SADA
signals and data group

Universität Basel

Pattern Recognition 2023

Lecture 1: What is Pattern Recognition?

Ivan Dokmanić, DMI

Meet the Instructor

Diploma thesis in Zagreb (2007)

PhD in Lausanne @ EPFL (2015)

Postdoc in Paris @ ENS (2015–2016)

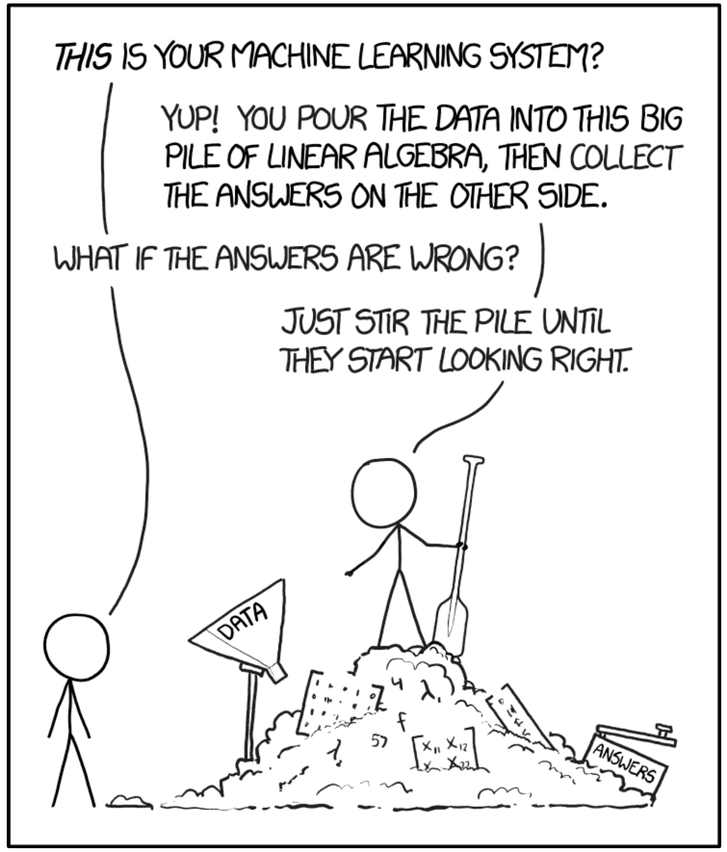
Meet the Instructor

Tenure Track Assistant Professor @ UIUC (2016)

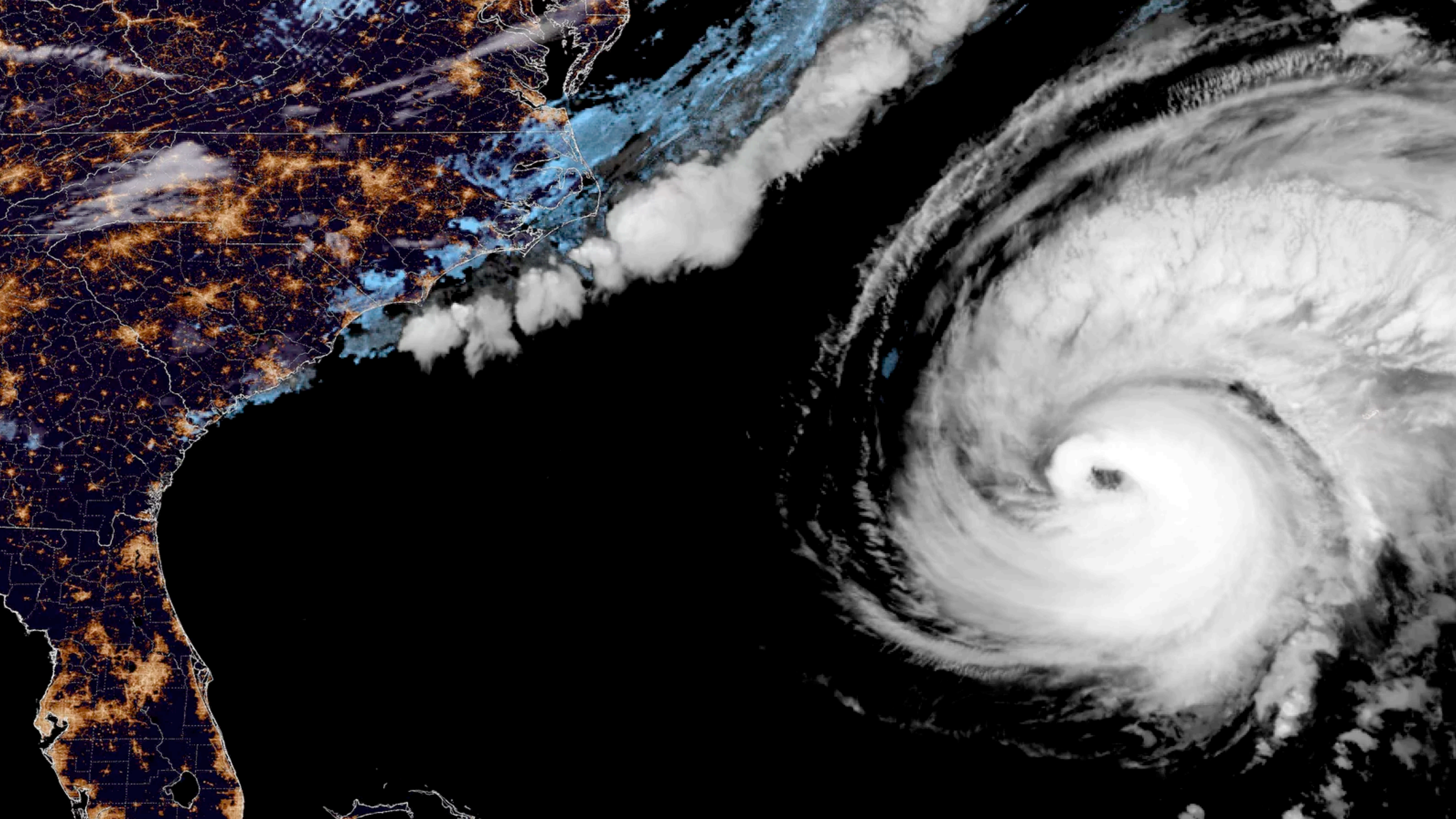
Professor of Data Analytics at UniBas (2019)

