INTEL·LIGÈNCIA ARTIFICIAL I NATURAL: DE LA DIVERSITAT A LA GENERALITAT

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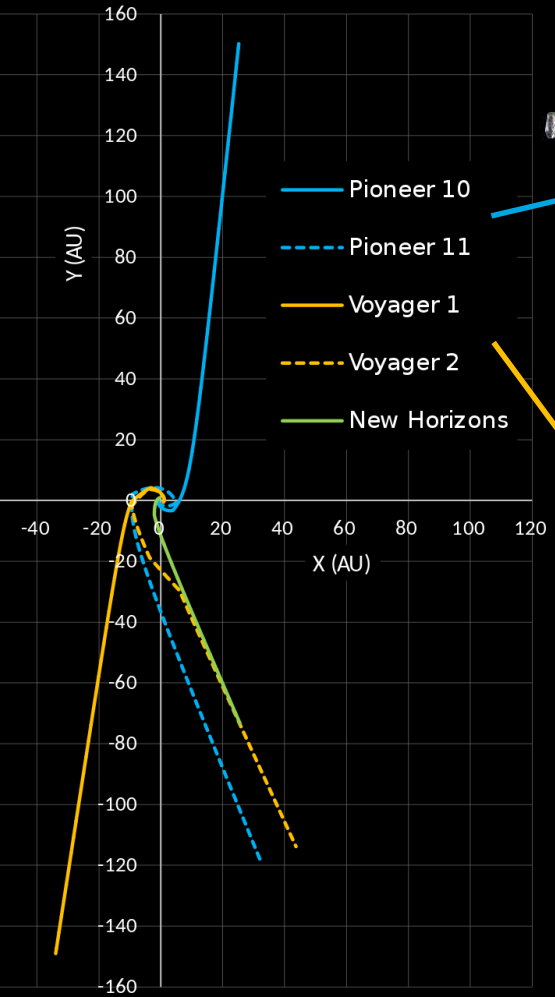
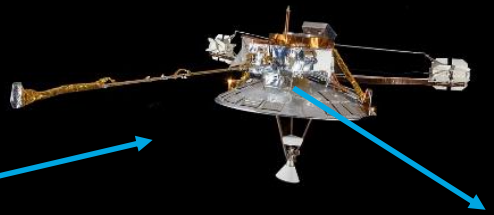
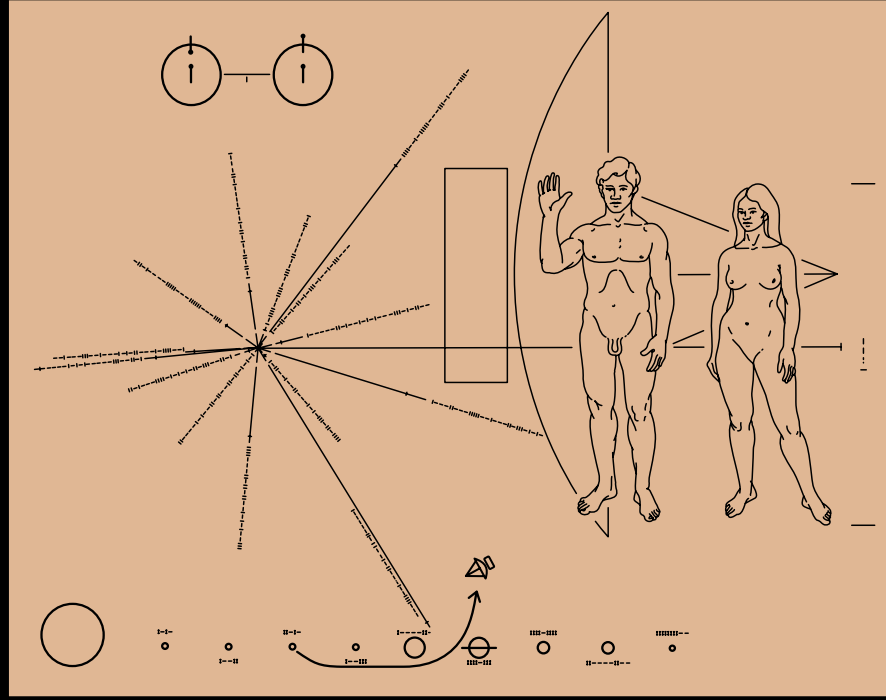
THE ANTHROPOCENE

