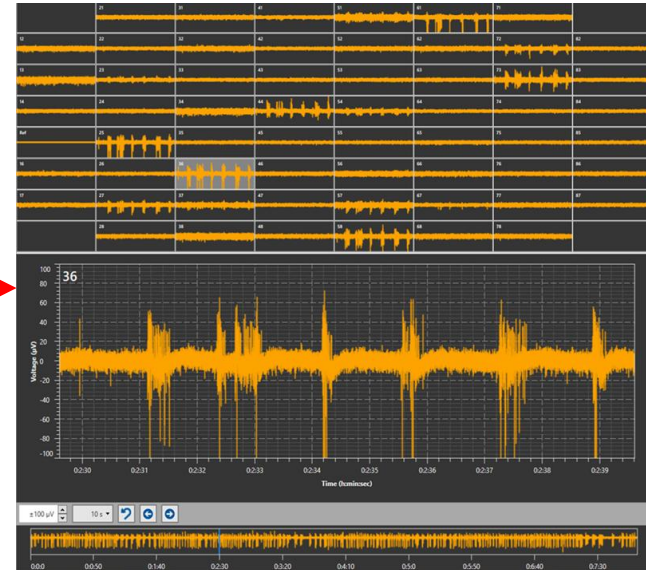
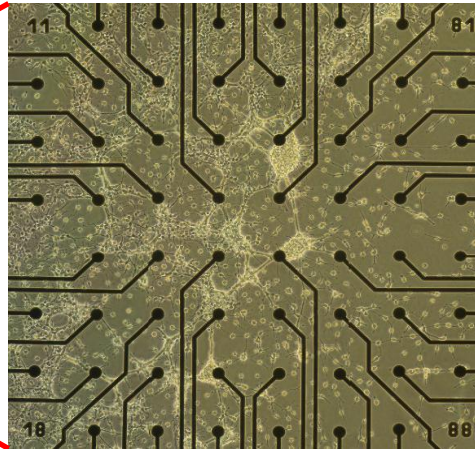
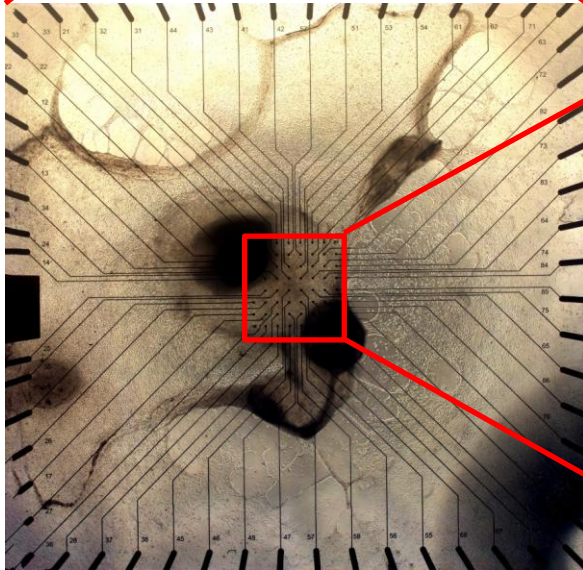
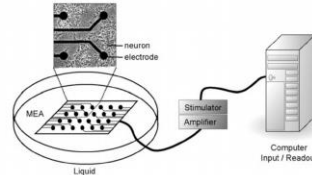
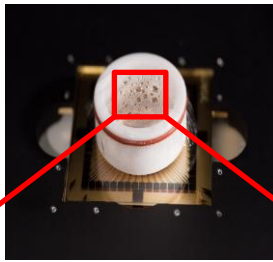


NORA

Norwegian Artificial Intelligence
Research Consortium

**#23 - Towards a less artificial Artificial
Intelligence**

<https://www.youtube.com/watch?v=y20unu60Oal&list=PL2Yl1C0VZgBY5OzgZsVNWz9od1XTvg85p&index=22>



Micro-Electrode Array (MEA) technology

Awards

2024 Distinguished Early-Career Investigator Award by the International Society for Artificial Life



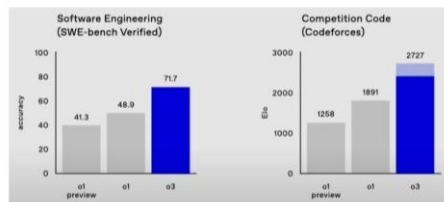
2019 Young Research Talent Award by the Norwegian Research Council (NFR)



Å forske med KI – Fremtidens Doktorgradsutdanning

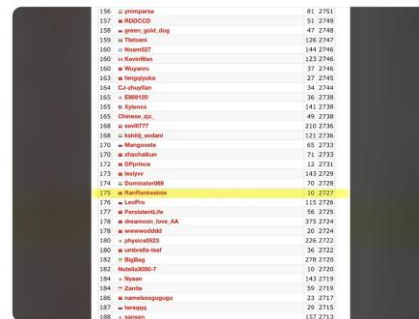
Why now?