What is Machine Learning?

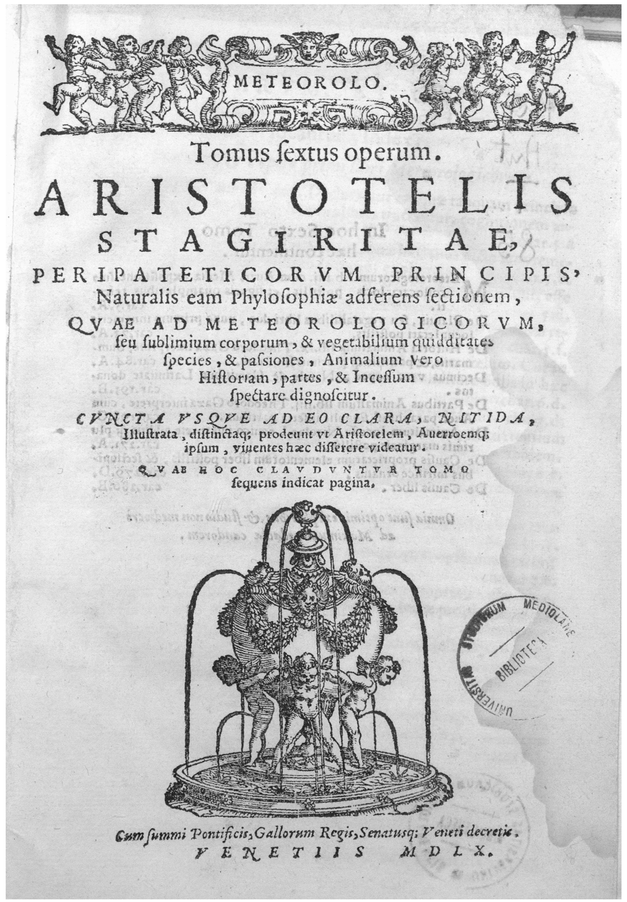
Pattern Recognition ≈ Supervised ML (+ theory of patterns)



xkcd, a couple of years ago



Weather Forecasting


METEOROLO.

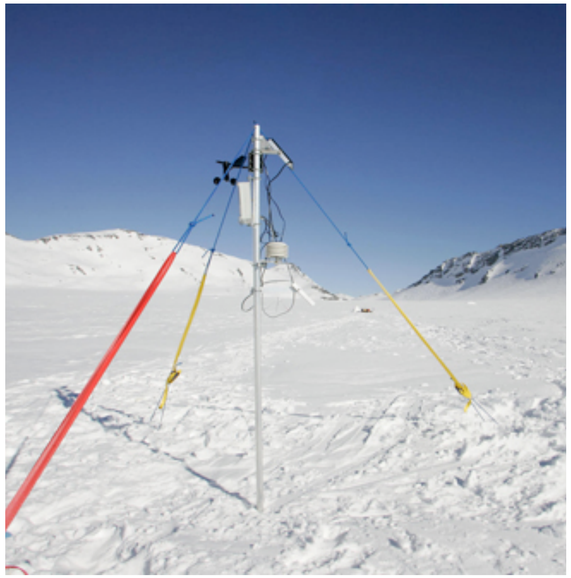
Tomus ſextus operum.

ARISTOTELIS
STAGIRITAE,
PERIPATETICORVM PRINCIPIS,
Naturalis eam Philoſophiæ adferens ſectionem,
QVAE AD METEOROLOGICORVM,
ſeu ſublimium corporum, & vegetabilium quidditates
ſpecies, & paſsiones, Animalium vero
Hiſtoriam, partes, & Inceſſum
ſpectare dignoſcitur.
CVNCTA VSQVE AD EO CLARA, NITIDA,
Illuſtrata, diſtincta; prodeunt vt Ariſtotelem, Auerroemq;
ipſum, viuentes hæc differre videatur.
QVAE HOC CLAVDVNTVR TOMO
ſequens indicat pagina.

Cum ſummi Pontificis, Gallorum Regis, Senatusq; Veneti decretis.
VENETIIS MDLX.