Trajectories of distant spacecraft from launch to 2030

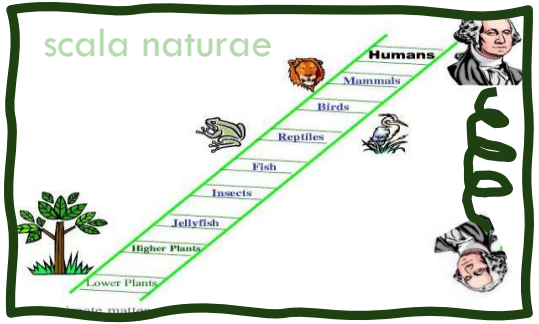






ANTHROPOCENTRISM SHOULD BE OVER

Aristarchus, Copernicus: Earth is not the centre of the universe



Darwin, Wallace: Humans are not at the top of any ladder

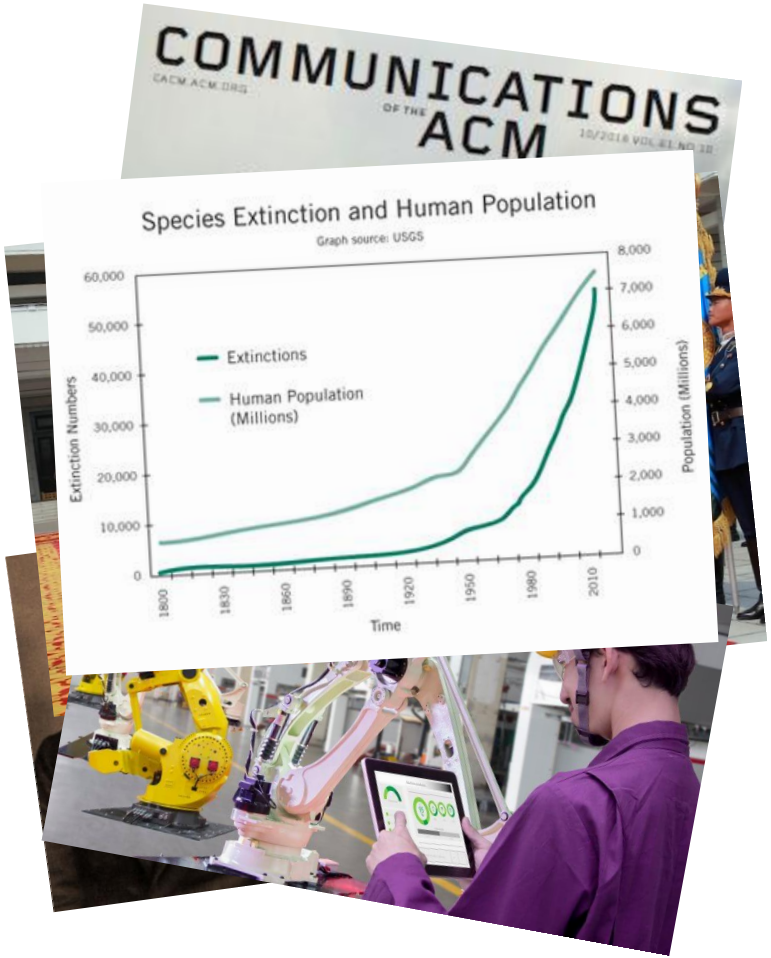
Cajal, Turing, Church: Life and intelligence are just computation (substrate not key)

Shannon, Solomonoff: Compression and learning are just algorithms

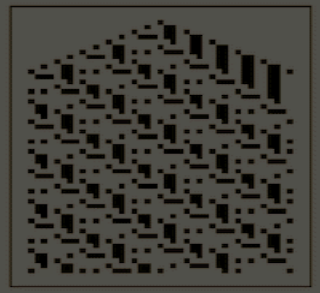
BUT IT'S LINGERING ON

- "Human-level" intelligence as a goal?
- By Turing's (human) imitation game?
- Human alignment. Whose values?
- Human in the loop. Or "human as a cog"?
- Existential risk. Preserve humans forever?

Should we look at AI from an anthropocentric perspective?



DIVERSITY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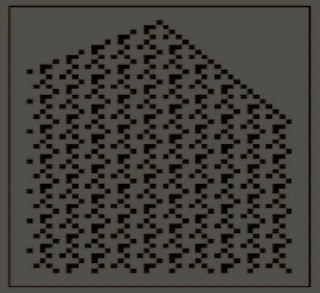
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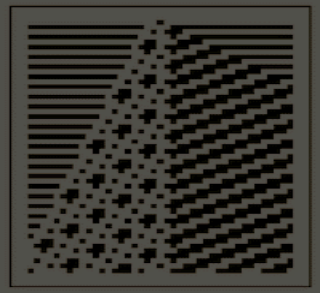
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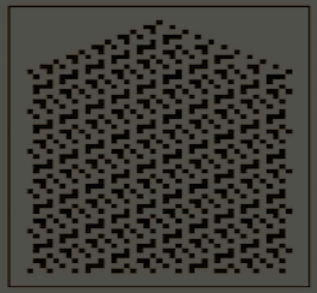
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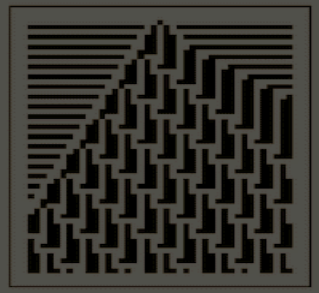
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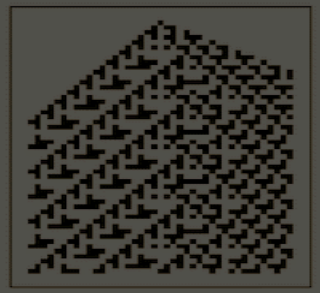
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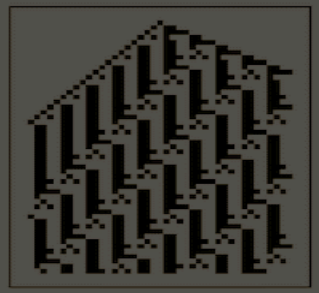
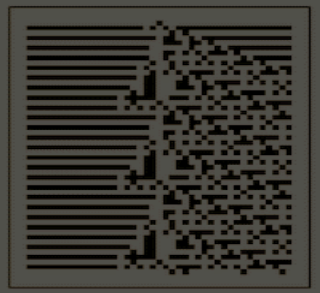
s=10: rule 316715877