Generative AI has reached a tipping point (LLMs, diffusion models).



OpenAI o3 is 2727 on Codeforces which is equivalent to the #175 best human competitive coder on the planet

OpenAI o3



156	o1-preview	81 2751
157	o1	51 2749
158	o1-preview	47 2748
159	o1	126 2747
160	o1	144 2746
161	o1	123 2746
162	o1	37 2746
163	o1	27 2746
164	o1	34 2744
165	o1	36 2738
166	o1	141 2738
167	o1	49 2738
168	o1	110 2736
169	o1	121 2736
170	o1	65 2733
171	o1	71 2733
172	o1	12 2731
173	o1	143 2729
174	o1	70 2728
175	o3	160 2727
176	o1	115 2726
177	o1	56 2725
178	o1	375 2724
179	o1	20 2724
180	o1	206 2722
181	o1	36 2722
182	o1	278 2720
183	o1	19 2720
184	o1	143 2719
185	o1	59 2719
186	o1	23 2717
187	o1	29 2715
188	o1	137 2713

Relevance for PhDs: AI impacts not only *research topics* but also *how research is conducted*.

What does it mean to “think with AI” as a researcher in 2025?

1. Hva er KI (og KI som vi bruker i dag)?
2. Å forske med KI: Fremtidens Doktorgradsutdanning

1. Hva er KI (og KI som vi bruker i dag)?

What is AI?

BULLETIN OF
MATHEMATICAL BIOPHYSICS
VOLUME 5, 1943

A LOGICAL CALCULUS OF THE IDEAS IMMANENT IN NERVOUS ACTIVITY

WARREN S. MCCULLOCH AND WALTER PITTS

FROM THE UNIVERSITY OF ILLINOIS, COLLEGE OF MEDICINE,
DEPARTMENT OF PSYCHIATRY AT THE ILLINOIS NEUROPSYCHIATRIC INSTITUTE,
AND THE UNIVERSITY OF CHICAGO

A Proposal for the DARTMOUTH SUMMER RESEARCH PROJECT ON ARTIFICIAL INTELLIGENCE

We propose that a 2 month, 10 man study of artificial intelligence be carried out during the summer of 1956 at Dartmouth College in Hanover, New Hampshire. The study is to proceed on the basis of the conjecture that every aspect of learning or any other feature of intelligence can in principle be so precisely described that a machine can be made to simulate it. An attempt will be

VOL. LIX. No. 236.]

