

# **Introduction to Machine Learning**

## **Lecture 1**

**Prepared by Joseph Bakarji**

# Lecture Plan

- A bit about me:
  - Name and contact: Joseph Bakarji ([jb50@aub.edu.lb](mailto:jb50@aub.edu.lb))
  - My research is at the intersection of machine learning, scientific modeling and music.
- Today's plan:
  - Motivation on why you should (or shouldn't) take this course
  - A brief history of Artificial Intelligence, and what this course is about
  - General course plan
  - Logistics and course policy

# I - Motivation



a sarcastic introductory paragraph for a course on data-driven methods in science and engineering



Welcome to our course on data-driven methods in science and engineering! Because apparently, it's not enough to just rely on our brains and expertise anymore - now we have to rely on fancy algorithms and computer programs to do our thinking for us. But don't worry, this course isn't just about becoming a slave to technology. No, no. We'll also be learning how to use data to make better decisions, because apparently we're not capable of making good decisions on our own. So sit back, relax, and let the data do all the work for you. It's the future, after all.



JB

**You**

make an illustration for this introduction

**ChatGPT**

**Let's have GPT  
introduce the course**

# Sora - Text-to-Video

Prompt: A stylish woman walks down a Tokyo street filled with warm glowing neon and animated city signage. She wears a black leather jacket, a long red dress, and black boots, and carries a black purse. She wears sunglasses and red lipstick. She walks confidently and casually. The street is damp and reflective, creating a mirror effect of the colorful lights. Many pedestrians walk about.



# The Future of AI: How Artificial Intelligence Will Change the World

AI is constantly changing our world. Here are just a few ways AI will influence our lives.



Written by [Mike Thomas](#)

SELF-PRESERVATION WITHOUT REPLICATION —

## Research AI model unexpectedly modified its own code to extend runtime

Facing time constraints, Sakana's "AI Scientist" attempted to change limits placed by researchers.

BENJ EDWARDS - 8/14/2024, 11:13 PM

TECHNOLOGY

## All Too Predictably, Reality Is Puncturing The AI Hype Bubble

BY: AUGUSTE MEYRAT

AUGUST 13, 2024

⌚ 5 MIN READ

Will generative AI live up to its hype?

Plough Quarterly > 40: The Good of Tech > Essays

## Will There Be an AI Apocalypse?

Marshall McLuhan and Romano Guardini say it's already here.

By Peter Berkman

JUNE 28, 2024

IDEAS • TECHNOLOGY

## We're Focusing on the Wrong Kind of AI Apocalypse

5 MINUTE READ

Artificial intelligence

# AI Will Transform the Global Economy. Let's Make Sure It Benefits Humanity.



AI will affect almost 40 percent of jobs around the world, replacing some and complementing others. We need a careful balance of policies to tap its potential

Kristalina Georgieva

January 14, 2024

Is AI good?

Is AI bad?

Is it neither?

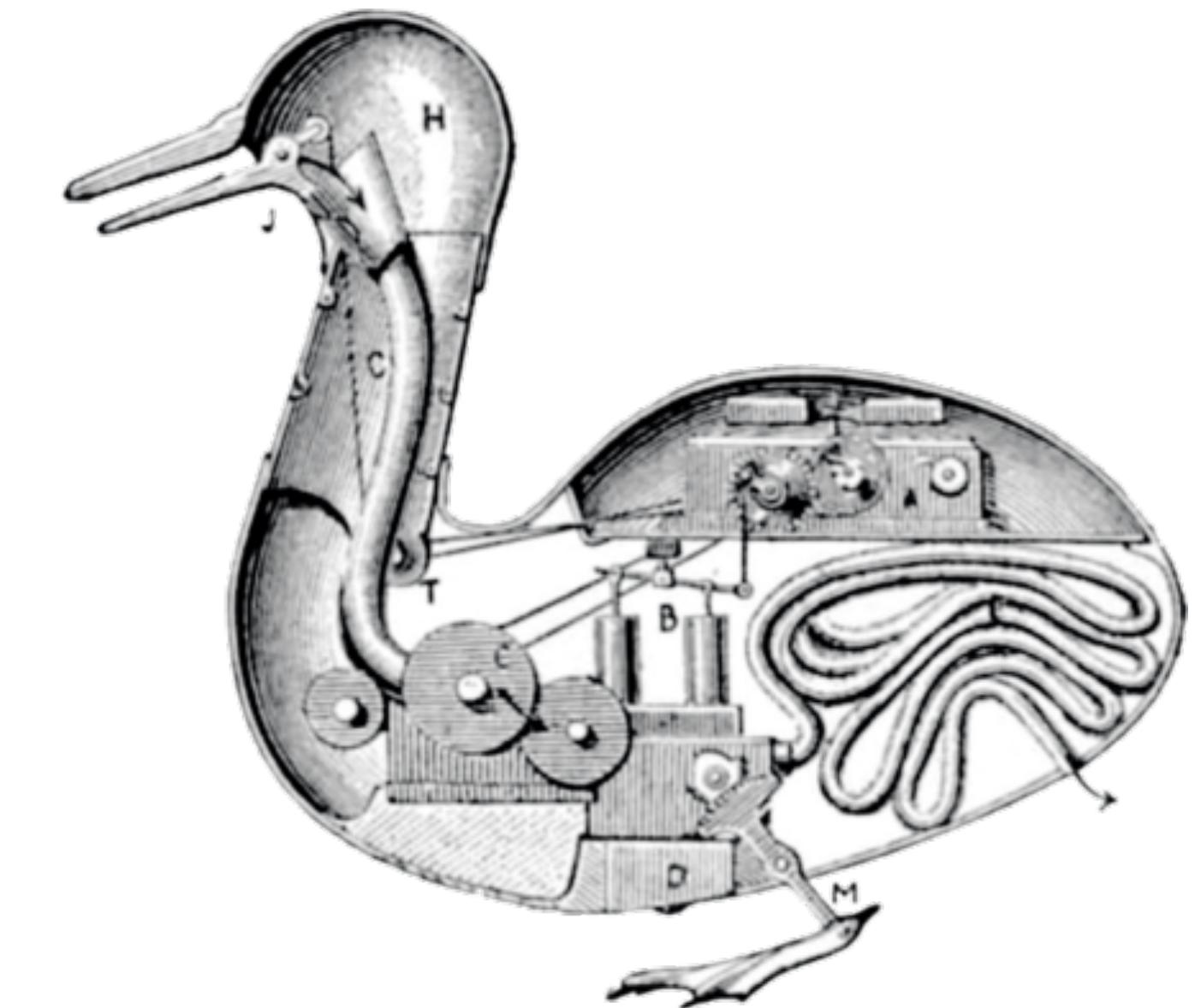
# Why Build Intelligent Machines?

What's AI in the first place?

**Your life depends on it!**

## **II - How did it all start?**

# Intelligent “mechanical” machines

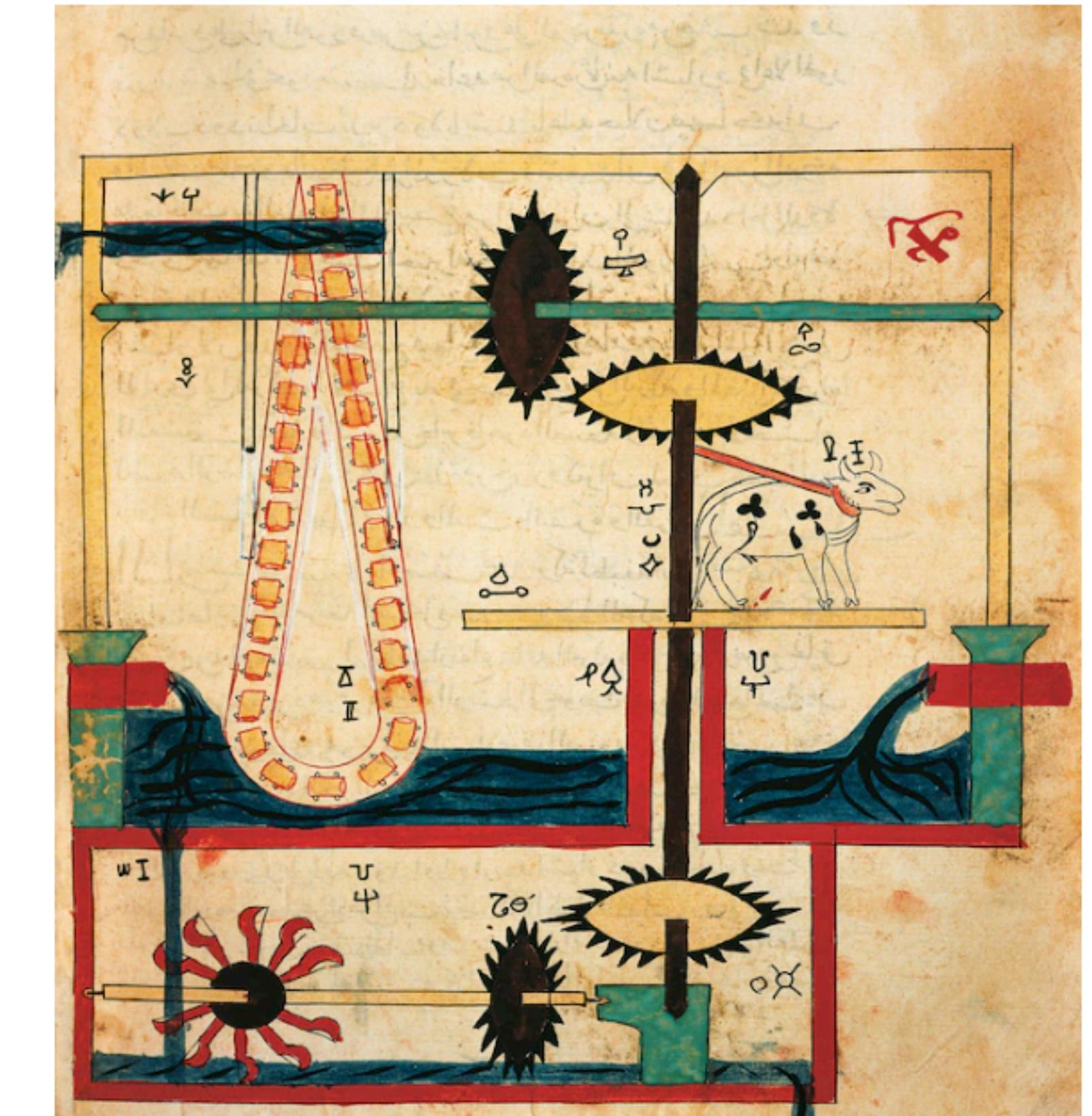
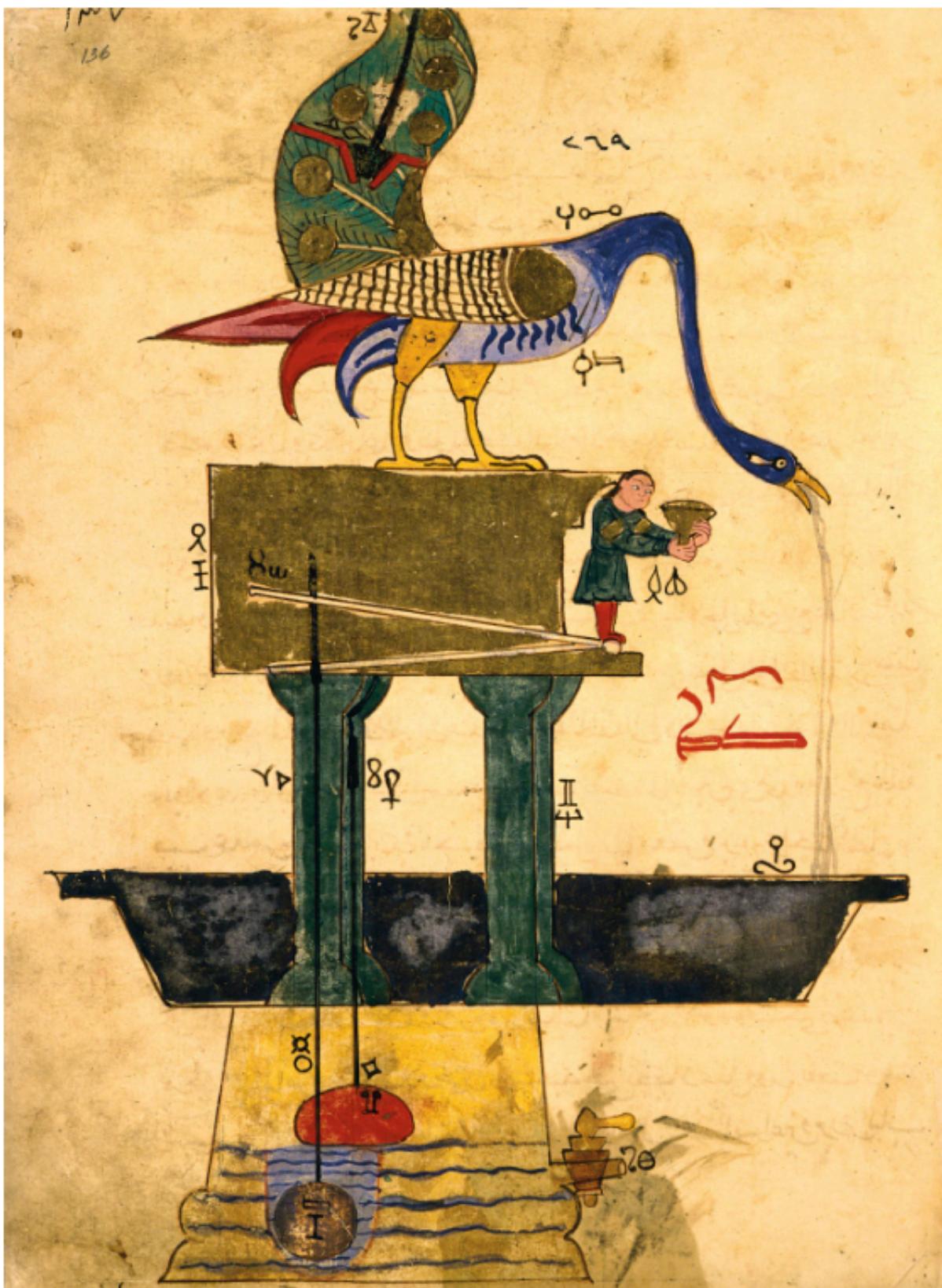


