Machine Learning

From Turing to Deep Learning

Two approaches in AI

Good Old-fashion AI

- **Algorithms !**
- Design from human knowledge.
- Fast, thoughtful and less dependant on data.
- Centralized processes (analyse, maths, blueprints)
- Examples : GOFAI
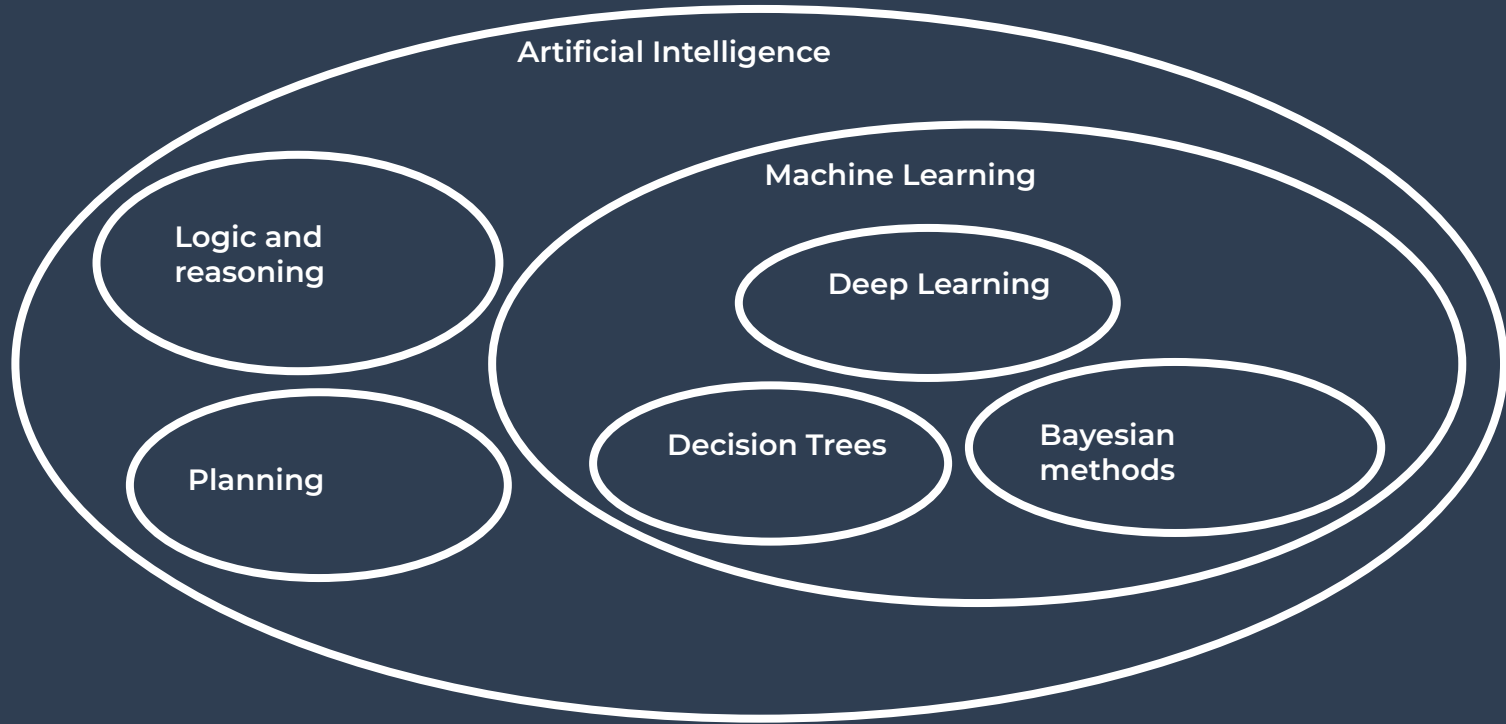- Less efficient

Data-driven AI

- **Learning from data !**
- Design extracted from data.
- Need time and data to exploit.
- Can be based on decentralized processes (neural network)
- Examples : machine learning, genetic algorithm, optimisation.
- Very efficient if enough data available.