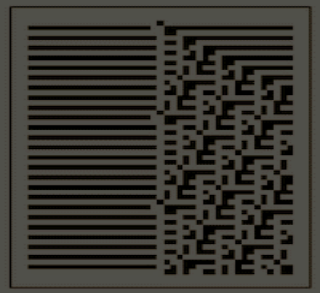

s=11: rule 3215526


s=12: rule 82866221


s=13: rule 22107076


14: rule 1006223533


15: rule 37788005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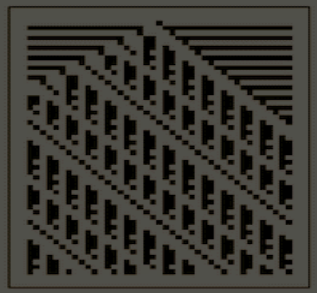
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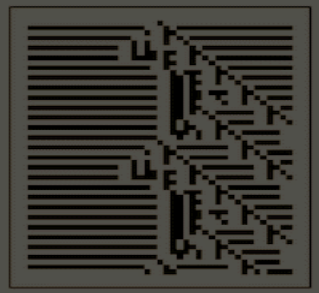

23: rule 22047073

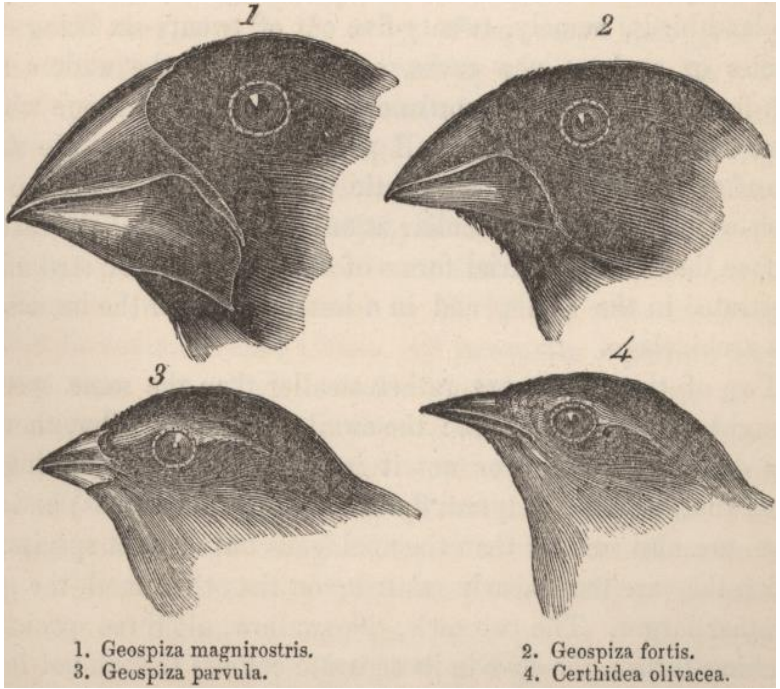
NATURAL DIVERSITY

- Ecosystems lead to niches and **specialisation**.

  "for an immediate, local environment"

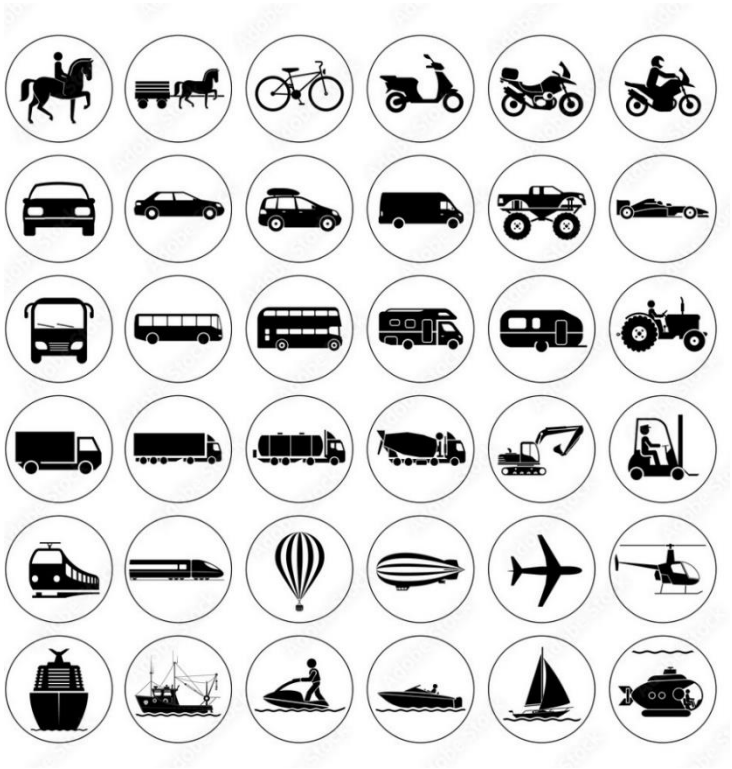
- Darwin's "survival of the fittest"

  (borrowed from economics, Spencer):



SOCIO-TECHNOLOGICAL DIVERSITY

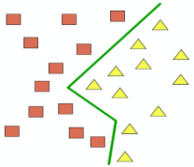
- Specialisation in science, technology and society pays off.
  - Division of labour
  - Specialise academic disciplines
  - Divide and conquer!