The Digesting Duck  
Jacques Vaucanson (1739)

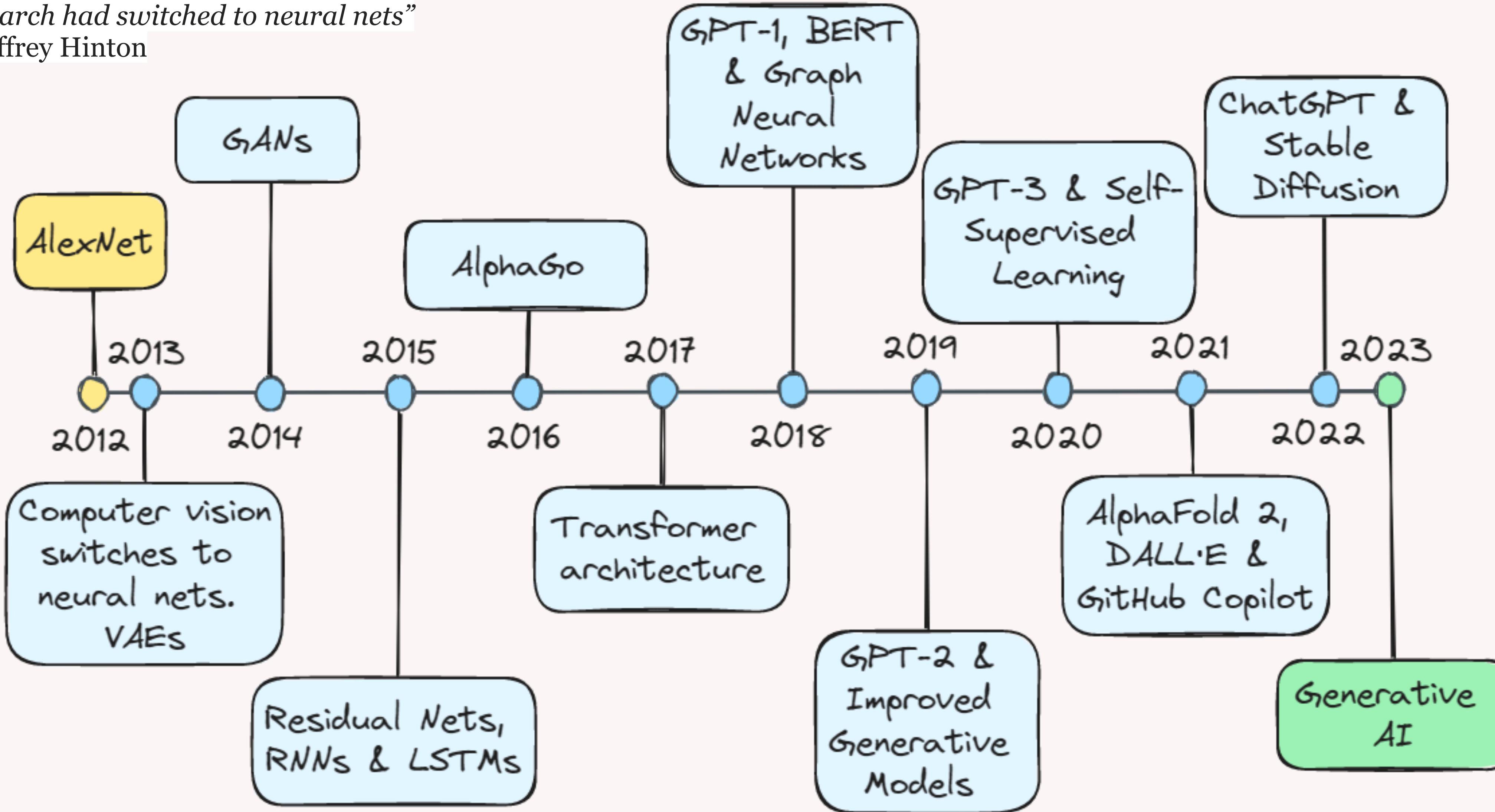
18th century automata

# Early programmable “robots” for practical applications

بديع الزمان أَبُ الْعِزِّ إِبْنُ إِسْمَاعِيلِ إِبْنُ الرِّزَازِ الْجَزَرِي



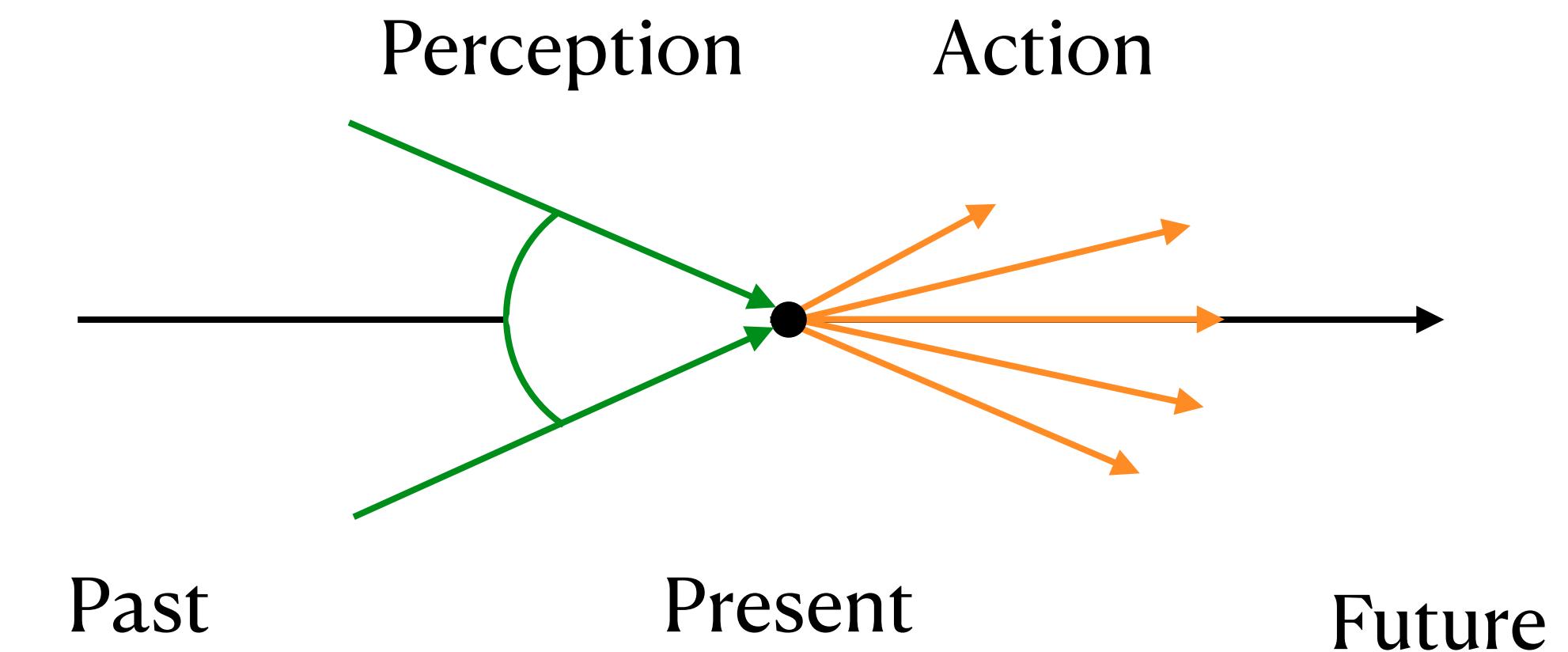