Machine Learning and AI

- **Machine Learning** is a subfield of Artificial Intelligence.

- ML is based on mathematics and statistics.

- **Goal**: machines that can learn from examples.

" Improving the performance of a program in solving tasks without being explicitly programmed to solve these tasks "

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Machine Learning and AI

Artificial Intelligence

Machine Learning

Logic and reasoning

Planning

Deep Learning

Decision Trees

Bayesian methods

" Change behavior in order to become more efficient in the future at a task "

What is learning ?

- Change behavior in order to become more efficient in the future at a task.

- A group of methods for finding and describing structural patterns in data.

- Take observations and model them, describe them, and make predictions.

- Opposed to the algorithmic approach (logic, expert systems) which does not start from data.
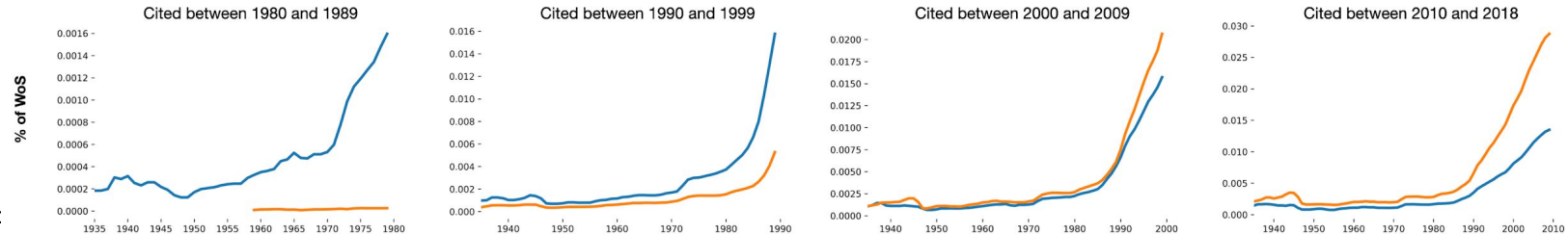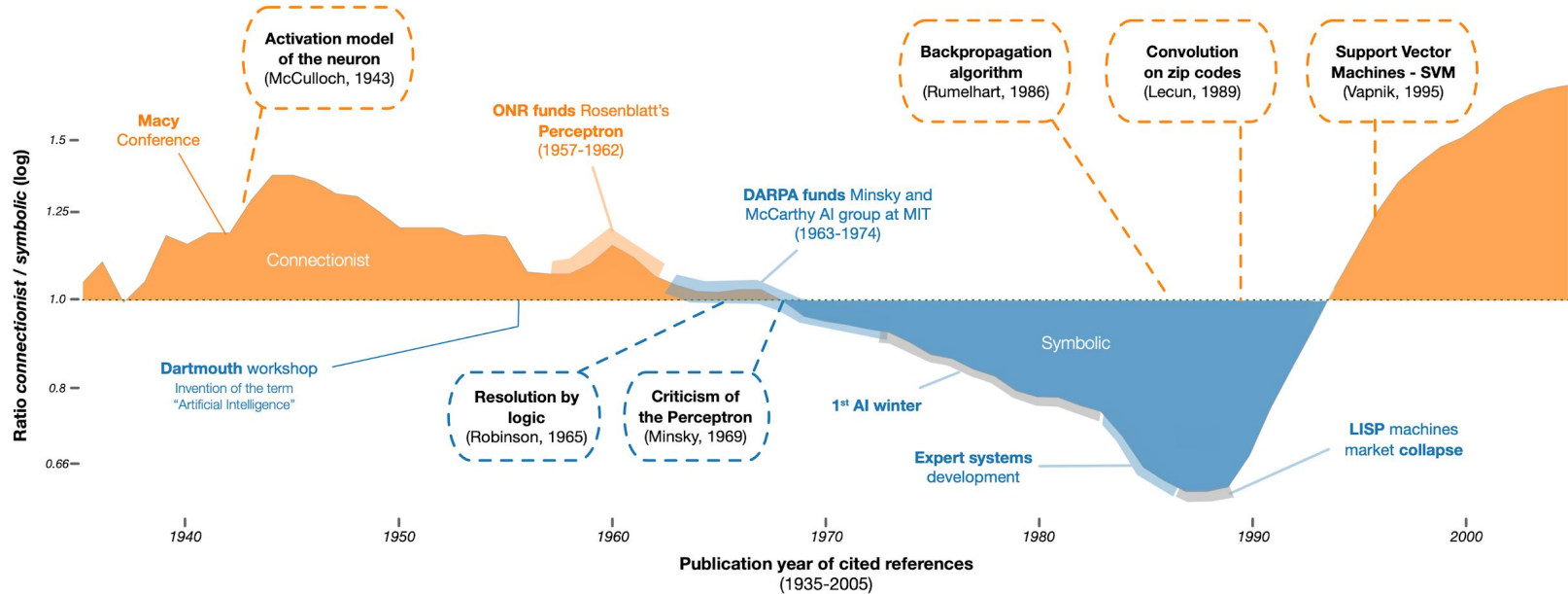
What is learning ?