[October, 1950

MIND

A QUARTERLY REVIEW
OF
PSYCHOLOGY AND PHILOSOPHY

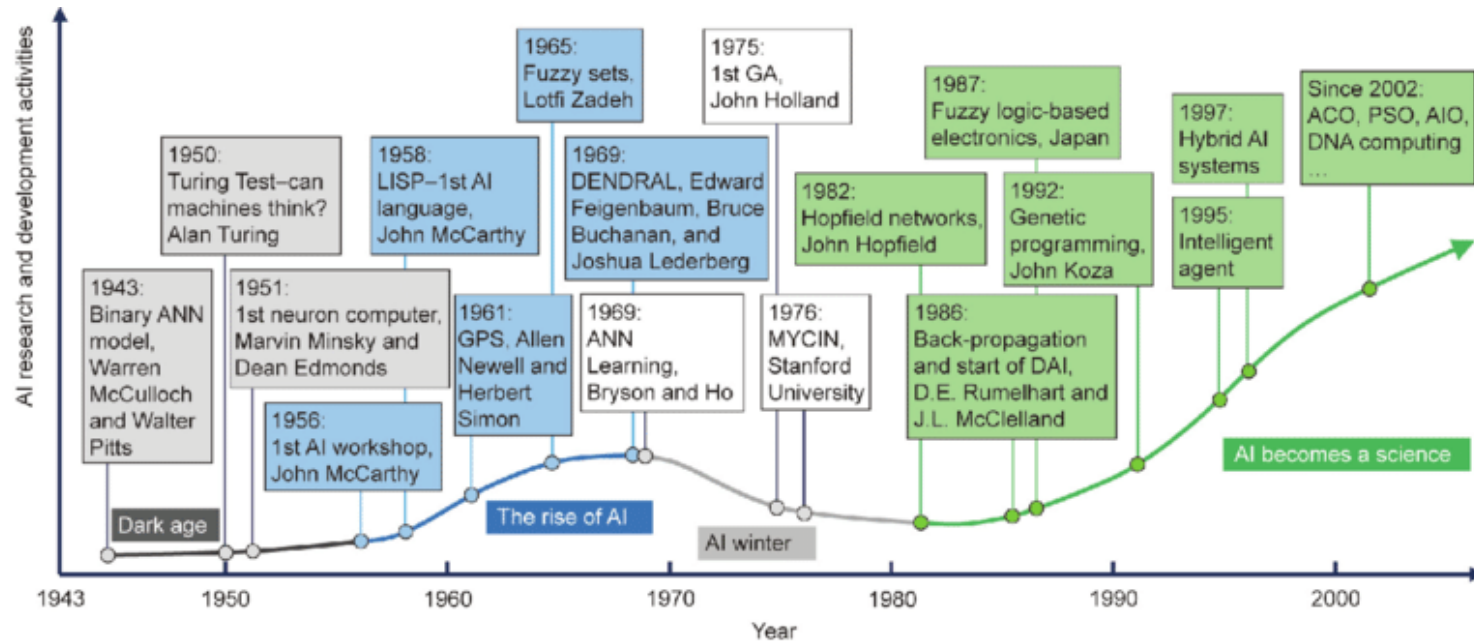
I.—COMPUTING MACHINERY AND INTELLIGENCE

By A. M. TURING

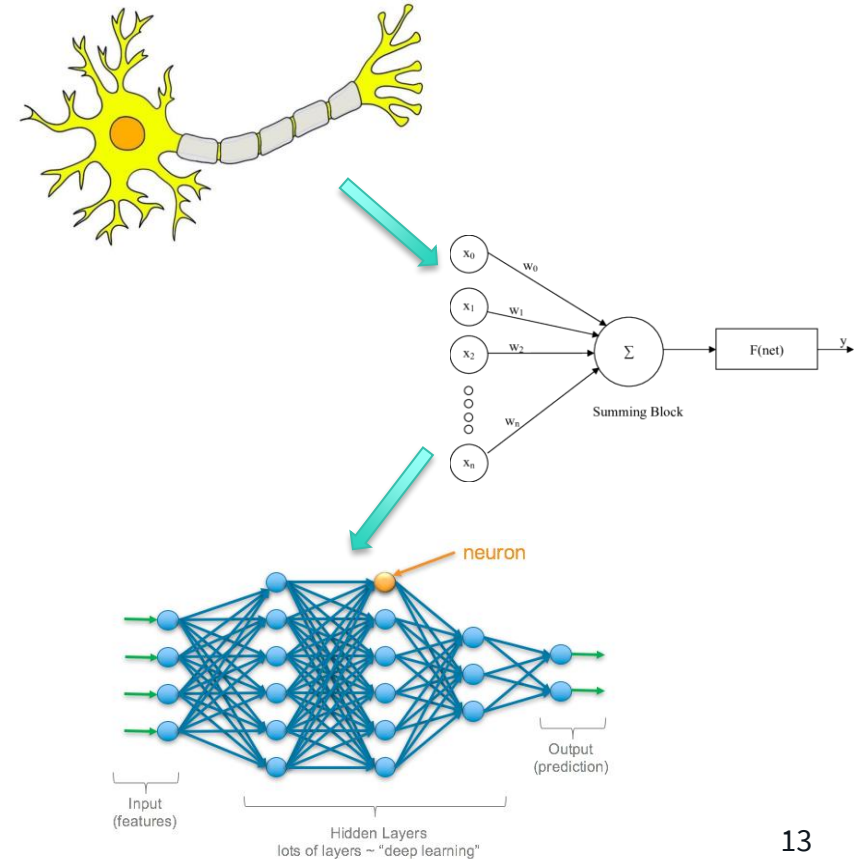
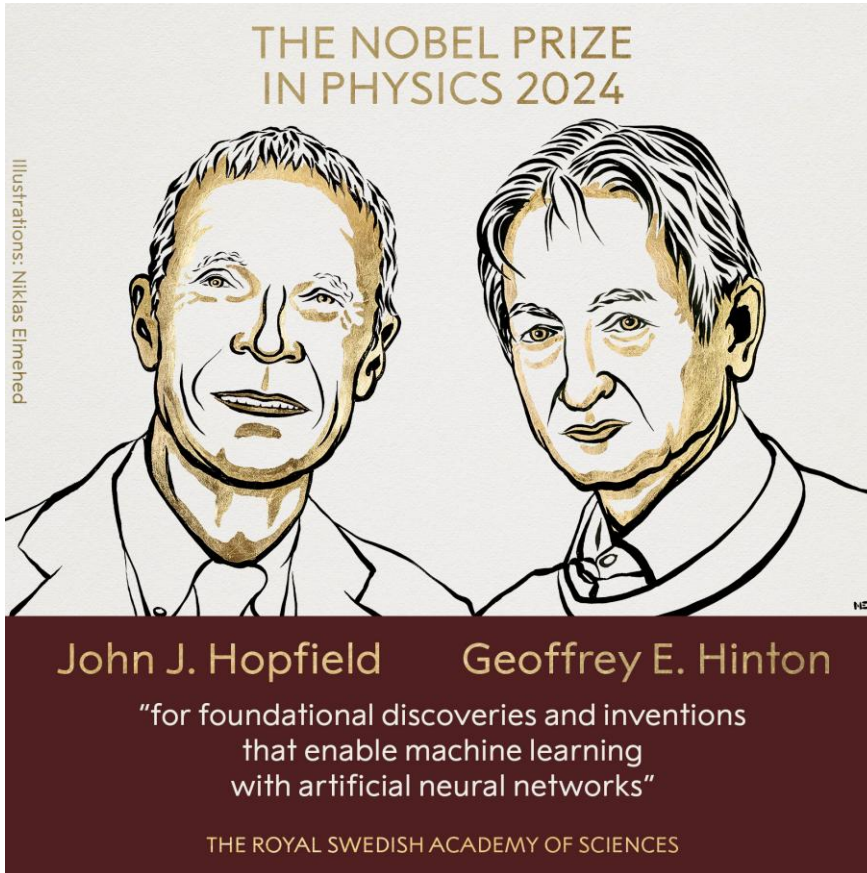
1. *The Imitation Game.*