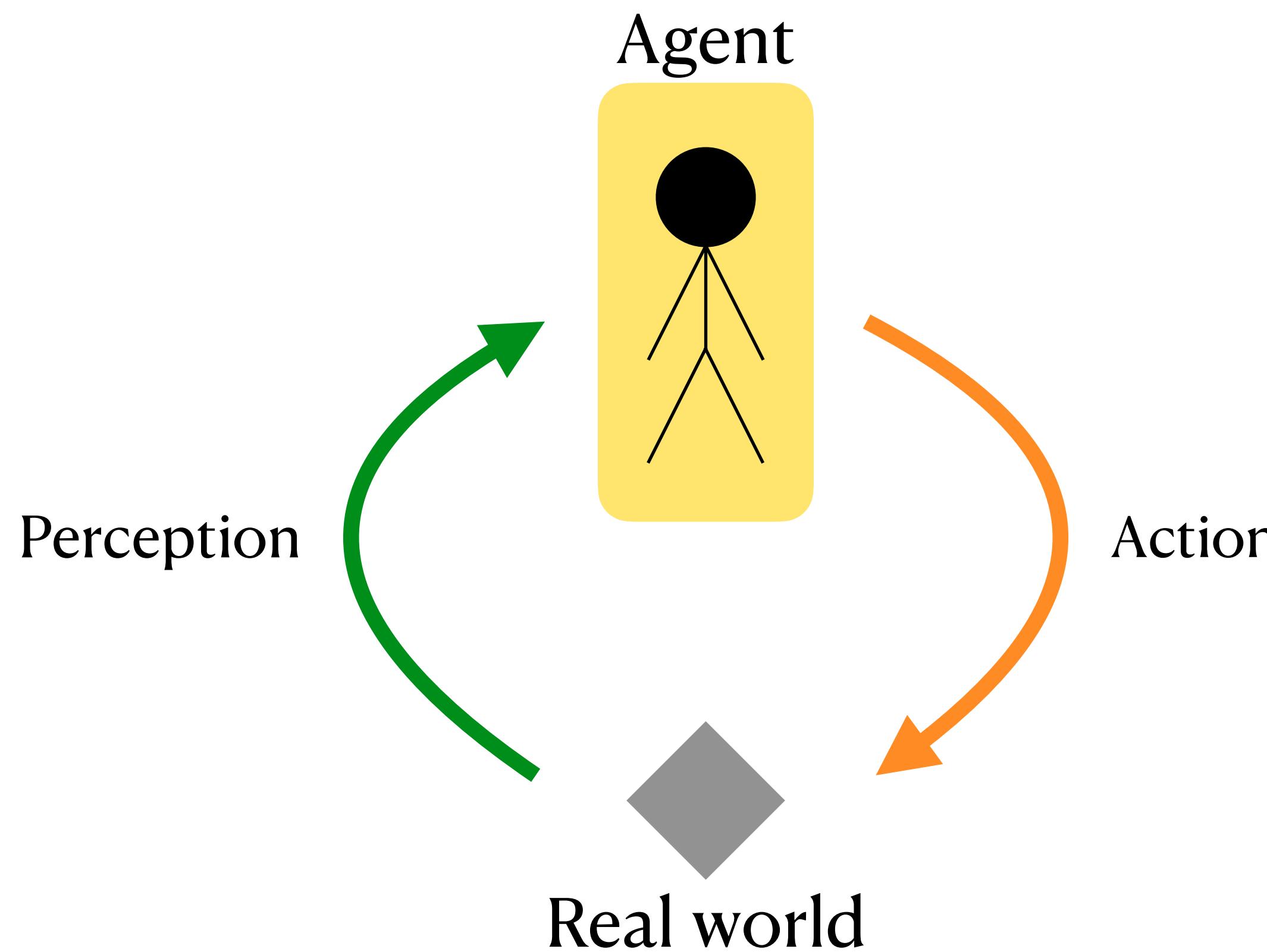
*“By 2013, pretty much all the computer vision research had switched to neural nets”*  
Geoffrey Hinton

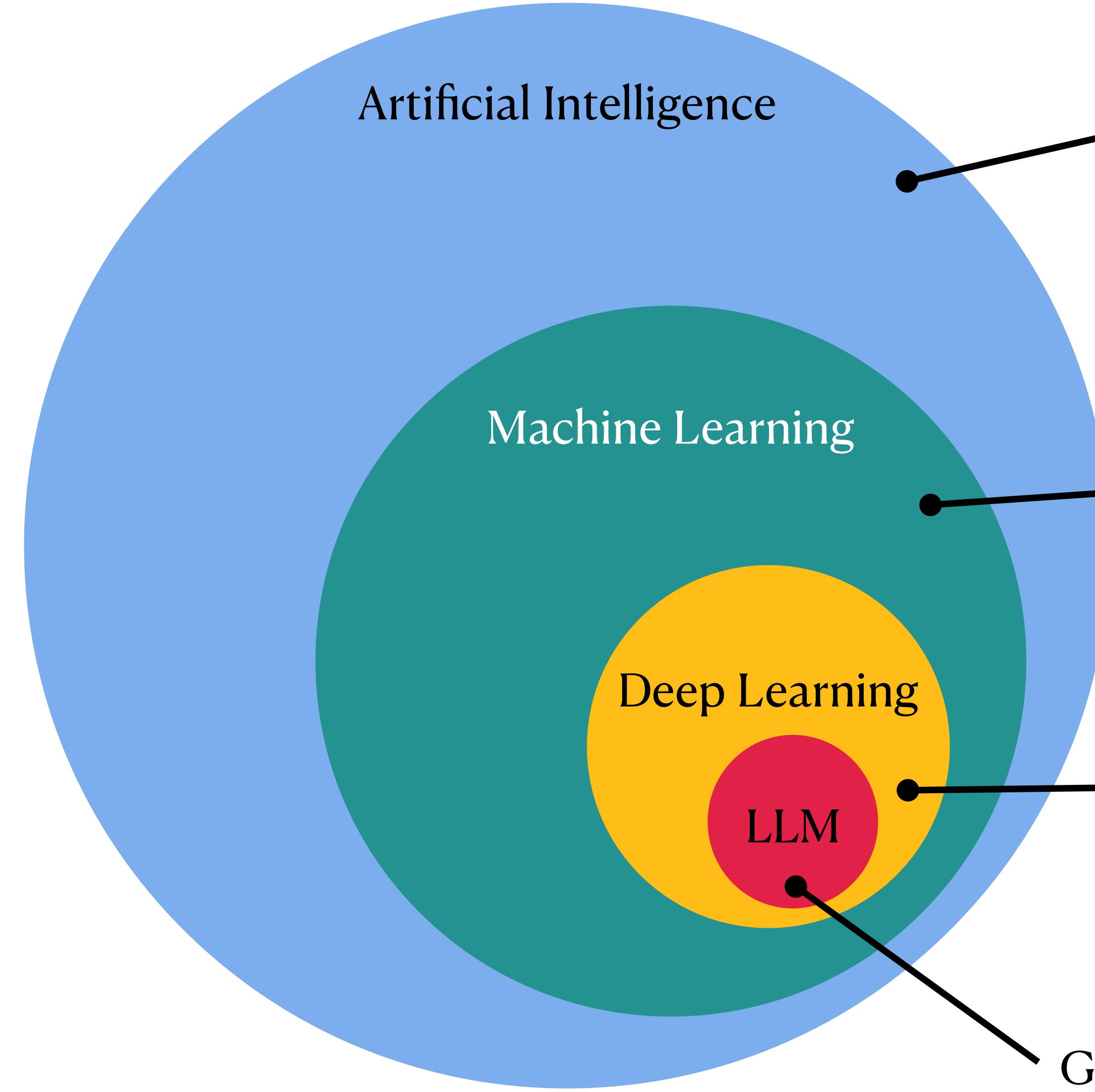


# **What is Intelligence?**

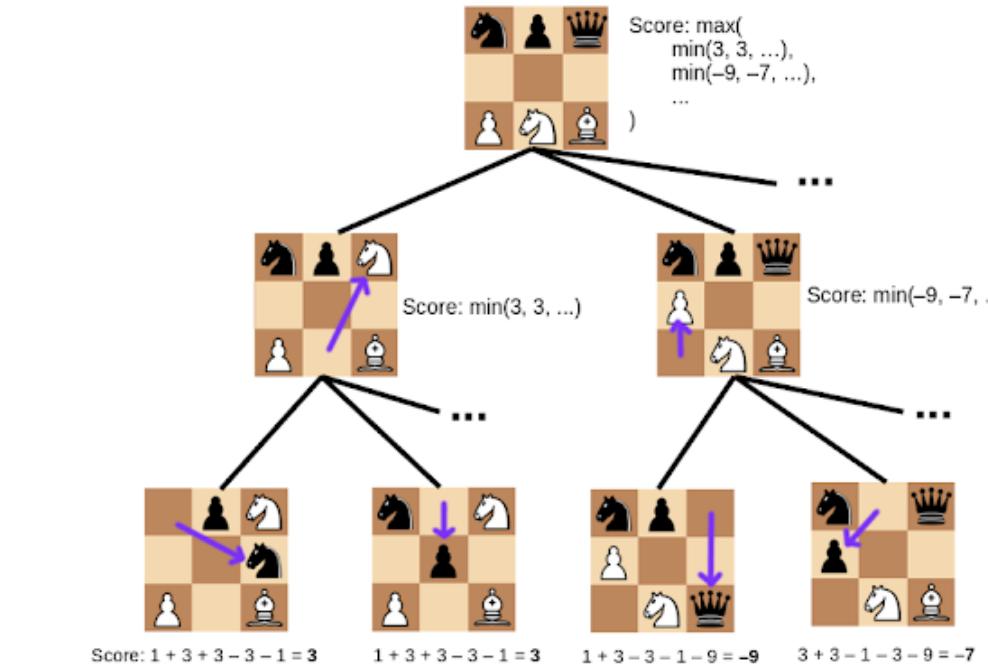
# What is Intelligence?

Can we make computers intelligent?