- Find a function **X → Y**

- We only have some observations:
  - **(x_1, y_1), (x_2, y_2), (x_3, y_3)**
  - Or learning examples

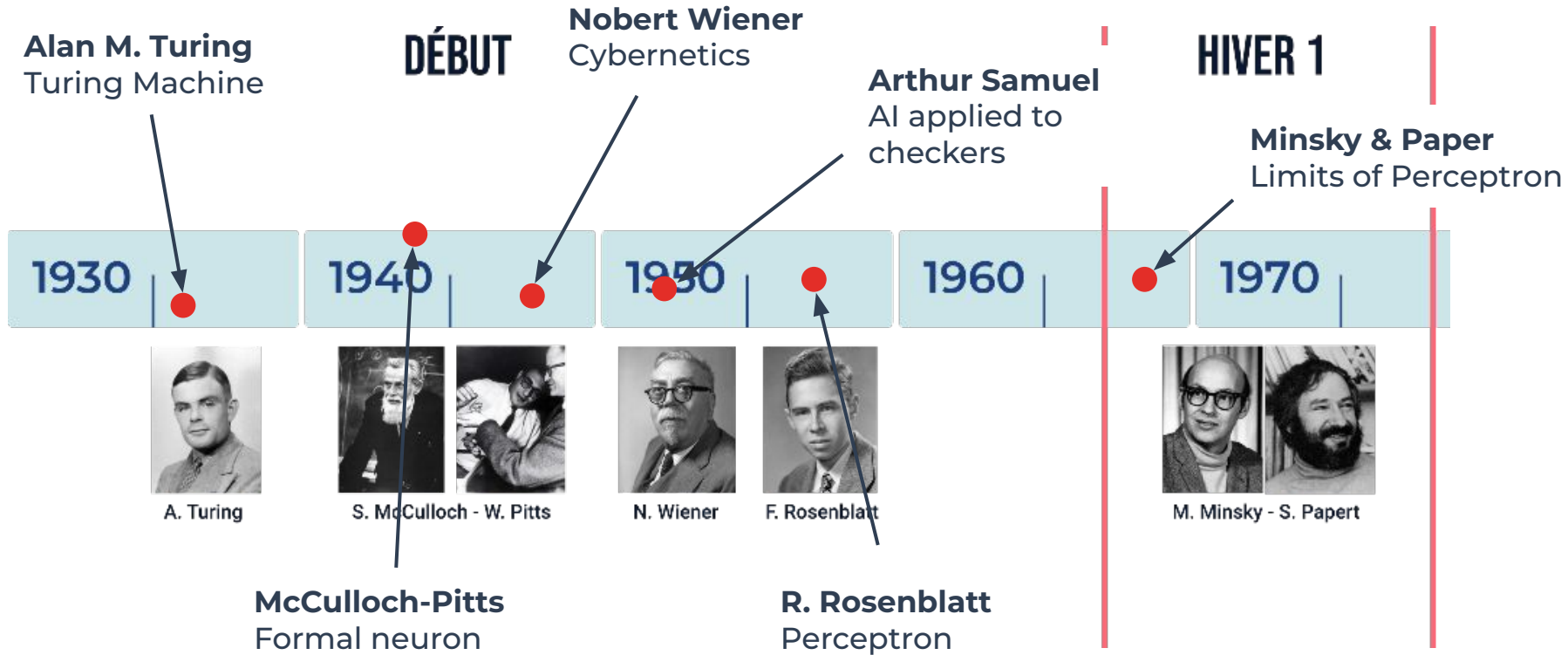- We want to predict y for a given x (**y = f(x)**)

What is learning ?