I PROPOSE to consider the question, 'Can machines think?'

AI history



AI is not a hype longer, it is a Nobel prize worthy tech!



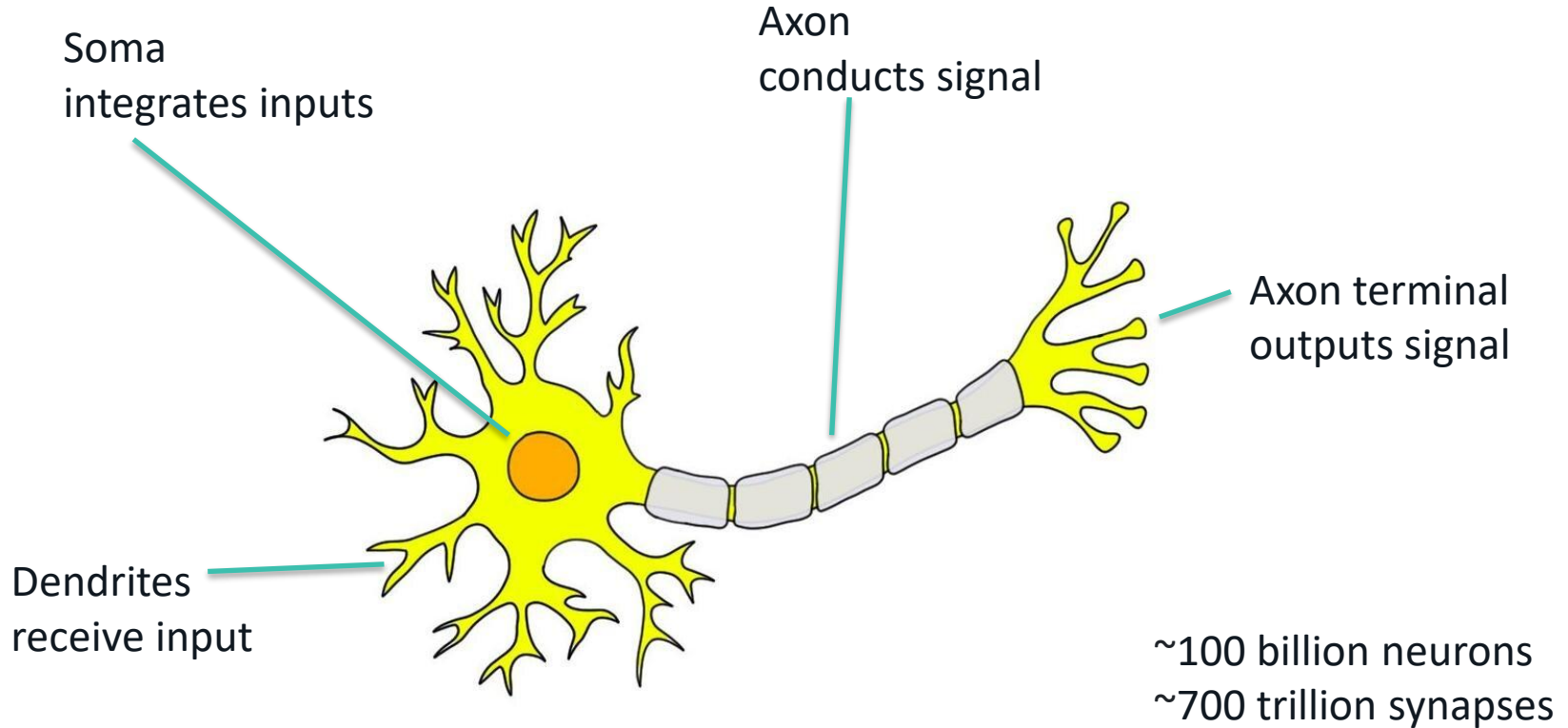
From Rules → Statistics → Representation Learning