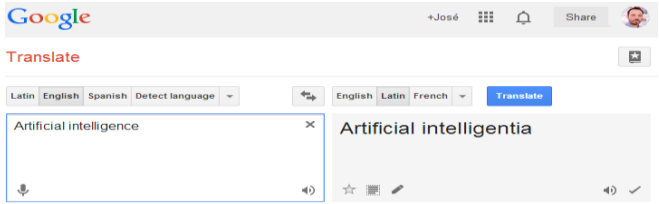
DIVERSITY IN AI

Specific (task-oriented) AI systems

PR: computer vision, speech recognition, etc.



Prediction and estimation

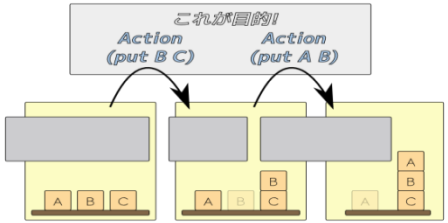


Machine translation

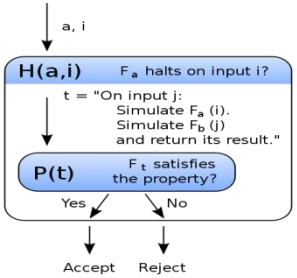
Robotic navigation

Knowledge-based assistants

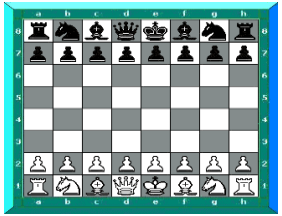
Driverless vehicles



Planning and scheduling



Automated deduction

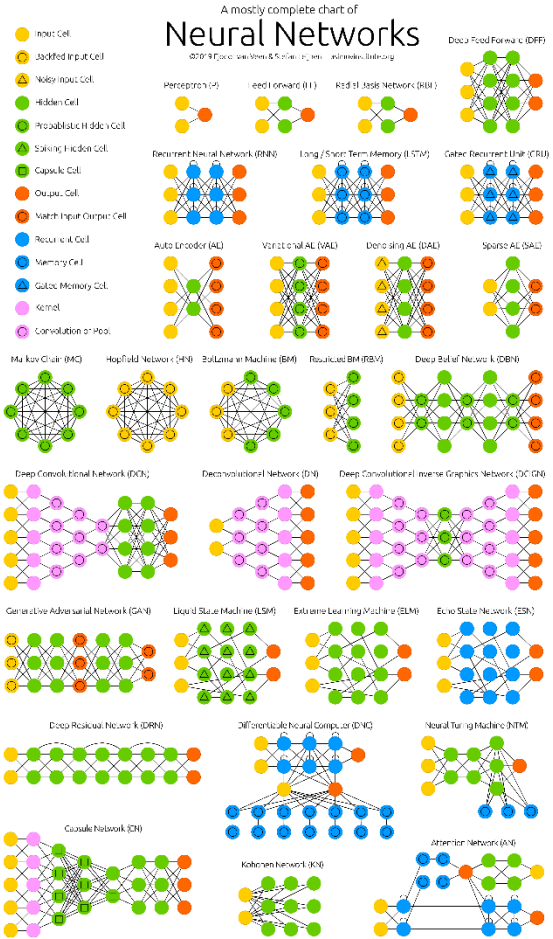


Game playing

All images from wikicommons

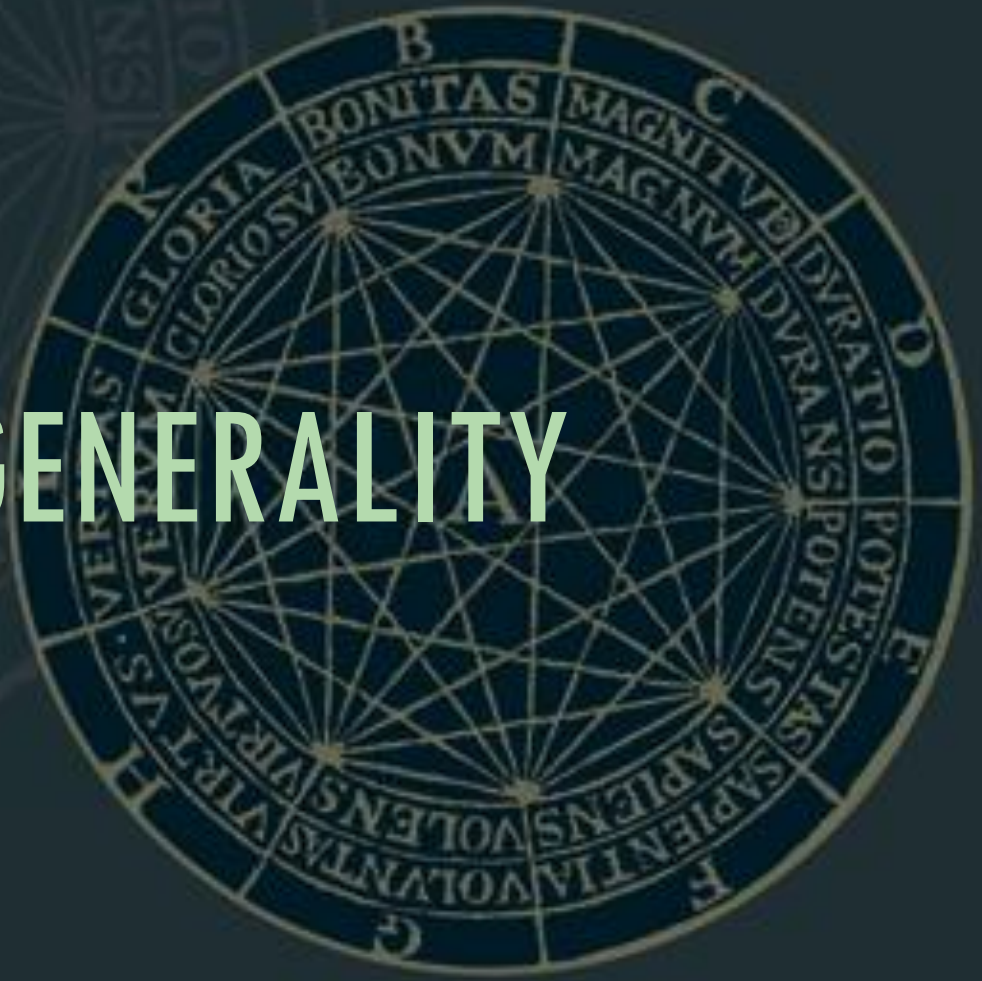
DIVERSITY IN MACHINE LEARNING

- **No-free-lunch theorems** for learning:
  - There are infinitely many niches, no system can be better for all niches, not even on average.
- Specialise ML techniques!
- Embed **learning bias** into the machines!
  - Bayes + specific prior / regulariser



https://www.asimovinstitute.org/neural-network-zoo/ (2019)

GENERALITY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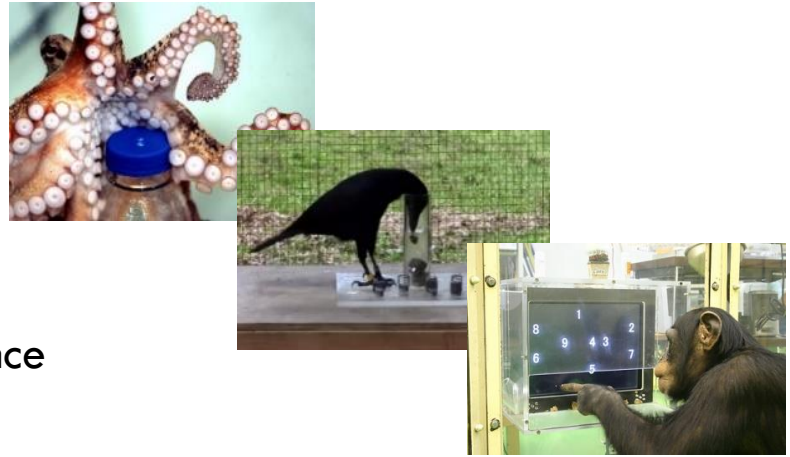
NATURAL GENERALITY

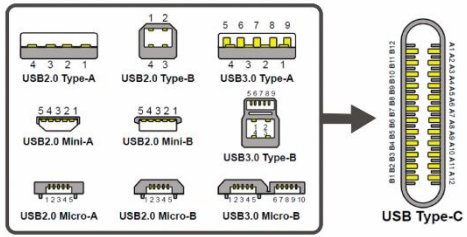
General intelligence is successful behaviour in a wide range of situations (up to a level of difficulty or resources)

- General intelligence and the *g* factor
  - *Spearman*: same latent factor explains performance in a range of cognitive tests.

- Convergent evolution
  - *General intelligence* is one of these traits!
    - Altricial vs precocial / nurture vs nature
    - Social hypothesis for general intelligence
    - Cultural hypothesis for more general intelligence



SOCIOTECHNOLOGICAL GENERALITY



- One-fits-all:
  - Standardisation or winner-takes-all
- General-purpose devices
  - Adaptable to many problems
  - Best example:
    - The **programmable computer**

Ada Byron's "Note D" algorithm

GENERALITY IN AI

- Llull's Ars Generalis
- Turing's "child machine"
- Simon & Newell's "General Problem Solver"
- McCarthy's dream for generality
- Artificial General Intelligence
- Solomonoff's theory of prediction:
  - Bayes + universal prior (Occam's razor)

1971 Turing Award Lecture

Generality in Artificial Intelligence

JOHN McCARTHY
Stanford University

The Turing Award Lecture given in 1971 by John McCarthy was never published. The postscript that follows, written by the author in 1986, endeavors to reflect the flavor of the original, as well as to comment in the light of development over the past 15 years.