Recall : garbage in, garbage out
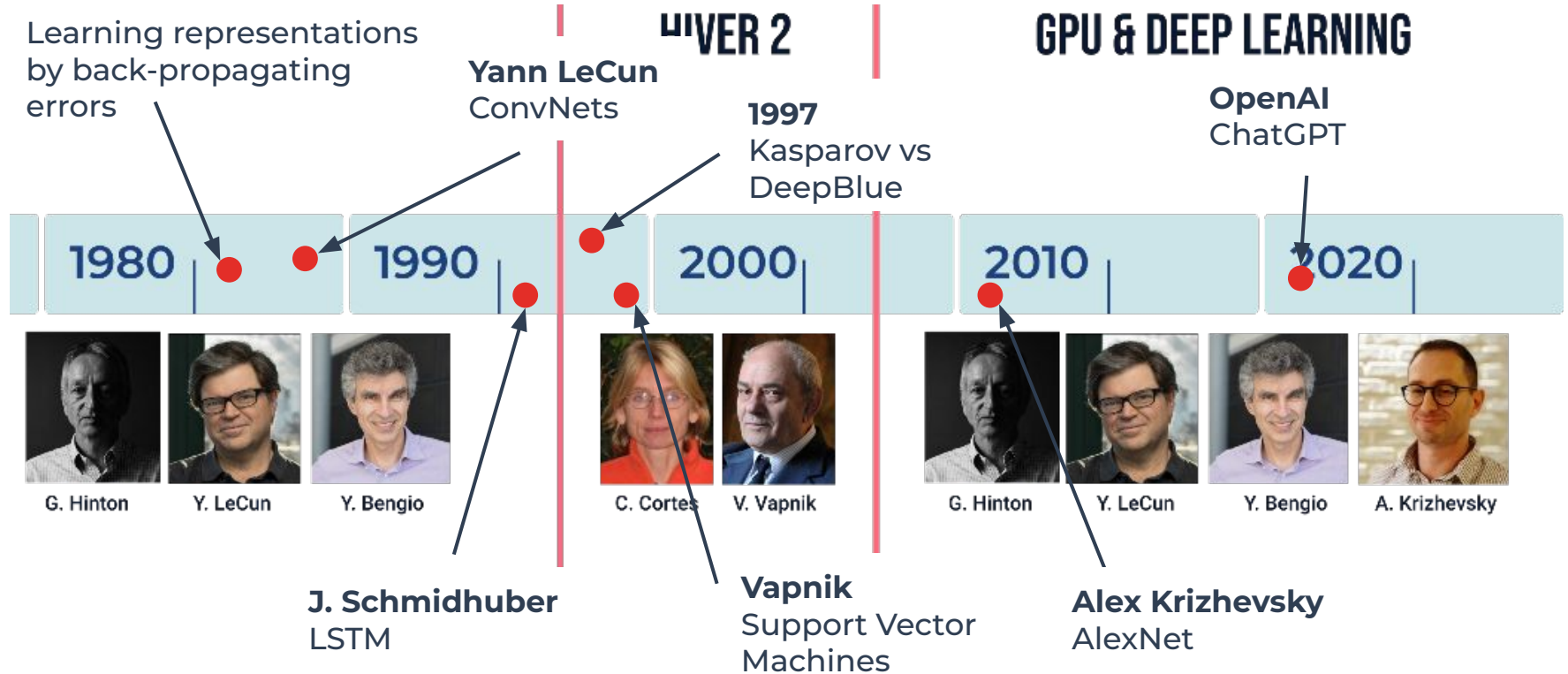
Bad, noisy data: nothing to learn.