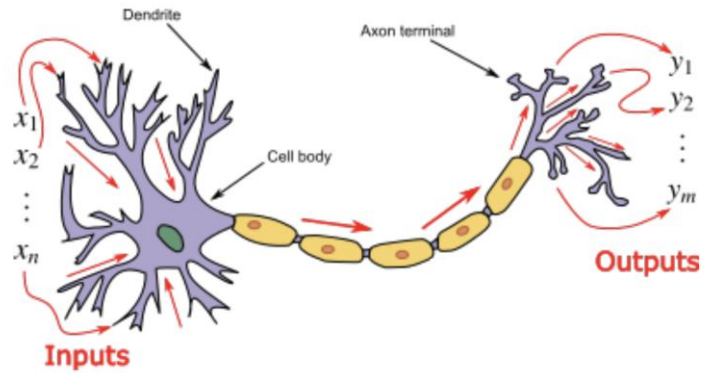
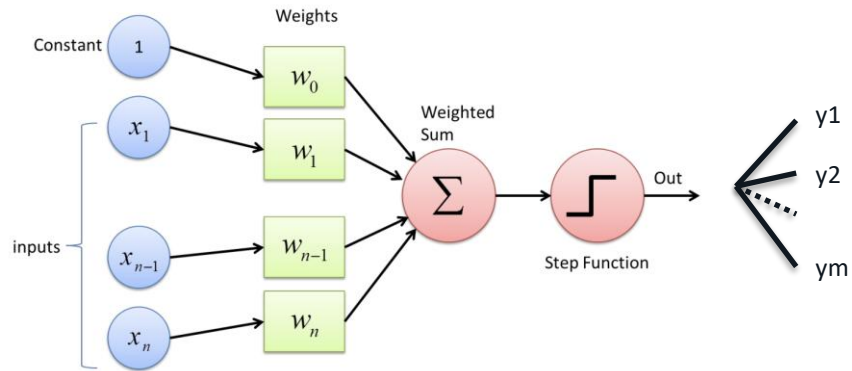
Key shift: models *learn patterns from data* rather than being explicitly programmed.