Postscript

My 1971 Turing Award Lecture was entitled "Generality in Artificial Intelligence." The topic turned out to have been overambitious in that I discovered that I was unable to put my thoughts on the subject in a satisfactory written form at that time. It would have been better to have reviewed previous work rather than attempt something new, but such wasn't my custom at that time.

I am grateful to the ACM for the opportunity to try again. Unfortunately for our science, although perhaps fortunately for this project, the problem of generality in artificial intelligence (AI) is almost as unsolved as ever, although we now have many ideas not available in

GENERALITY IN MACHINE LEARNING

- Generality is finally here!!!
  - At least since 2020 (GPT-3)
- Made possible by:
  - *the **transformers***:

Attention Is All You Need

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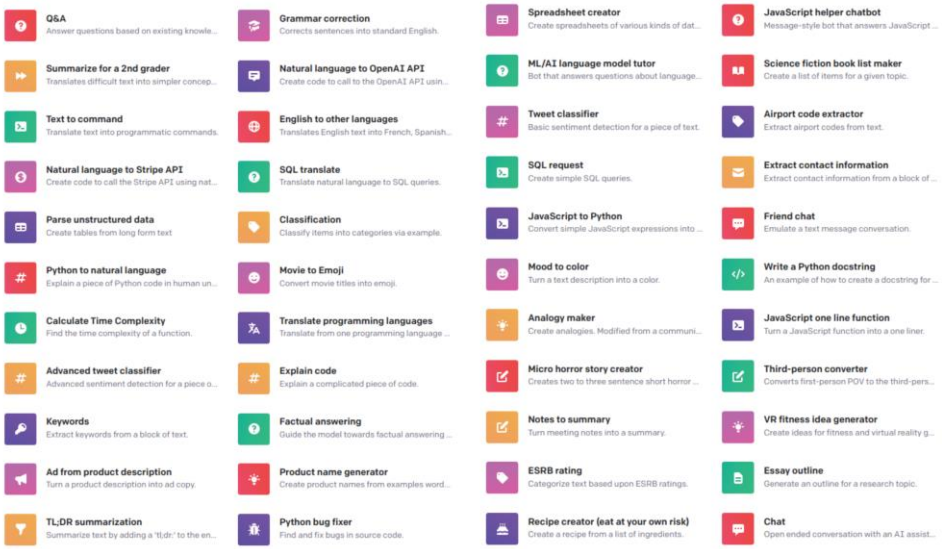


Task examples in OpenAI's playground

THE LESSONS

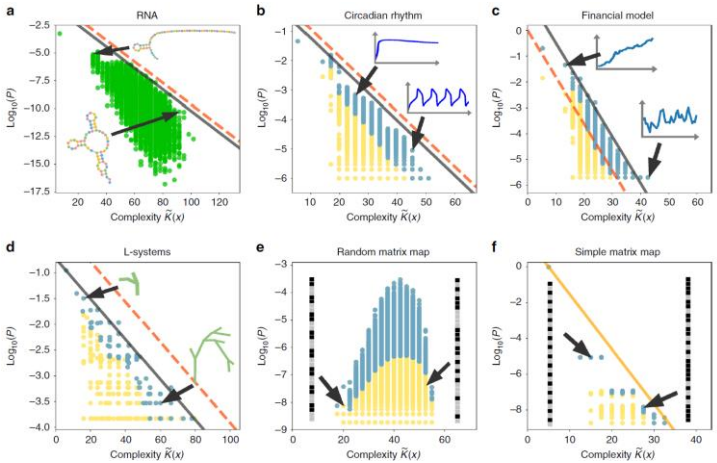
THE SALTY LESSON: “OUR” WORLD IS COMPRESSIBLE

- Physics, life and society as computation.
  - Random inputs lead to low-complexity outputs.
  - No-free-lunch assumptions not true!
    - Lunch is affordable!
- Solomonoff was right.
  - Modern deep learning and transformers have Occam’s razor as a prior!
  - Same prior is all you need!

Input–output maps are strongly biased towards simple outputs

Kamaludin Dingle, Chico Q. Camargo & Ard A. Louis

Nature Communications **9**, Article number: 761 (2018) | Cite this



THE SWEET LESSON: IMITATION IS A GPT

- Shannon (1948): “language model”
- Turing’s imitation game (1950)
- 2020s Surprise!
  - as compression improves, imitation improves, and many tasks become possible.

Human culture

Transformer

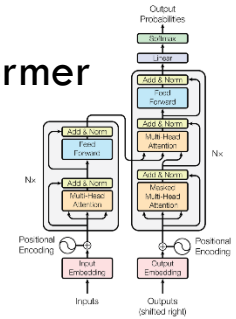
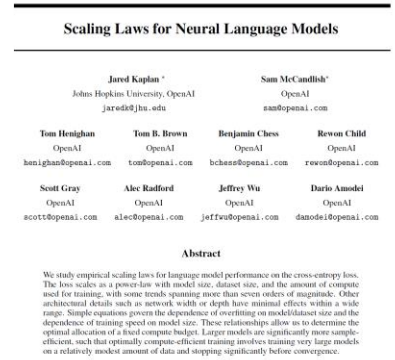


Figure 1: The Transformer - model architecture.