History of Machine Learning

History of Machine Learning

Alan M. Turing
Turing Machine

DÉBUT

Nobert Wiener
Cybernetics

Arthur Samuel
AI applied to checkers

HIVER 1

Minsky & Paper
Limits of Perceptron

1930

1940

1950

1960

1970

A. Turing

S. McCulloch - W. Pitts

N. Wiener

F. Rosenblatt

M. Minsky - S. Papert

McCulloch-Pitts
Formal neuron

R. Rosenblatt
Perceptron

History of Machine Learning

Learning representations by back-propagating errors

Yann LeCun
ConvNets

HIVER 2

GPU & DEEP LEARNING

1997
Kasparov vs DeepBlue

OpenAI
ChatGPT

1980   1990   2000   2010   2020

G. Hinton   Y. LeCun   Y. Bengio

C. Cortes   V. Vapnik

G. Hinton   Y. LeCun   Y. Bengio   A. Krizhevsky

J. Schmidhuber
LSTM

Vapnik
Support Vector Machines

Alex Krizhevsky
AlexNet

History of Artificial Intelligence

- **On Computable Numbers, with an Application to the Entscheidungsproblem** (Alan M. Turing, 1936)

- **A Logical Calculus of the Ideas Immanent in Nervous Activity** (McCulloch, W. S., Pitts, W., 1943)

- **Cybernetics or Control and Communication in the Animal and the Machine** (Norbert Wiener, 1948)

- **Computing Machinery and Intelligence** (Alan M. Turing, 1950)

- **The Perceptron, A perceiving and recognizing automaton** (R. Rosenblatt, 1957)

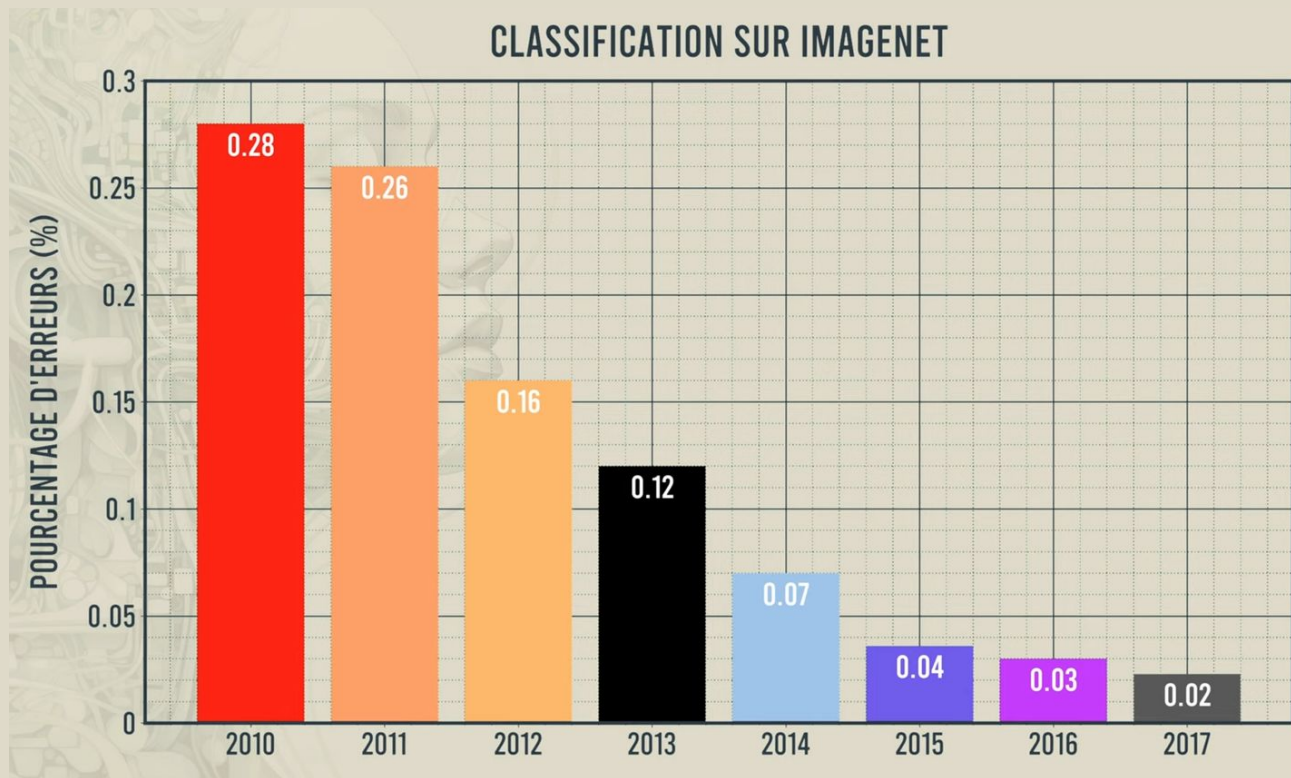- **Perceptrons** (Minsky & Paper, 1969)