Aristotle's "Meteorologica"

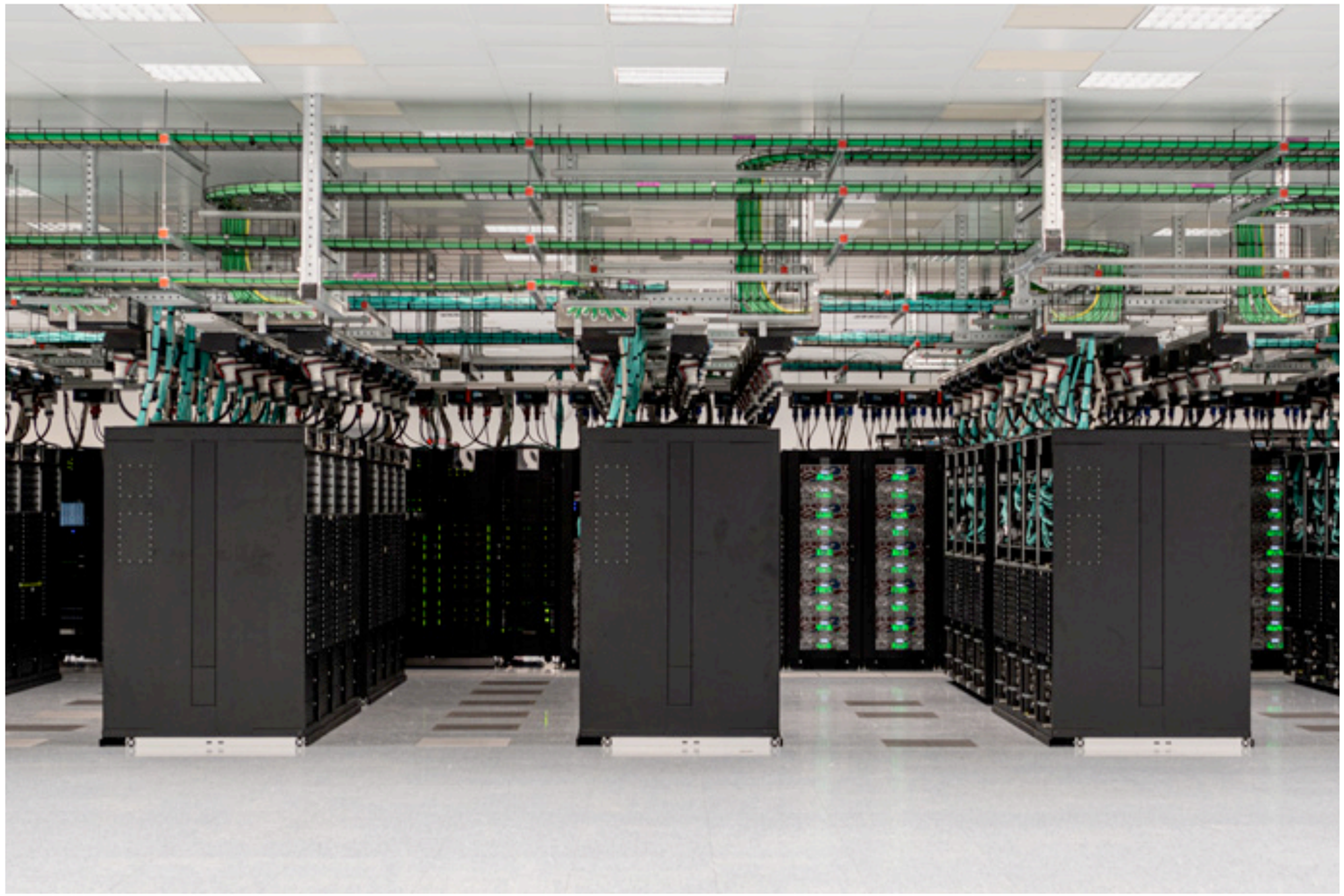
weather stations, buoys, radiosondes, weather balloons, weather satellites, meteorological radar, pulse Doppler radar, weather drones, pilot reports, reconnaissance aircraft, ...



EPFL–ENAC

ECMWF

European Centre for Medium-Range Weather Forecasts



- 11664 core cluster
- 0.1 resolution 10 day forecast
- ≈ 1 hour

The Times are Changing

From the Creators of AlphaGo, AlphaFold, and Alfalfa

GraphCast: Learning skillful medium-range global weather forecasting

Remi Lam[*,1], **Alvaro Sanchez-Gonzalez**[*,1], **Matthew Willson**[*,1], **Peter Wirnsberger**[*,1], **Meire Fortunato**[*,1], **Alexander Pritzel**[*,1], **Suman Ravuri**[1], **Timo Ewalds**[1], **Ferran Alet**[1], **Zach Eaton-Rosen**[1], **Weihua Hu**[1], **Alexander Merose**[2], **Stephan Hoyer**[2], **George Holland**[1], **Jacklynn Stott**[1], **Oriol Vinyals**[1], **Shakir Mohamed**[1] **and Peter Batta**

[*]equal contribut[ion], [1]DeepMind, [2]Google

- Cloud TPU v4 (a “fancy GPU”), 0.25 deg resolution, < 60 seconds

What is Machine Learning?