A General-Purpose Tool

THE BITTER LESSON : SCALING IS ALL YOU NEED

- Rich Sutton's "bitter lesson" (2019):
  - AI has traditionally built specialised techniques that leverage "human knowledge of the domain, but the only thing that matters in the long run is the leveraging of computation".
- Scaling laws hold better than Moore's law!



Scaling Laws for Neural Language Models

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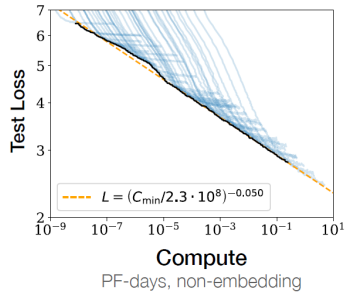
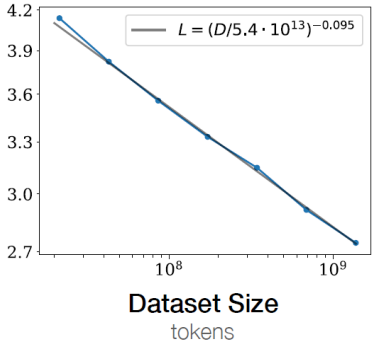
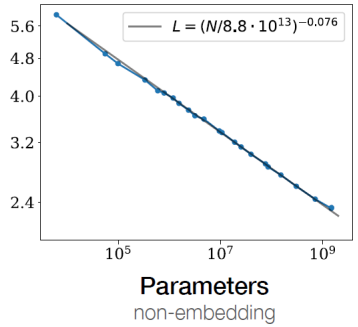
Abstract

We study empirical scaling laws for language model performance on the cross-entropy loss. The loss scales as a power-law with model size, dataset size, and the amount of compute used for training, with some trends spanning more than seven orders of magnitude. Other architectural details such as network width or depth have minimal effects within a wide range. Simple equations govern the dependence of overfitting on model/dataset size and the dependence of training speed on model size. These relationships allow us to determine the optimal allocation of a fixed compute budget. Larger models are significantly more sample-efficient, such that optimally compute-efficient training involves training very large models on a relatively modest amount of data and stopping significantly before convergence.