History of Artificial Intelligence

- **Learning representations by back-propagating errors** (David E. Rumelhart, Geoffrey E. Hinton & Ronald J. Williams, 1986)

- **Backpropagation Applied to Handwritten Zip Code Recognition** (LeCun, Y. Boser, ..., 1989)

History of Machine Learning

Performance in image recognition
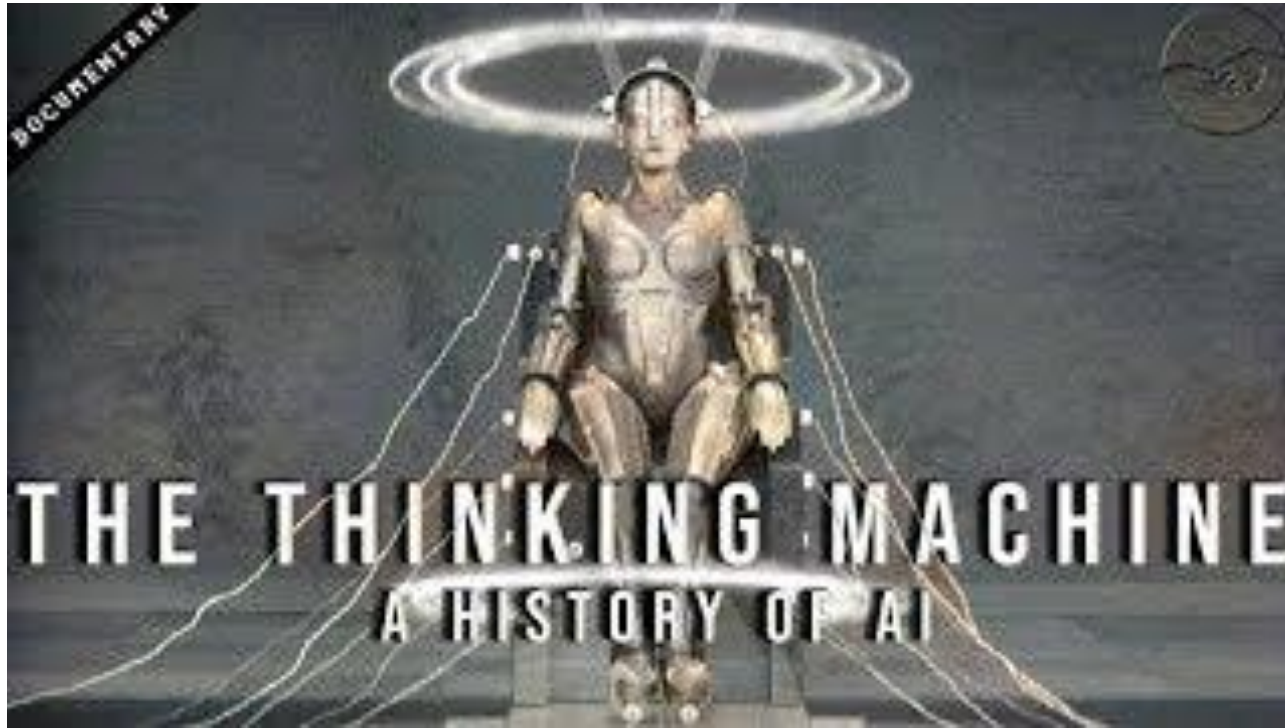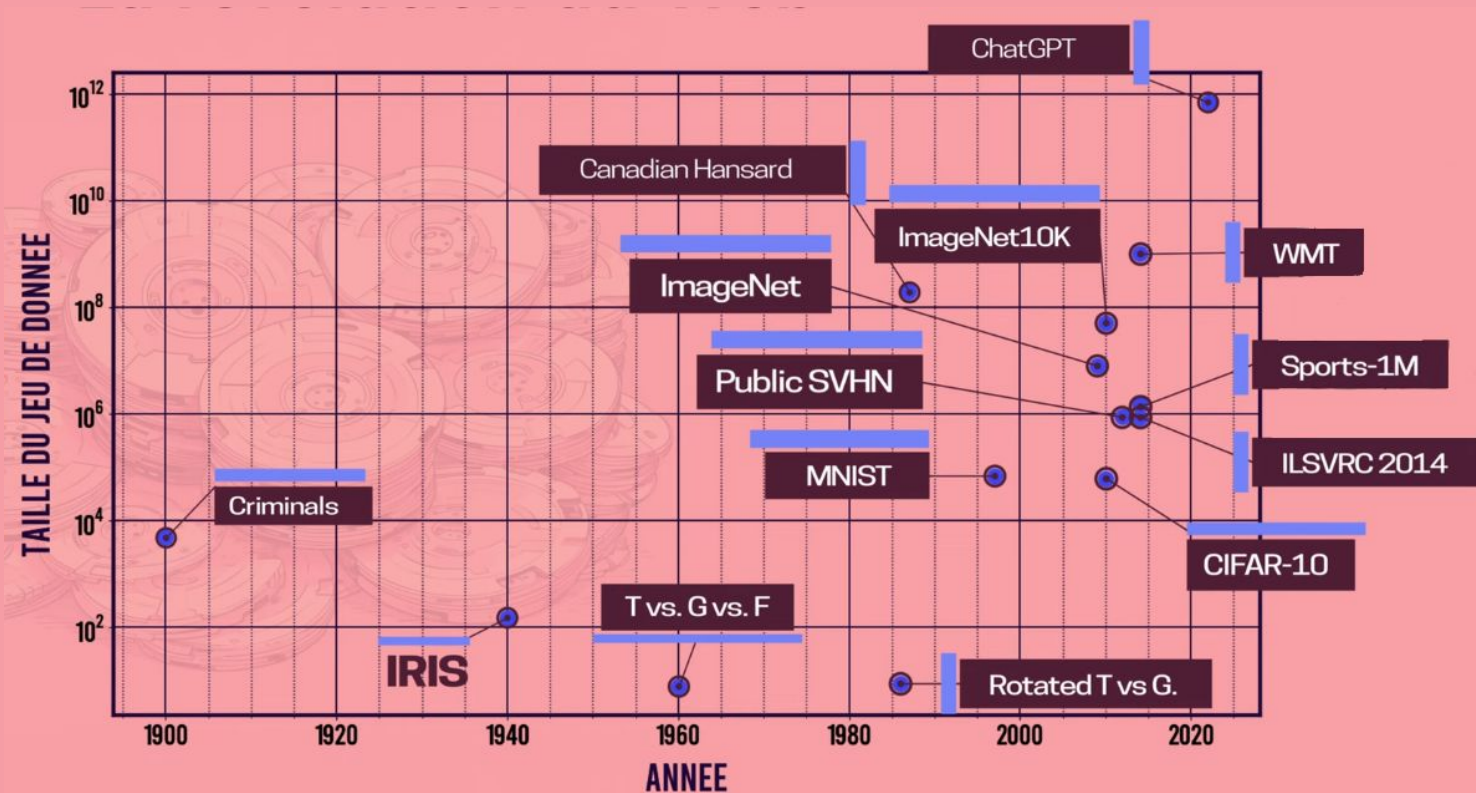