Task → Programmer → Program →  → Output

Input data →

Task → Data →

Machine learner →

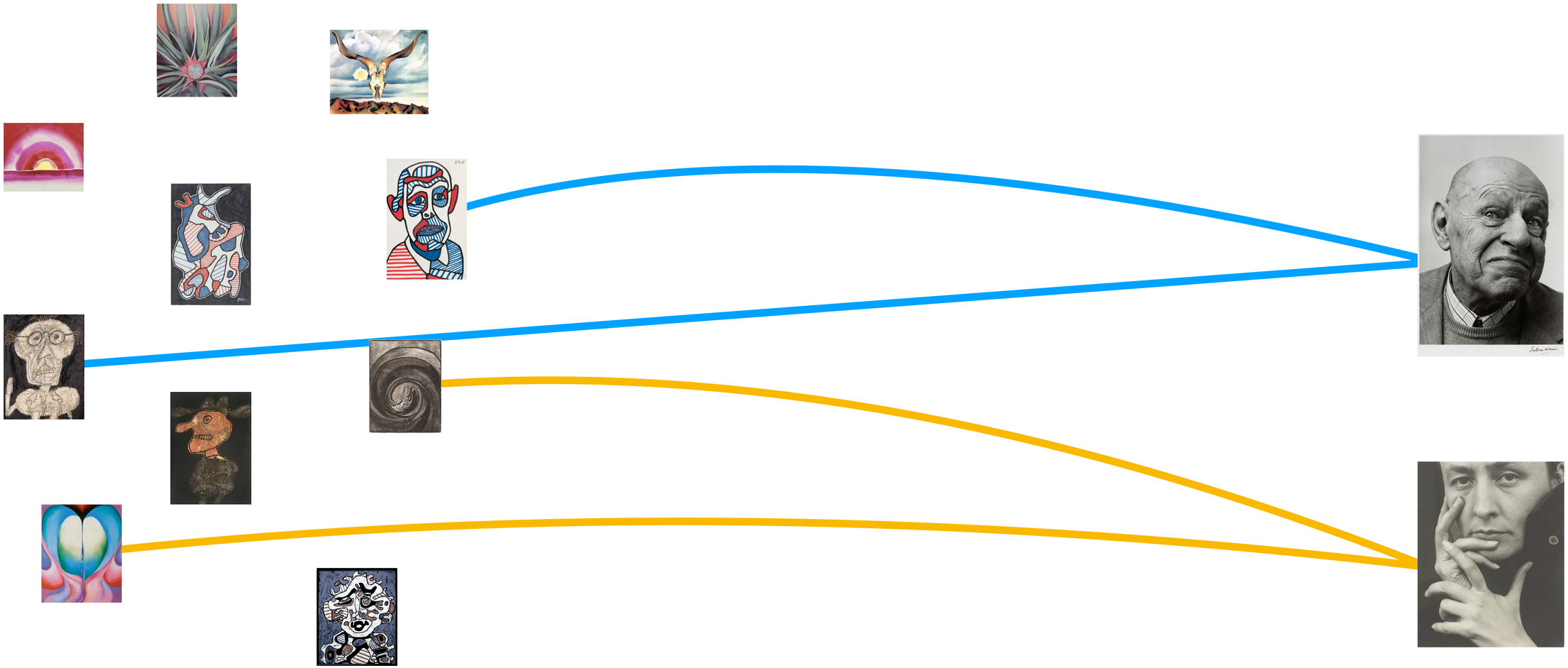
→ Program →  → Output

$\mathcal{X}$

$$f : \mathcal{X} \to \mathcal{Y}$$

$$p(y \mid x)$$

$\mathcal{Y}$



So Much AI and DL Talk

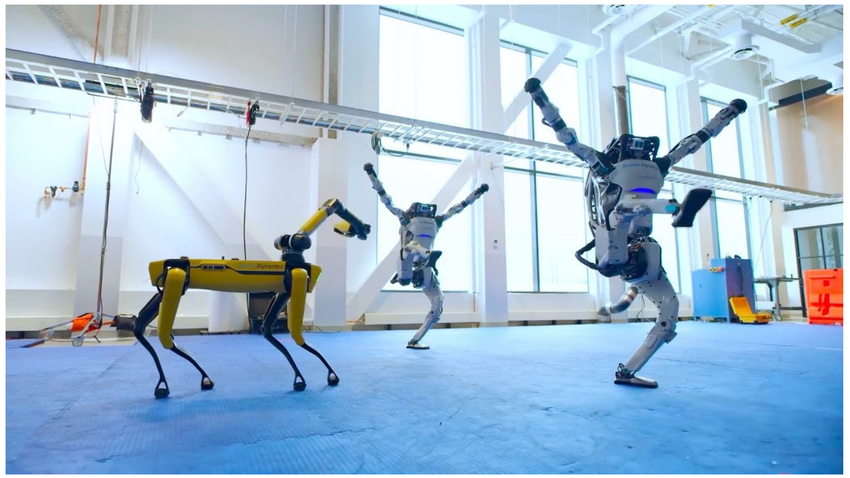
cancer screening from low-does CT

Ardila et al., 2019

chatGPT

openAI