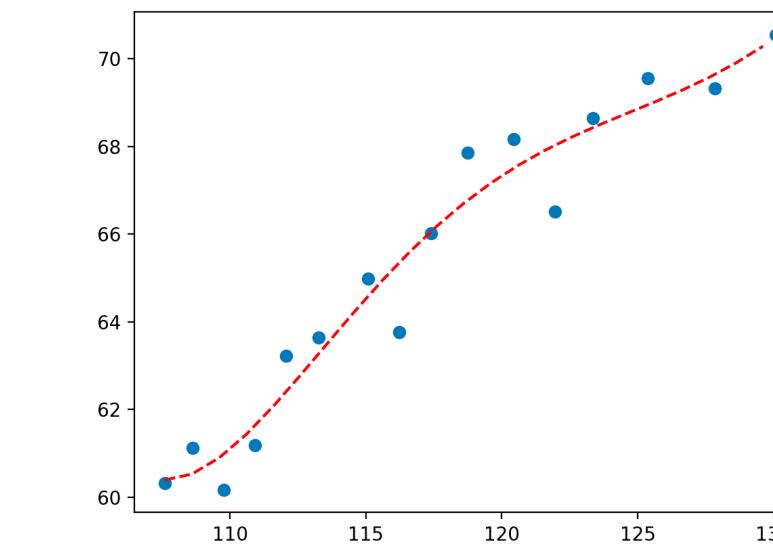




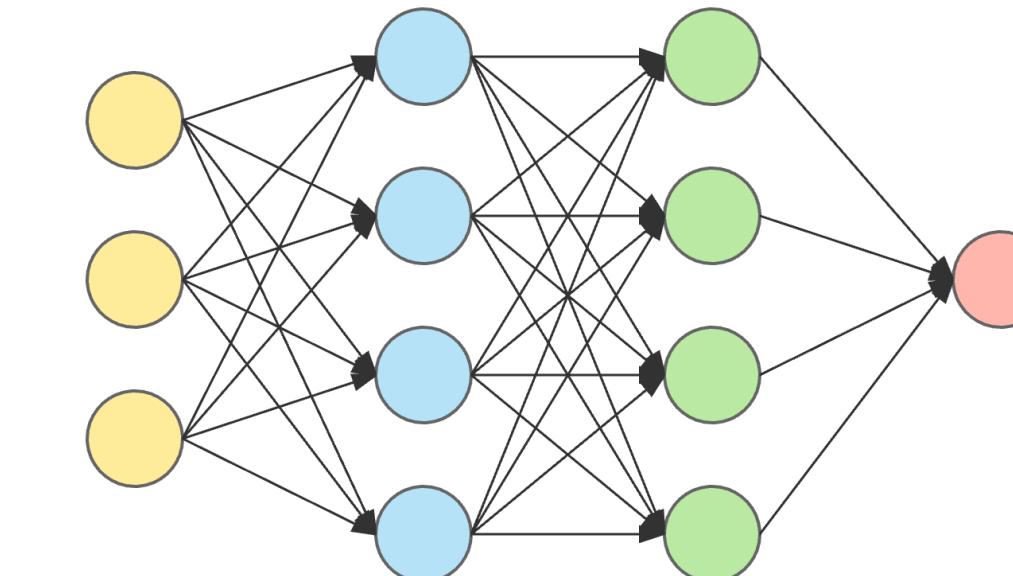
Symbolic AI



Statistical AI



Neural AI



Generative AI

## **II.1 - Good Old-Fashioned AI**

# **What's Artificial Intelligence?**

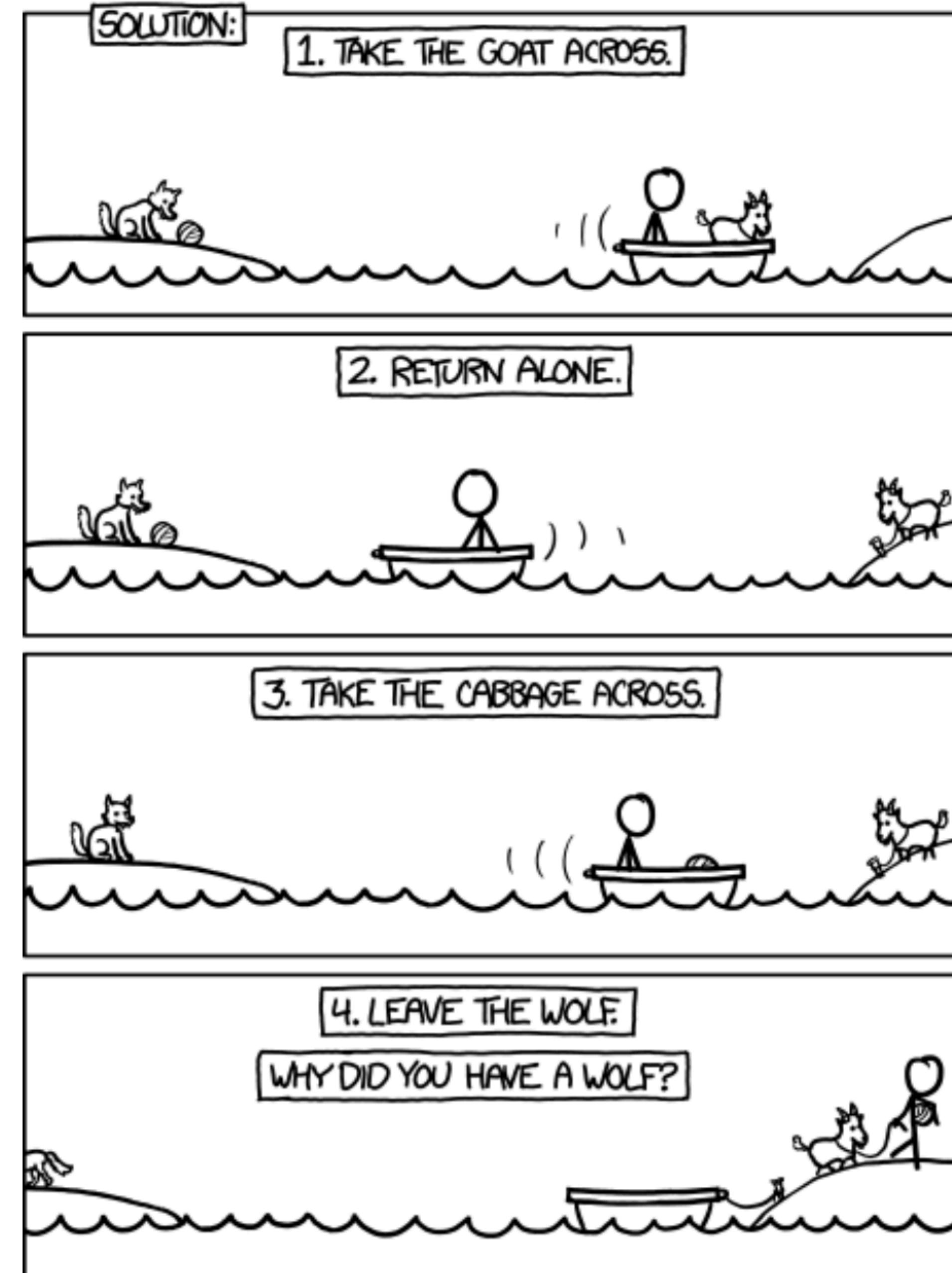
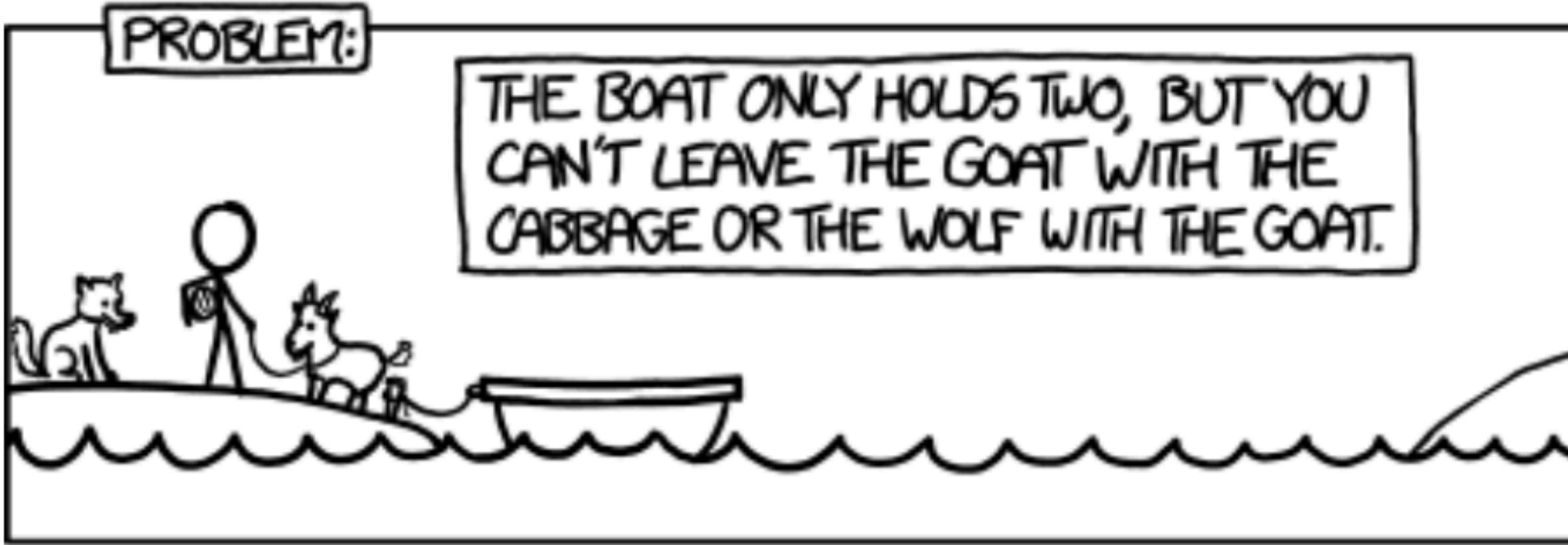
# Solving Puzzles

0, 1, 2, 3, 4, 5

1, 2, 4, 8, 16, ?