CLASSIFICATION SUR IMAGENET

Performance in image recognition

ImageNet classification with Deep Convolutional neural networks

(Alex Krizhevsky, Ilya Sutskever, Geoffrey E. Hinton)

A data-driven world
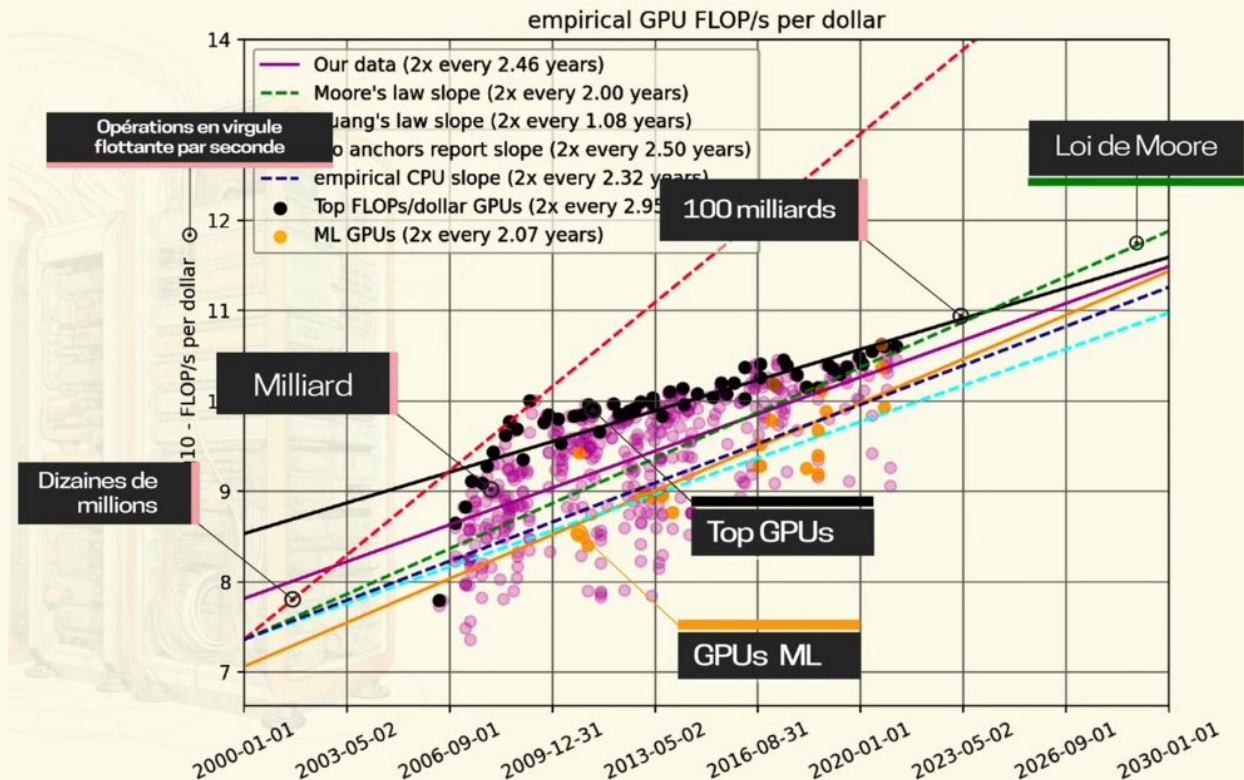
A data-driven world

The Largest database (2013!)

1. World Data Centre for Climate (6 PB)
2. National Energy Research Computing Center (3 PB)
3. AT&T (312 TB)
4. Google
5. Sprint
6. Choice Point.
7. YouTube (45 TB)
8. Amazon (42 TB)
9. CIA
10. Library of Congress (20 TB)

A data-driven world

- We are overwhelmed by data (amount of data doubled every 20 months)

- We need methods to automatically extract information.

- Data is not information
  - Data record facts in a formal way (0 and 1)
  - Information is the patterns underlying the data.

A GPU-driven world

A GPU-driven world

Trends in GPU price-performance

(Marius Hobbhabn and Tamay Besiroglu)