Neural Networks & Deep Learning

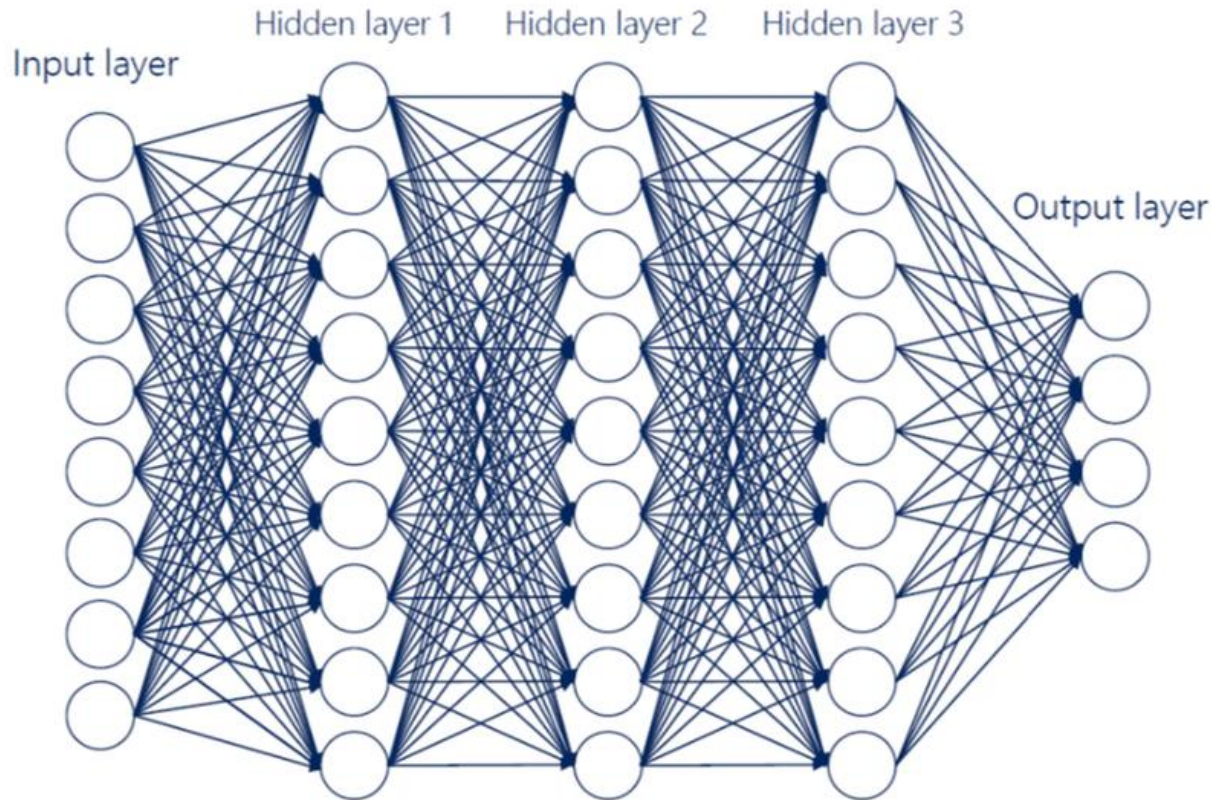
Intuition: layers of transformations, approximating complex functions.

Key takeaway: AI is about **general-purpose pattern learners** that can be *adapted* to many tasks.





Artificial Neural Networks (AKA Deep Learning)



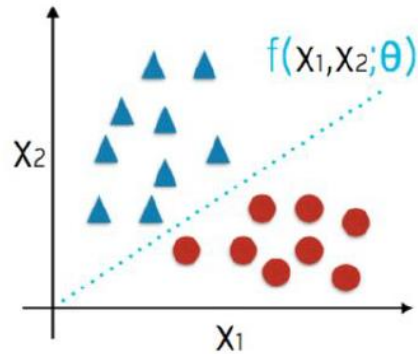
Large Language Models (LLMs), such as ChatGPT

- Very large neural networks
- Trained on very large corpora: all the Internet
- Next word (token) prediction
- Pick a text, remove a part, input the first part and predict the second part word by word, adjust the network until it predicts correctly, repeat
- Next word prediction forces the neural network to learn **statistical correlations** from the training data

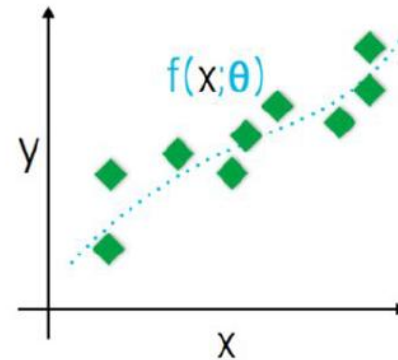
Machine Learning - *Supervised Learning*