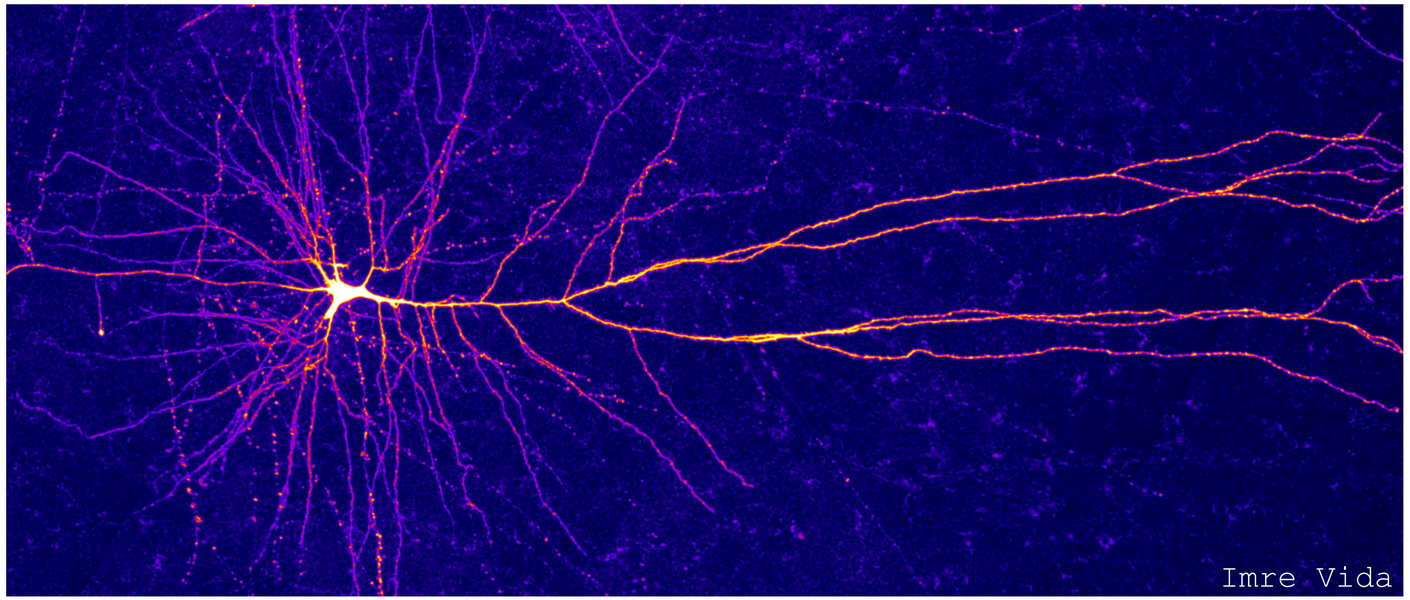
creepy dancing robots



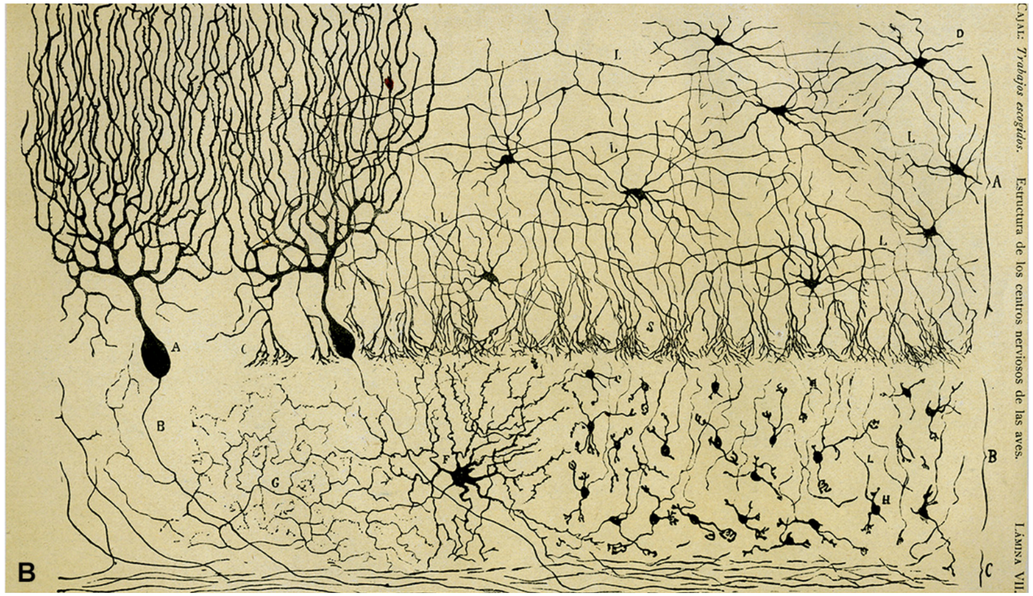
boston dynamics

Neural Networks

The Non-Artificial Kind



Santiago Ramón y Cajal, 1888



Vertical section of a cerebellar convolution of a hen. Impregnation by the Golgi method. A represents the molecular zone, B designates the granular layer and C the white matter. (From DeFelipe, 2015)