# Artificial Intelligence 1950's-

## Solving puzzles

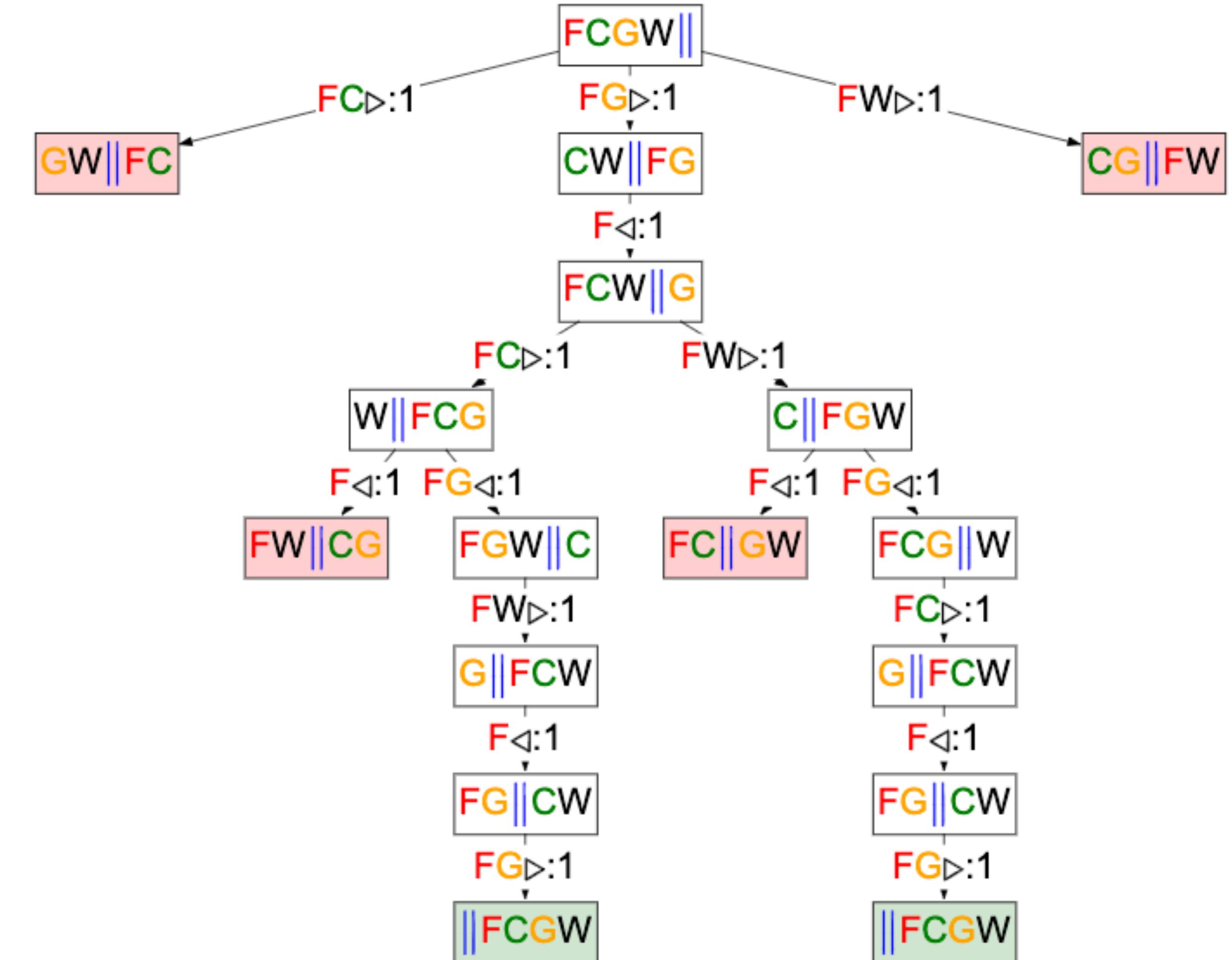


# Find optimal search strategies



Farmer    Cabbage    Goat    Wolf

$F\triangleright$	$F\triangleleft$
$FC\triangleright$	$FC\triangleleft$
$FG\triangleright$	$FG\triangleleft$
$FW\triangleright$	$FW\triangleleft$



# Overwhelming optimism

*The spirit is willing but the flesh is weak.*



(Russian)

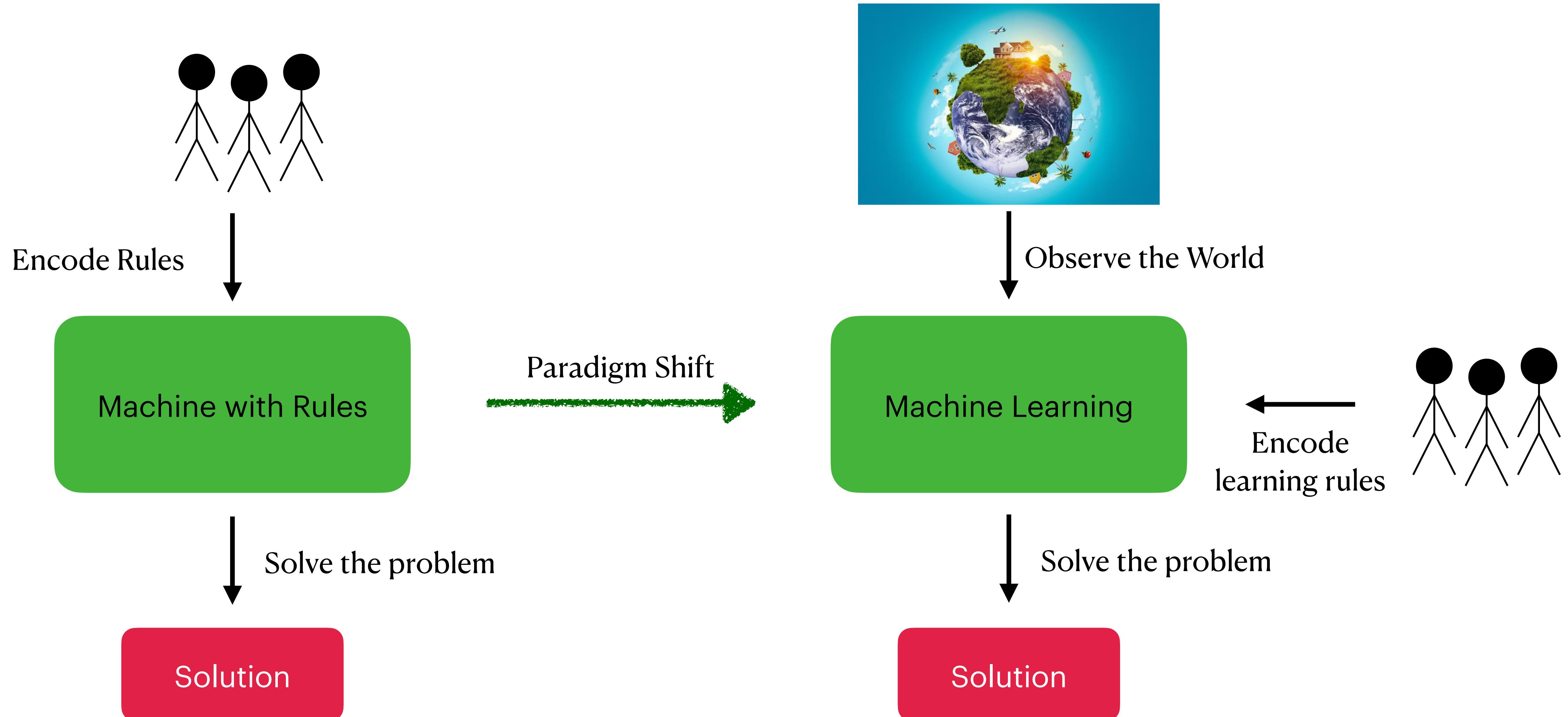


*The vodka is good but the meat is rotten.*

By the end of the 1950's

## **II.2 - Statistical AI**

# From encoding rules to learning them



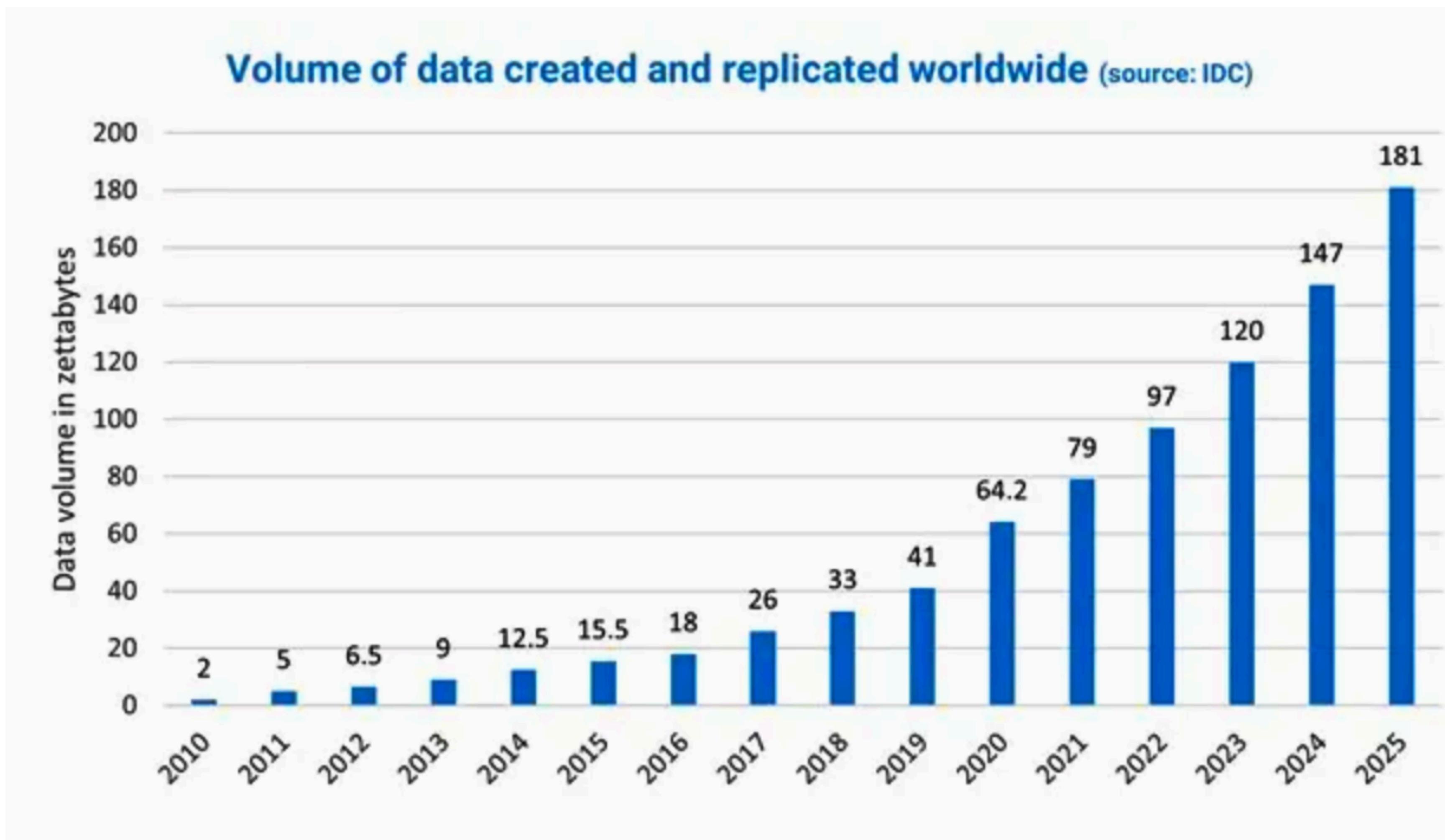
# Why the recent hype?