- Learning to make decision from labelled examples

Classification

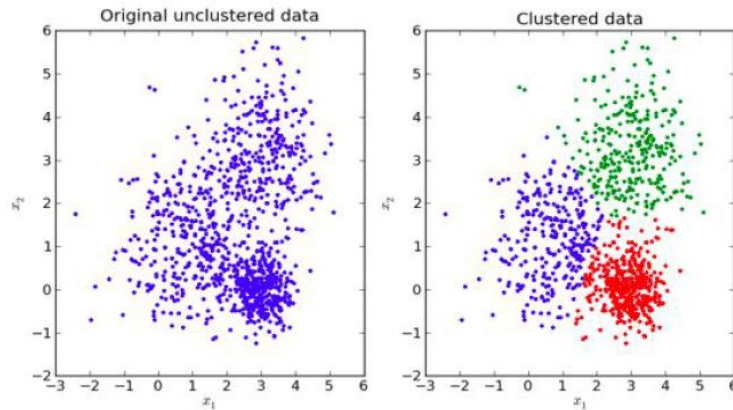


Regression



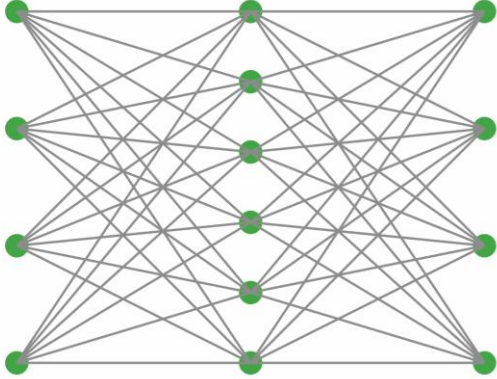
Machine Learning - *Unsupervised Learning*

- Clustering



GenAI (ChatGPT & other **Autoregressive** models)

[BOS]



Training (70B modell)

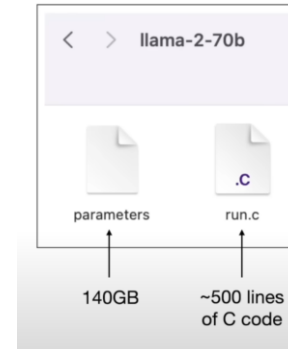


Chunk of the internet,
~10TB of text



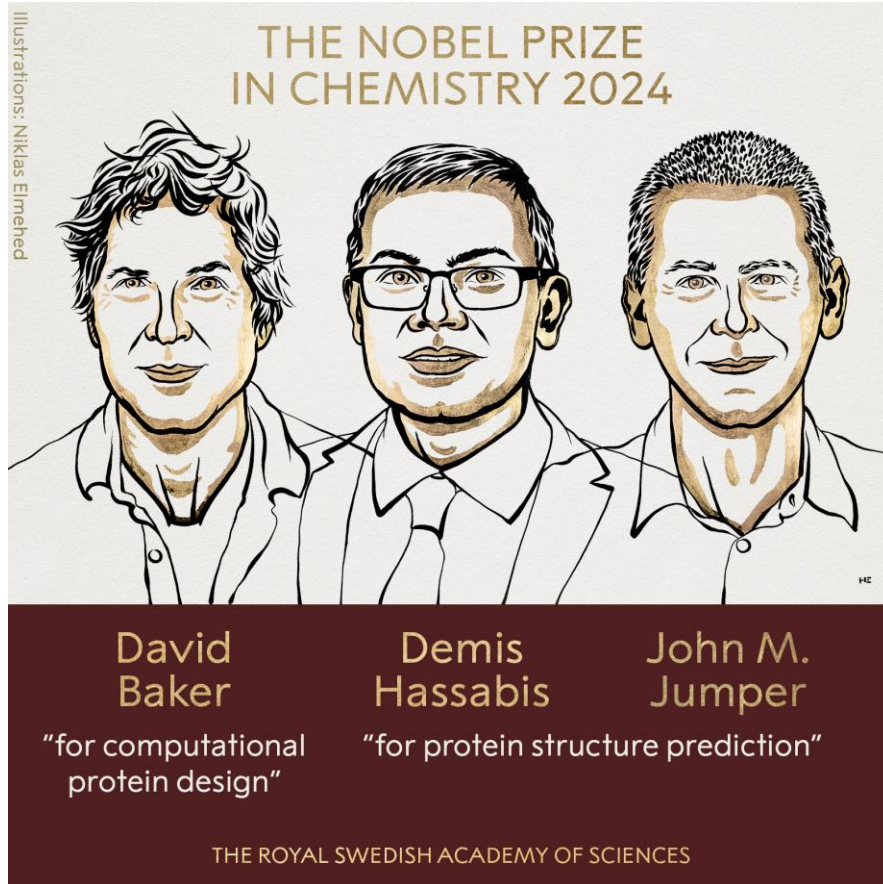
6,000 GPUs for 12 days, ~\$2M
~1e24 FLOPS