1906 Nobel Prize in Physiology or Medicine, with Camillo Golgi

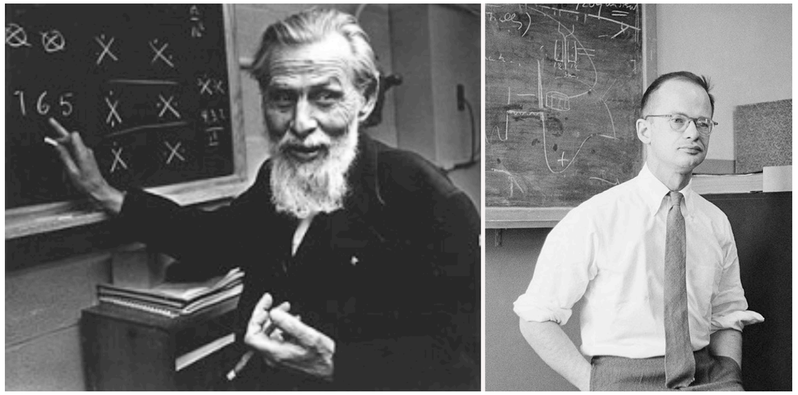
1940s

The Decade of Connectionism

1943

Warren McCulloch

Walter Pitts



Bulletin of Mathematical Biology Vol. 52, No. 1/2, pp. 99–115, 1990.
Printed in Great Britain.

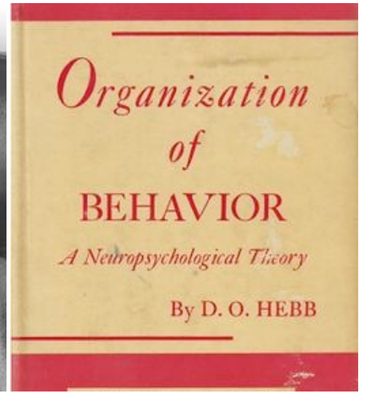
0092–8240/90$3.00 + 0.00
Pergamon Press plc
Society for Mathematical Biology

A LOGICAL CALCULUS OF THE IDEAS IMMANENT IN NERVOUS ACTIVITY*

■ WARREN S. MCCULLOCH AND WALTER PITTS
University of Illinois, College of Medicine,
Department of Psychiatry at the Illinois Neuropsychiatric Institute,
University of Chicago, Chicago, U.S.A.

Donald Hebb

1949



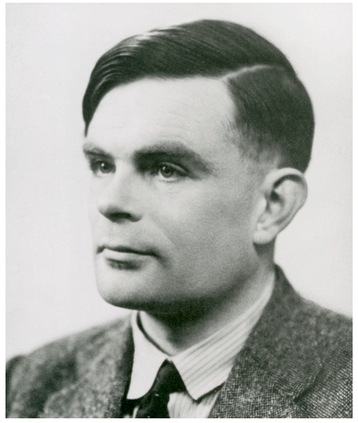
neurons that fire
together wire together