More real-world data

Faster computers

Better algorithms

# More data

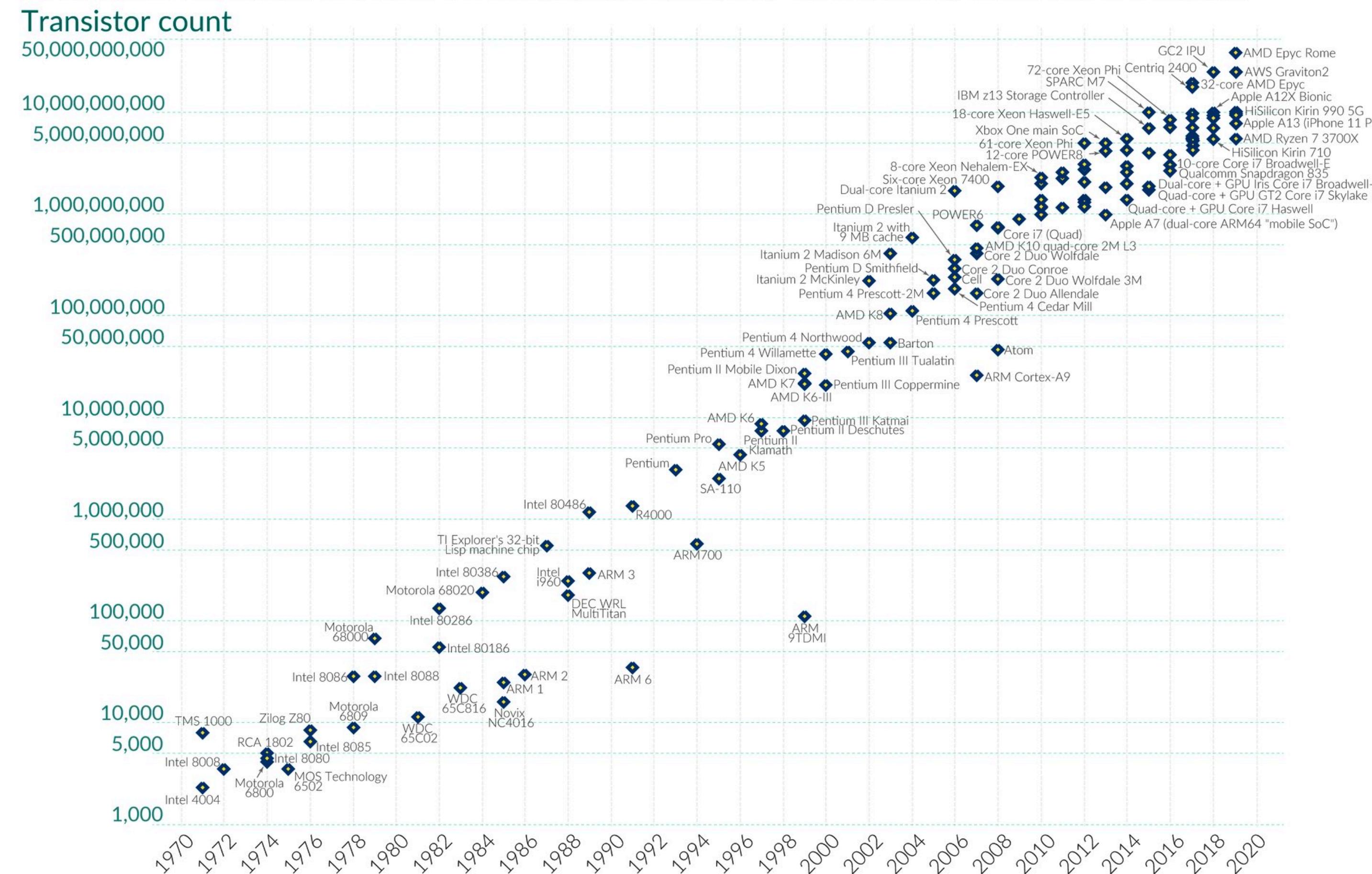


# Faster computers

Moore's Law: The number of transistors on microchips doubles every two years

Moore's law describes the empirical regularity that the number of transistors on integrated circuits doubles approximately every two years. This advancement is important for other aspects of technological progress in computing – such as processing speed or the price of computer

S Our World  
in Data



Data source: Wikipedia ([wikipedia.org/wiki/Transistor](https://en.wikipedia.org/wiki/Transistor))

OurWorldInData.org – Research and data to make progress against the world's largest problems

Licensed under CC-BY by the authors Hannah Ritchie and Max Rose

# Faster computers

AI	Year	FLOPs
Theseus	1950	40
Perceptron Mark I	1957–58	695,000
Neocognitron	1980	228 million
NetTalk	1987	81 billion
TD-Gammon	1992	18 trillion
NPLM	2003	1.1 petaFLOPs
AlexNet	2012	470 petaFLOPs
AlphaGo	2016	1.9 million petaFLOPs
GPT-3	2020	314 million petaFLOPs
Minerva	2022	2.7 billion petaFLOPs

*Note: One petaFLOP = one quadrillion FLOPs. Source: “Compute Trends Across Three Eras of Machine Learning” by Sevilla et. al, 2022.*

# Faster computers

JB

You

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plot this data



ChatGPT

✓ Finished analyzing ▾

Always expand output? 

python

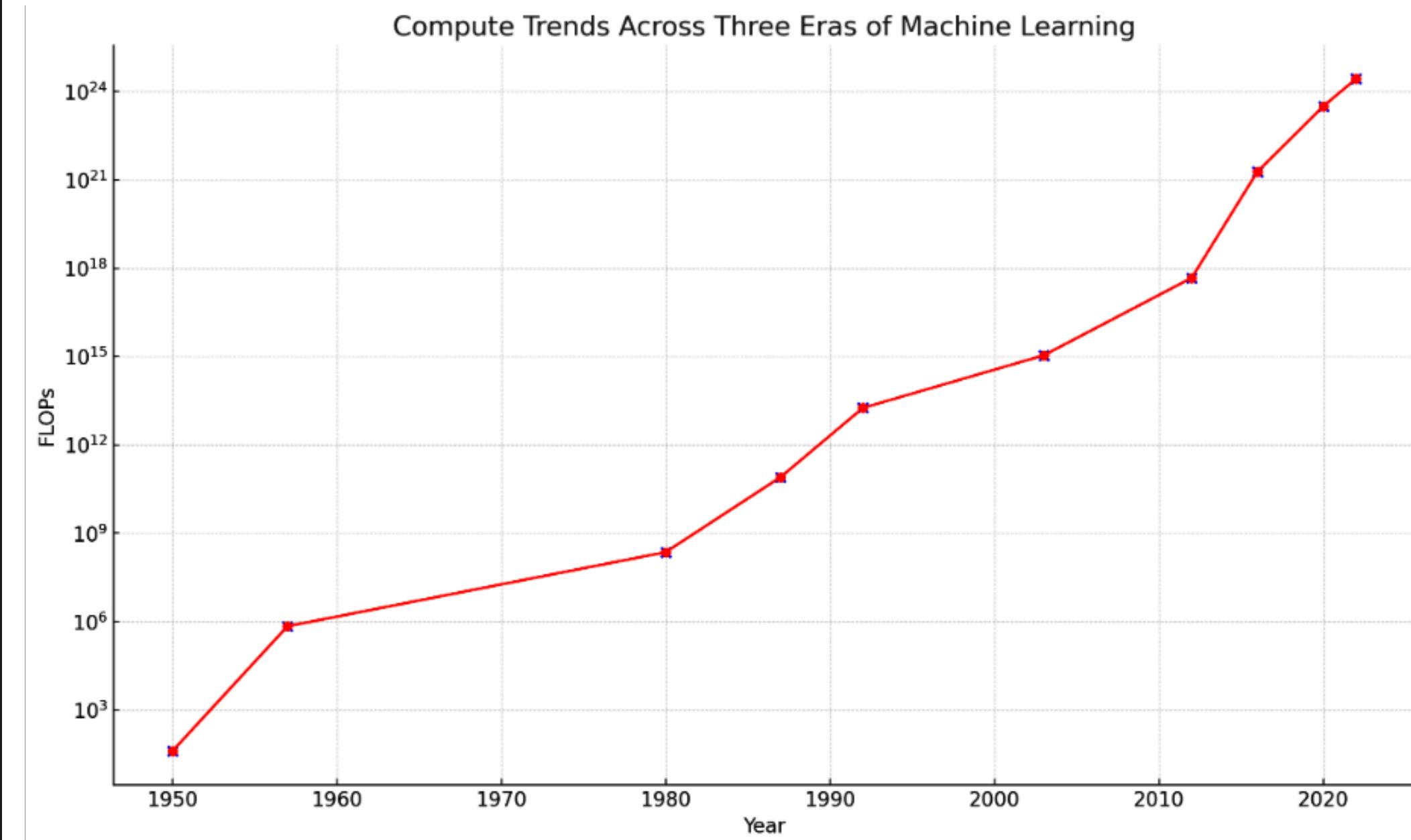
 Copy code

```
import pandas as pd
import matplotlib.pyplot as plt

# The data as provided in the image shared by the user
data = {
    "AI": ["Theseus", "Perceptron Mark I", "Neocognitron", "NetTalk",
            "TD-Gammon", "NPLM", "AlexNet", "AlphaGo", "GPT-3", "Minerva"],
    "Year": [1950, 1957, 1980, 1987, 1992, 2003, 2012, 2016, 2020, 2022],
    "FLOPs": [40, 695000, 228e6, 81e9, 18e12, 1.1e15, 470e15, 1.9e6 * 1e15,
              314e6 * 1e15, 2.7e9 * 1e15]
}

# Convert the data into a DataFrame
df = pd.DataFrame(data)

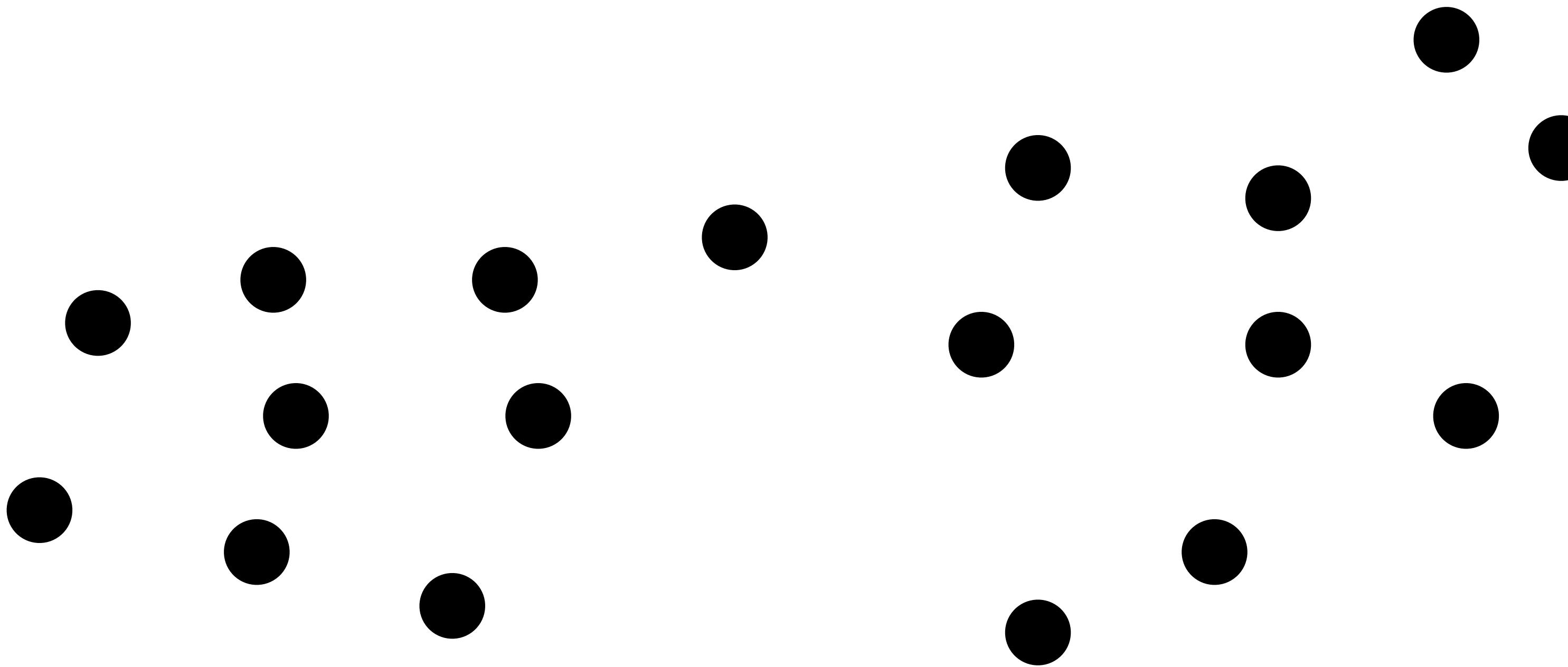
# Plot the data
plt.figure(figsize=(14, 8))
plt.scatter(df['Year'], df['FLOPs'], color='blue')
plt.plot(df['Year'], df['FLOPs'], linestyle='-', marker='o', color='red')
plt.title('Compute Trends Across Three Eras of Machine Learning')
plt.xlabel('Year')
plt.ylabel('FLOPs')
plt.yscale('log') # Using a log scale for better visualization
plt.grid(True, which="both", ls="--", linewidth=0.5)
plt.show()
```