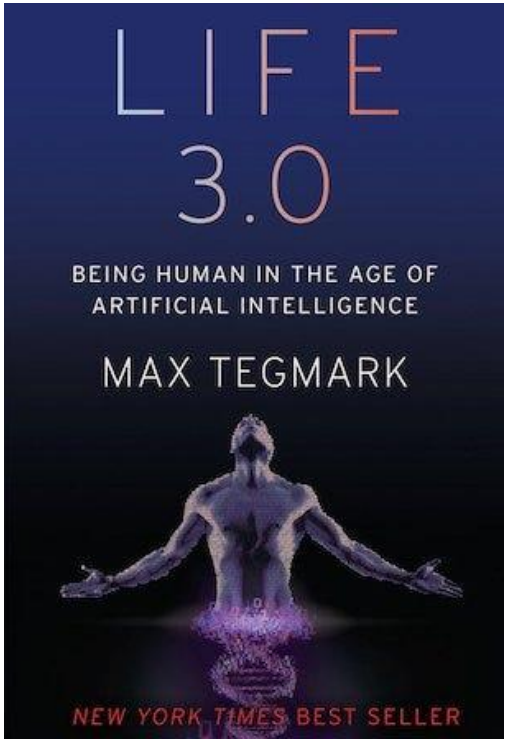






THE SOUR LESSON : CULTURE REPLICATION IS CHEAP

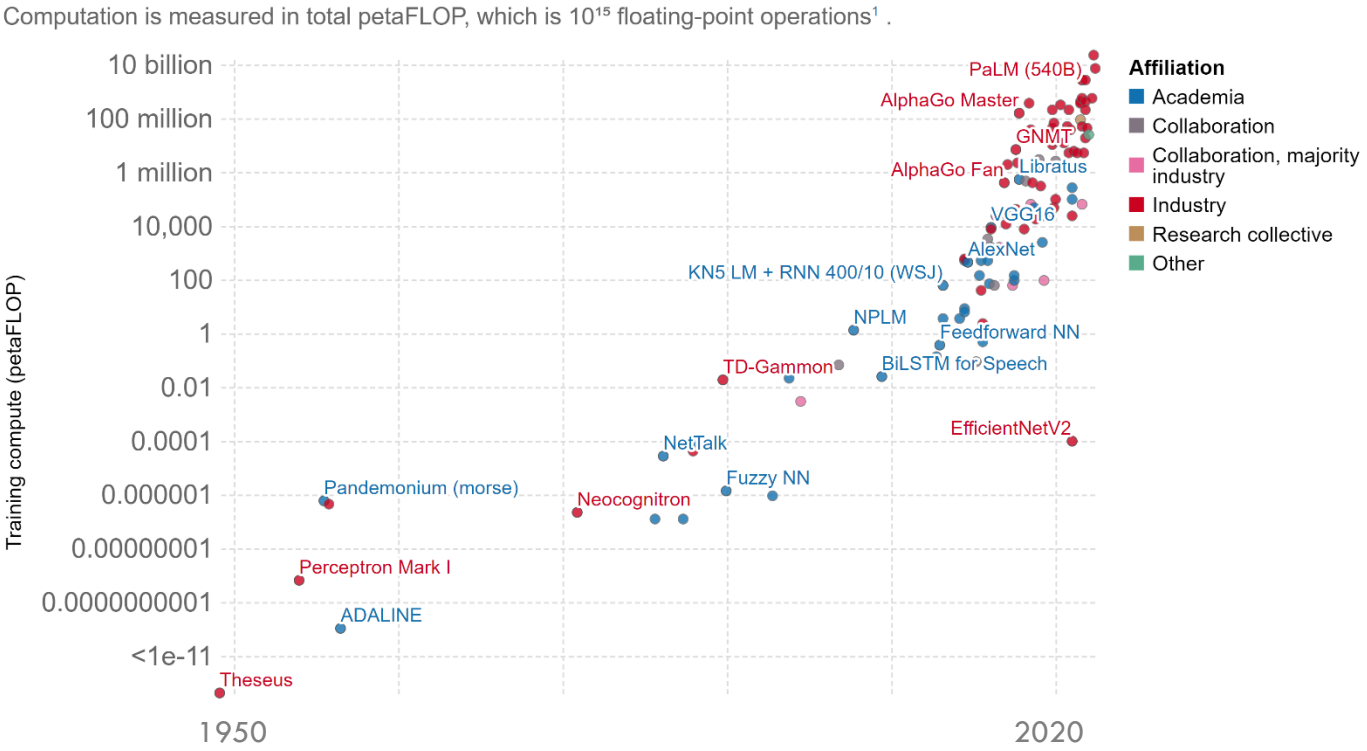
- With humans, cultural transmission is slow
  - Books, schools, universities, …
- With AI it's fast (Hinton just realised)
- "Foundation models"
  - Generalise first, specialise next (finetune, prompt)



THE MECHANOCENE

* Term adapted from Huw Price's "the machinocene"

ENERGY-HUNGRY



ROOTING FOR THE MACHINES

"I can visualize a time in the future when we will be to robots as dogs are to humans. [...] I am rooting for the machines!" – Shannon (1987).

Only by understanding what intelligence is, will we make AI safe, regulate it well and know who we really are and want to be.

Mitigating the risk of extinction from AI should be a global priority alongside other societal-scale risks such as pandemics and nuclear war.

Signatories:

AI Scientists

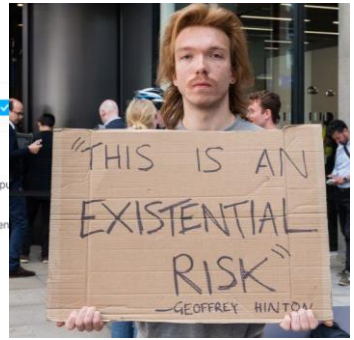
Geoffrey Hinton
Emeritus Professor of Compu

Yoshua Bengio
Professor of Computer Scien

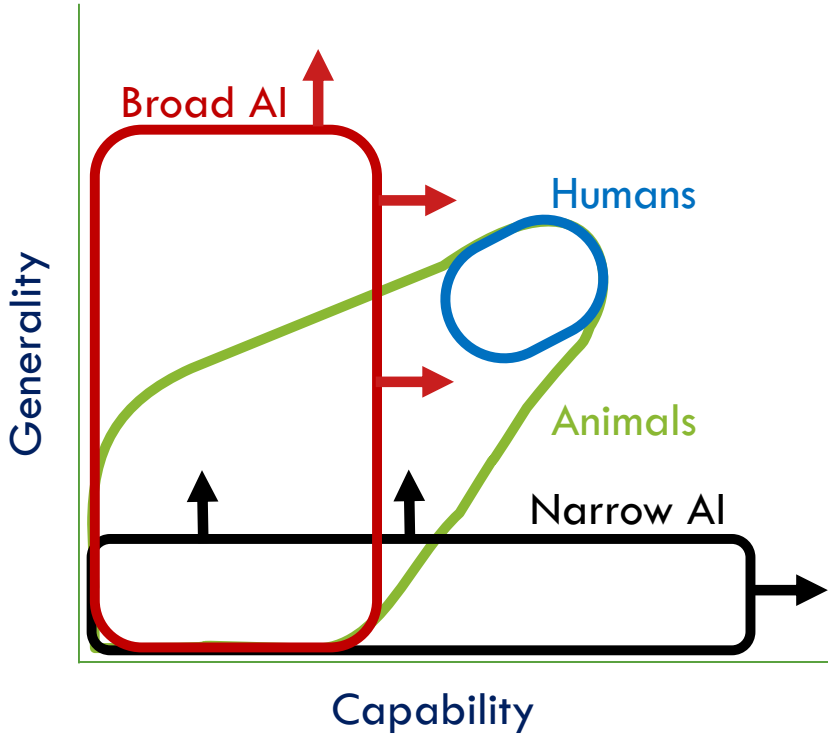
Demis Hassabis
CEO, Google DeepMind

Sam Altman
CEO, OpenAI

Dario Amodei
CEO, Anthropic



A NEW BREED : A NEW INTELLIGENCE LANDSCAPE




THANK
YOU !