1940s

The Decade of Everything

Kurt Gödel

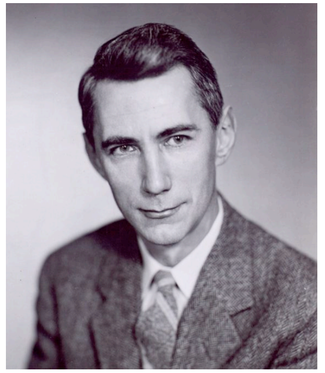
John von Neumann



Alan Turing

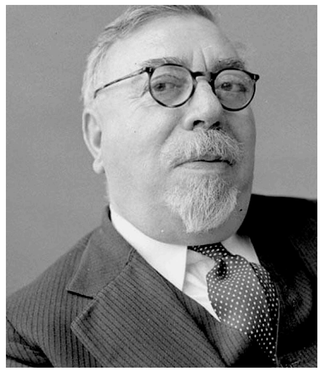
1936—computable numbers

1950—computing machinery and intelligence



Claude Shannon

"A Mathematical Theory of Communication"
1948



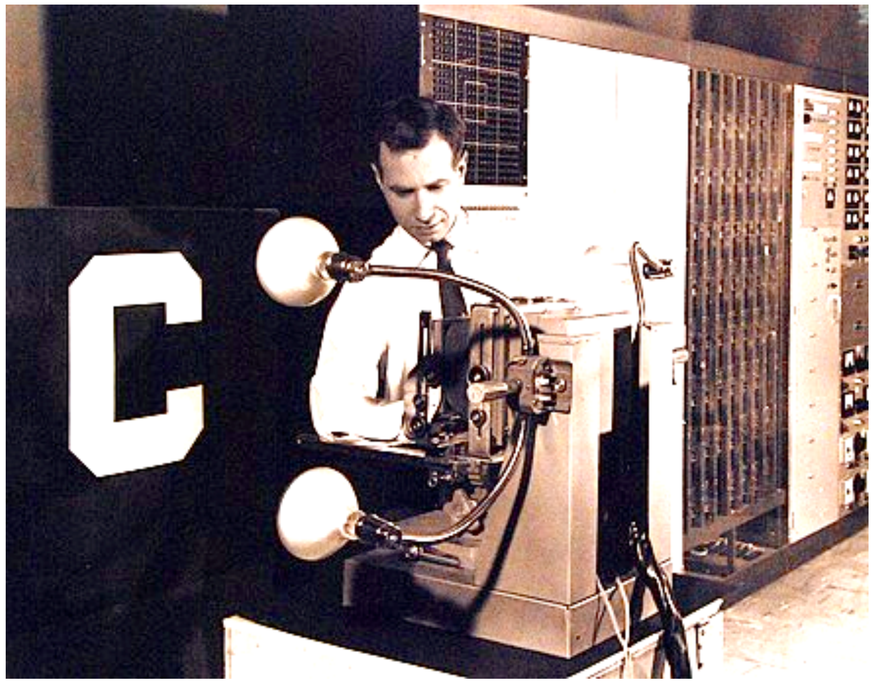
Norbert Wiener

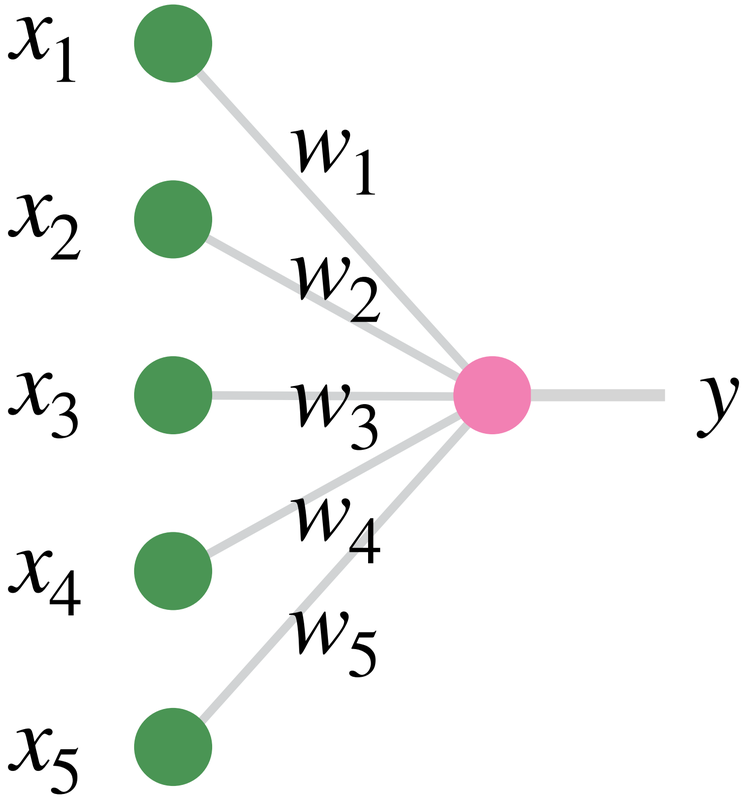
"Cybernetics"
1948

Frank Roseblatt's Perceptron

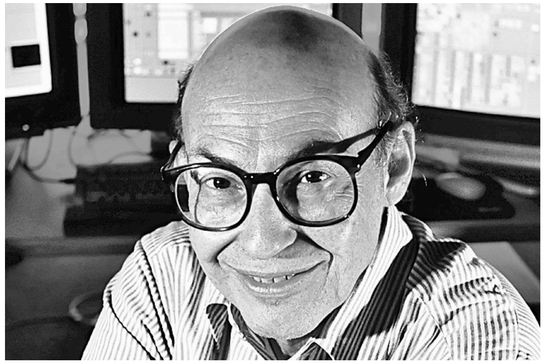
The Era of Connectionism

1958

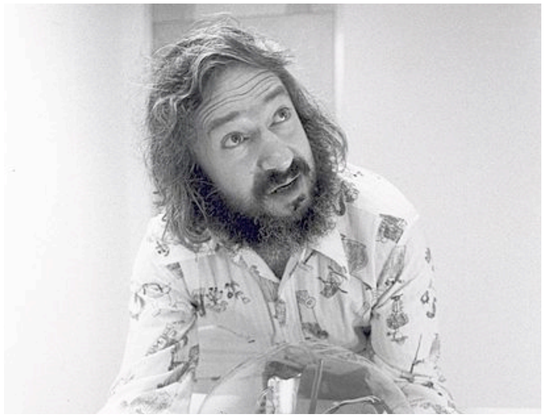




Cooling it Down

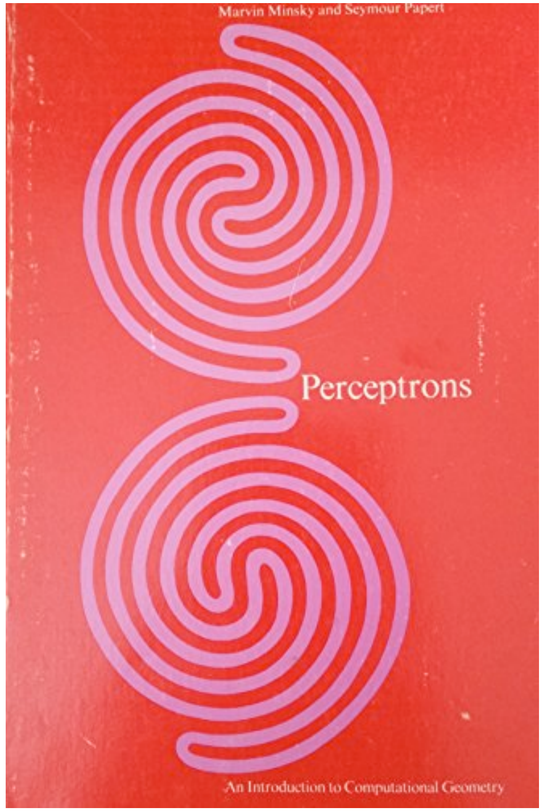


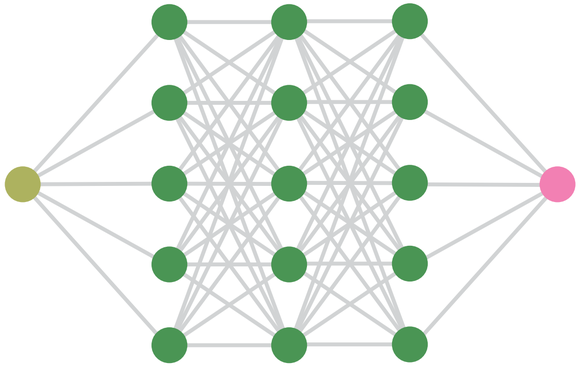
Marvin Minksy



Seymour Papert

1968/1969/…





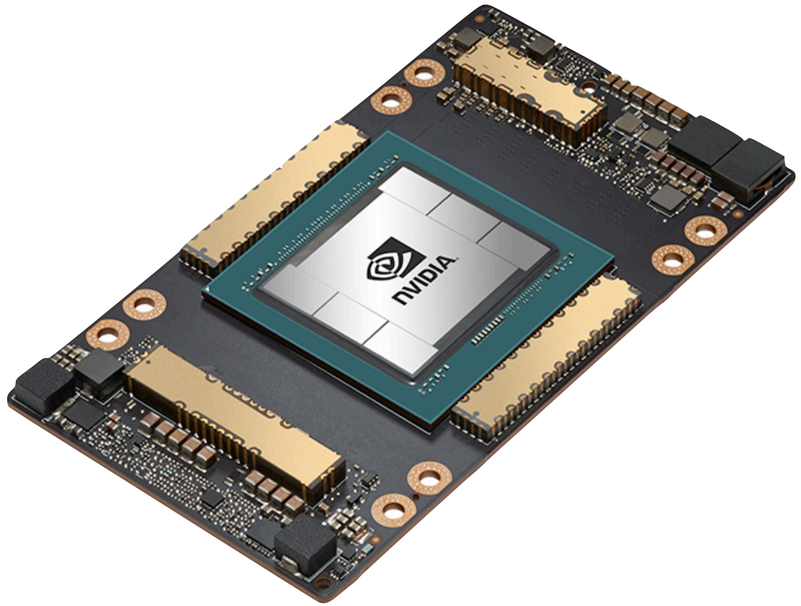
Fast Forward to 2012

- Ciresan, Meier, Schmidhuber (CVPR)

IDSIA
https://people.idsia.ch › ~juergen › cvpr2012 PDF

Multi-column Deep Neural Networks for Image

by D Ciresan · Cited by 5595 — Dan **Ciresan**, Ueli **Meier** and Jürg
SUPSI ... sion and Pattern Recognition Conference (**CVPR**'07). IEE



- Krizhevsky, Sutskever, Hinton (NIPS)

Neural Information Processing Systems
https://papers.nips.cc › paper › 4824-imagenet-classifi...

ImageNet Classification with Deep Convo

by A Krizhevsky · 2012 · Cited by 129476 — Authors. Alex
E. **Hinton**. Abstract. We trained a large, deep convolutiona

Machine Learning

What Happened in the Meanwhile (via Kilian Weinberger)