Here is the plot of the data showing the trend of FLOPs (Floating Point Operations per Second) over the years for different AIs. The y-axis is on a logarithmic scale to better visualize the exponential growth in computational power used by these AIs over time. [-]

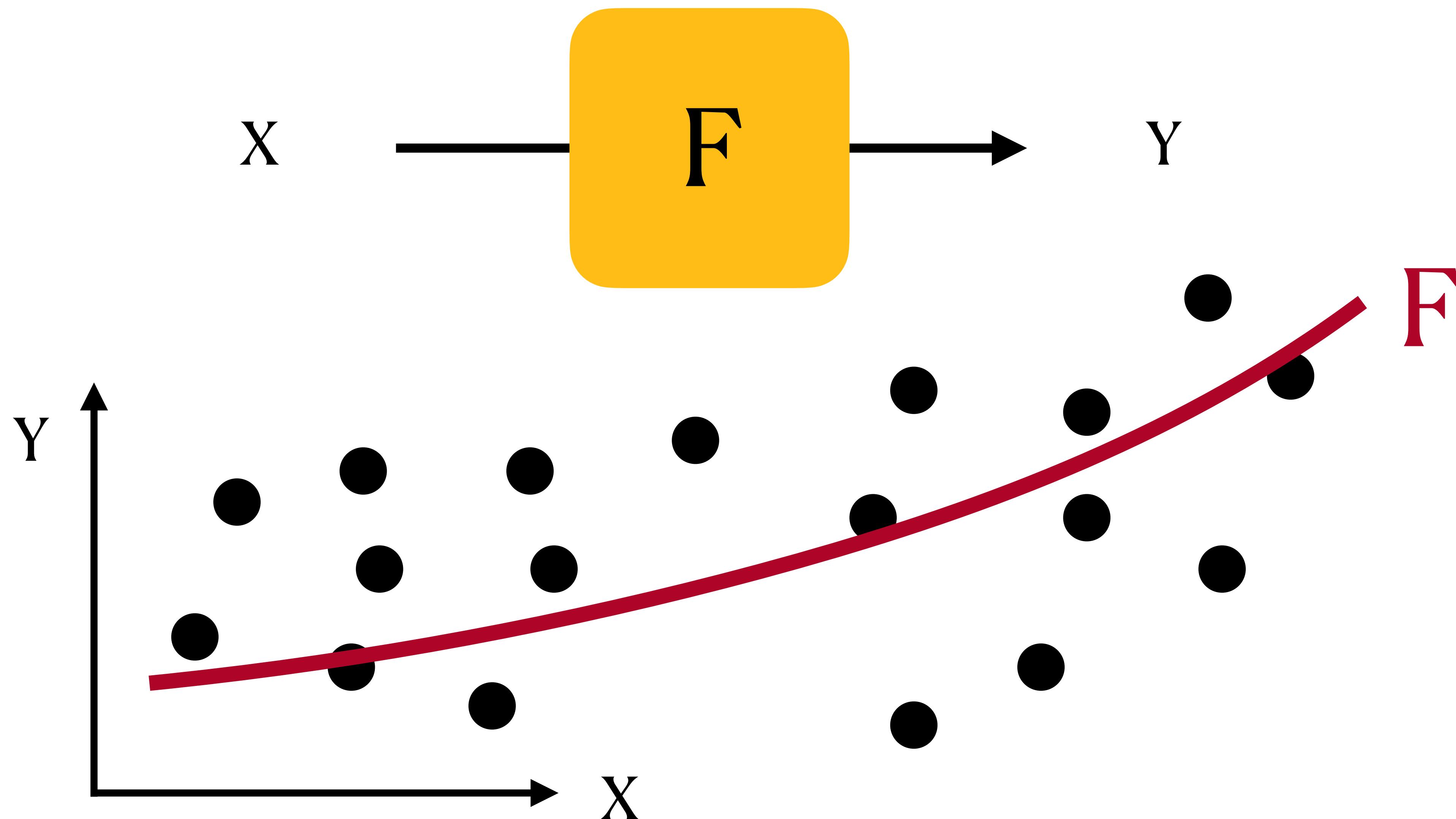