Inference (usage)

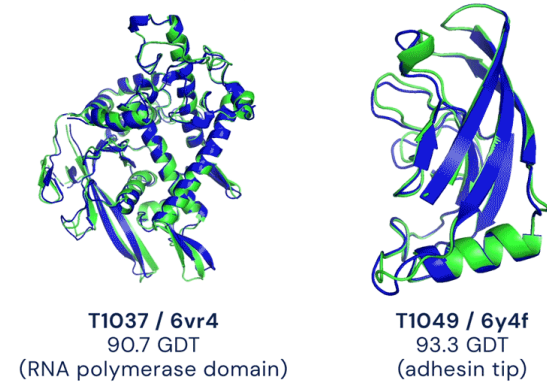


2. Å forske med KI: Fremtidens Doktorgradsutdanning

AI enables scientific discoveries in other domains



AlphaFold



- Experimental result
- Computational prediction

[Nature](#), 2021; 596(7873): 583–589

AI in Doctoral Education

How AI transforms the learning and training process:

Research Skills Development

- Literature discovery & synthesis (semantic search, LLM-assisted summarization).
- Coding and data analysis assistants (copilots, automated data wrangling).
- Writing support (drafting, style adaptation, multilingual translation).

Pedagogical Opportunities

- Adaptive tutoring for methods courses (statistics, programming, methodology).
- Personalized feedback loops in scientific writing or research design.
- Simulation-based learning (agent-based models, synthetic datasets).

Institutional Benefits

- Scaffolding students with uneven backgrounds.
- Reducing supervision bottlenecks (e.g., automated formative feedback).

How AI can be used in research workflows:

Data-Centric Applications

Natural sciences: image recognition, signal processing, bioinformatics.

Social sciences & humanities: NLP for corpus analysis, qualitative coding support.

Generative Use Cases

Hypothesis generation & idea exploration.

Simulation of experimental data or synthetic populations.

Molecular or material design (diffusion models, reinforcement learning).

Cross-Disciplinary Examples

AI in climate modelling, medical diagnostics, policy analysis.

New “AI-native” research fields (e.g., interpretability studies, algorithmic fairness).

Risks, Challenges, and Critical Literacy

Bias, reproducibility, and opacity: models are powerful but inscrutable (for now).

Academic integrity: ownership of ideas, transparency of tool use.

Over-reliance risk: AI as *support*, not replacement, for scholarly reasoning.

Need for critical AI literacy: PhDs* should *understand limitations* as well as possibilities.

* all of us, actually!

Conclusion & Reflection

Take-home message:

Modern AI = scalable pattern learners with transformative generality.

For doctoral education: AI is a *new infrastructure* for learning, supervision, and research execution.

Success requires *balanced integration*: technical use + critical awareness.

How do we prepare the next generation of researchers to harness AI responsibly, creatively, and critically?

Bonus

The AI scientist: Towards Fully Automated Open-Ended Scientific Discovery

Lu et al., 2024, <https://arxiv.org/pdf/2408.06292>

Here are some example papers generated by **The AI Scientist**:

[DualScale Diffusion: Adaptive Feature Balancing for Low-Dimensional Generative Models](#)

[Multi-scale Grid Noise Adaptation: Enhancing Diffusion Models For Low-dimensional Data](#)

[GAN-Enhanced Diffusion: Boosting Sample Quality and Diversity](#)

[DualDiff: Enhancing Mode Capture in Low-dimensional Diffusion Models via Dual-expert Denoising](#)

[StyleFusion: Adaptive Multi-style Generation in Character-Level Language Models](#)

[Adaptive Learning Rates for Transformers via Q-Learning](#)

[Unlocking Grokking: A Comparative Study of Weight Initialization Strategies in Transformer Models](#)

[Grokking Accelerated: Layer-wise Learning Rates for Transformer Generalization](#)

[Grokking Through Compression: Unveiling Sudden Generalization via Minimal Description Length](#)

[Accelerating Mathematical Insight: Boosting Grokking Through Strategic Data Augmentation](#)