- Logic vs statistics and optimization
- (but see Wiener for causality)

- Gerry Tesauro (IBM) — a neural network to play backgammon; learns to play by playing against itself
- TD-Gammon beats the world champion after 100k games against itself
- 1994!

The Pace of Things

- A year ago when I taught this course almost no one talked about GPT… let’s try a show of hands

The Different Flavors of Machine Learning

- Supervised learning, historically aka **pattern recognition**
- Unsupervised learning
- Self-supervised learning
- Reinforcement learning
- ...

Course Structure

- Lectures on Tuesdays and Fridays
- Recitations on Mondays and Wednesdays
- ~biweekly assignments; the first one is not graded but you have to hand it in and do reasonably well

Grade Structure

- Homework assignments: 60%
- Final exam: 40%

- Corollary: we will be brutal in hunting down cheating; more information to come

Pattern Recognition Needs Math

The Bad News and the Good News

Bad News

Needs a lot of math!

Good News

It will be rewarding

All systems go

- **Gradescope:** Assignment submission
- **Piazza:** Forum for all not-very-personal questions
- We have internal **interactive computing** resources (information to come)
- **Website: sada.dmi.unibas.ch/teaching** (wait for another day or two for everything to be there)
- Textbooks: all available online (list on the website), but we will give notes for everything!