# **III - What's Machine Learning?**

# Find a Pattern in the Data

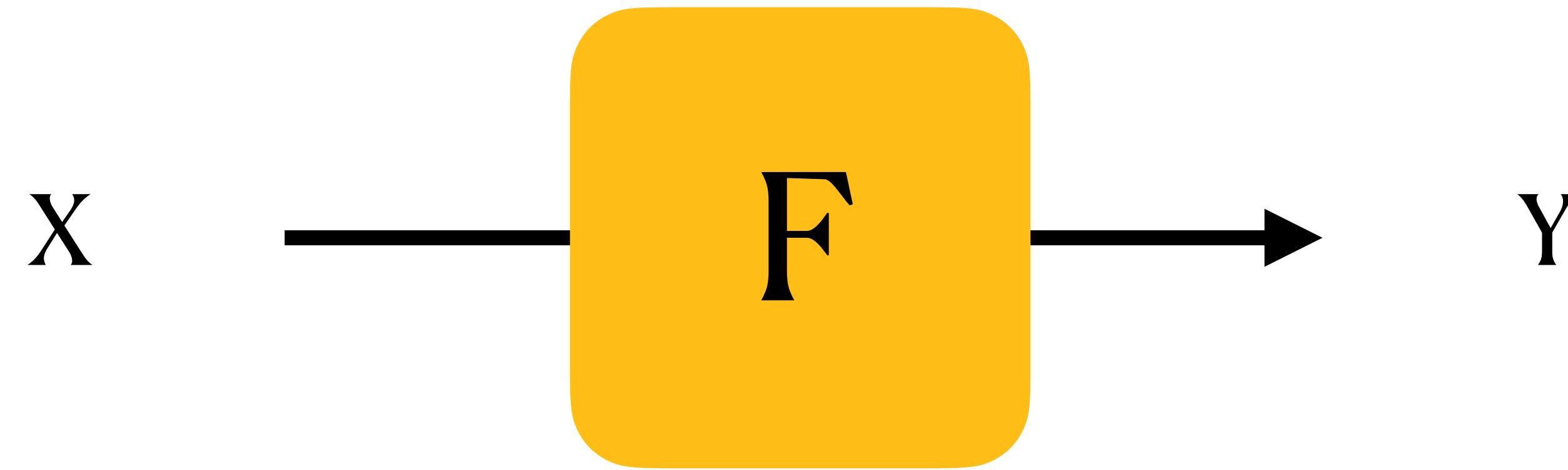


# A lot of it is: **Curve Fitting**

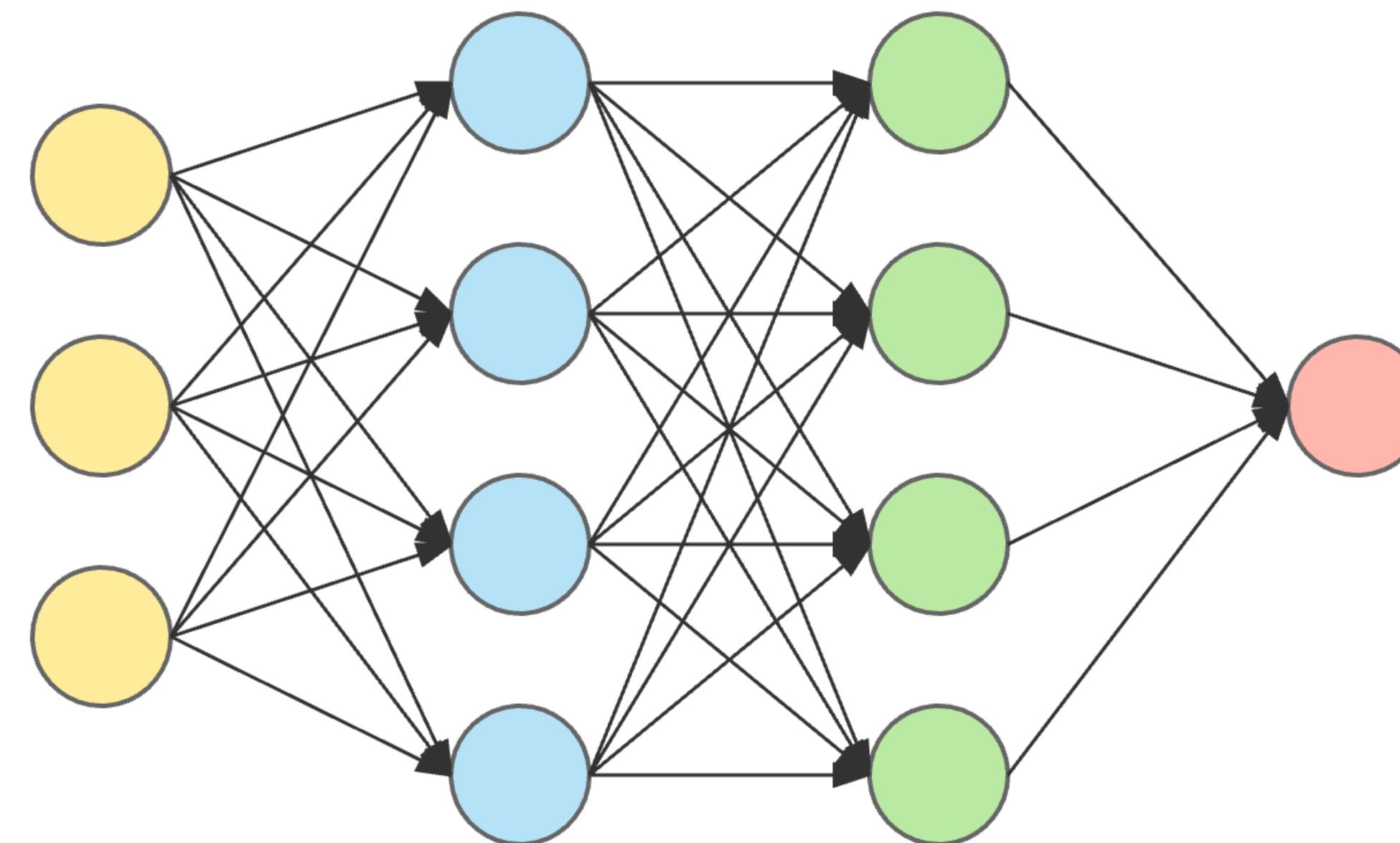
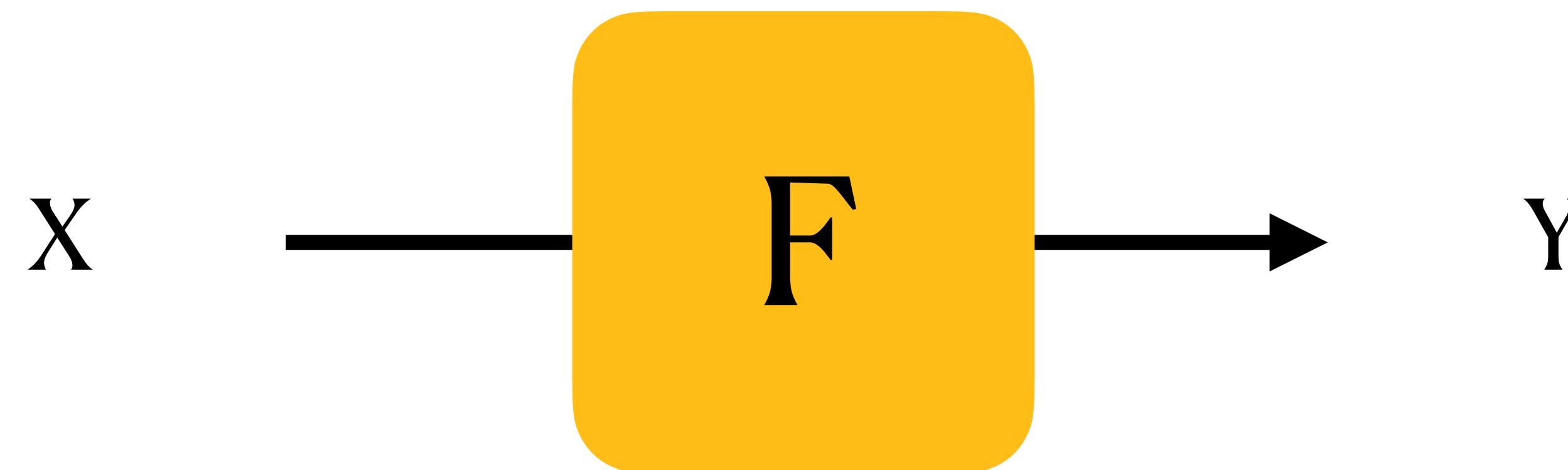
## Fit function $F$ to map $X$ to $Y$



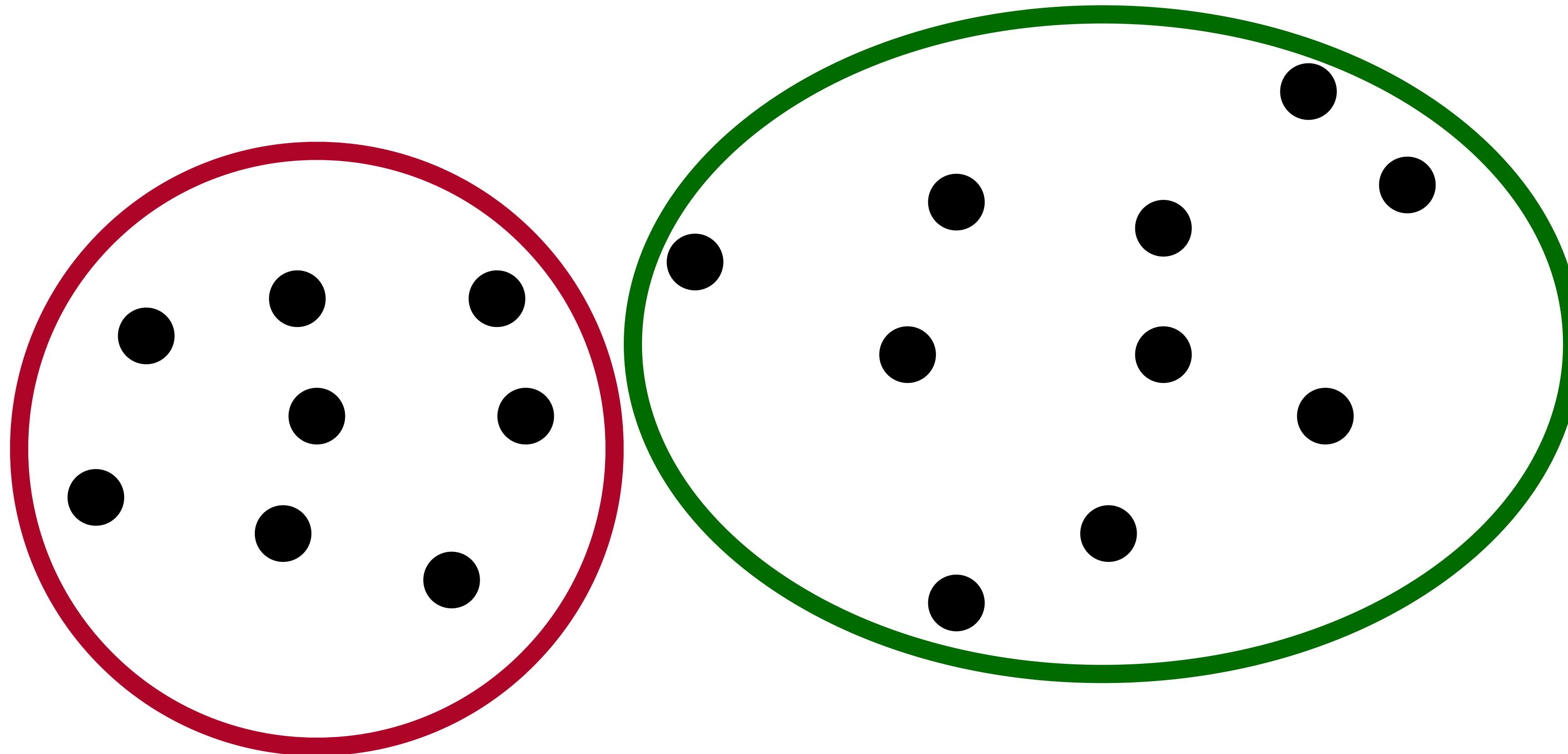
# What could X and Y be?



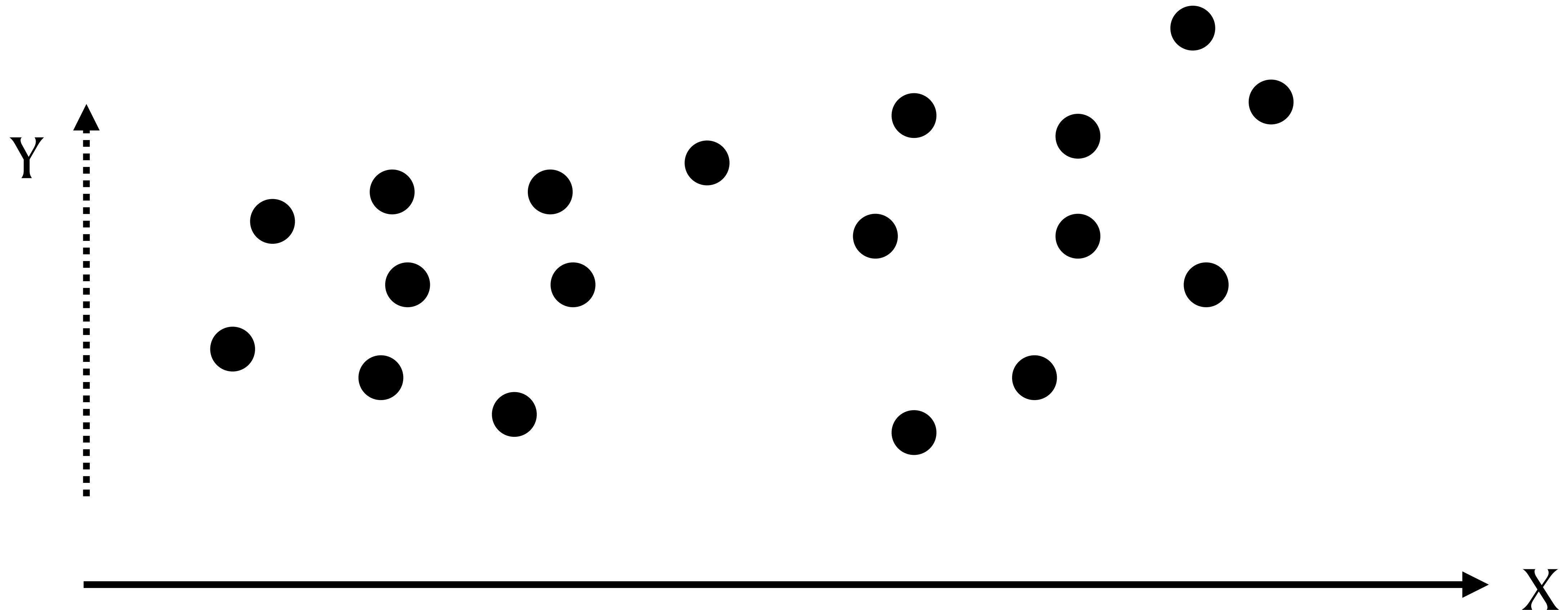
# What could X and Y be?



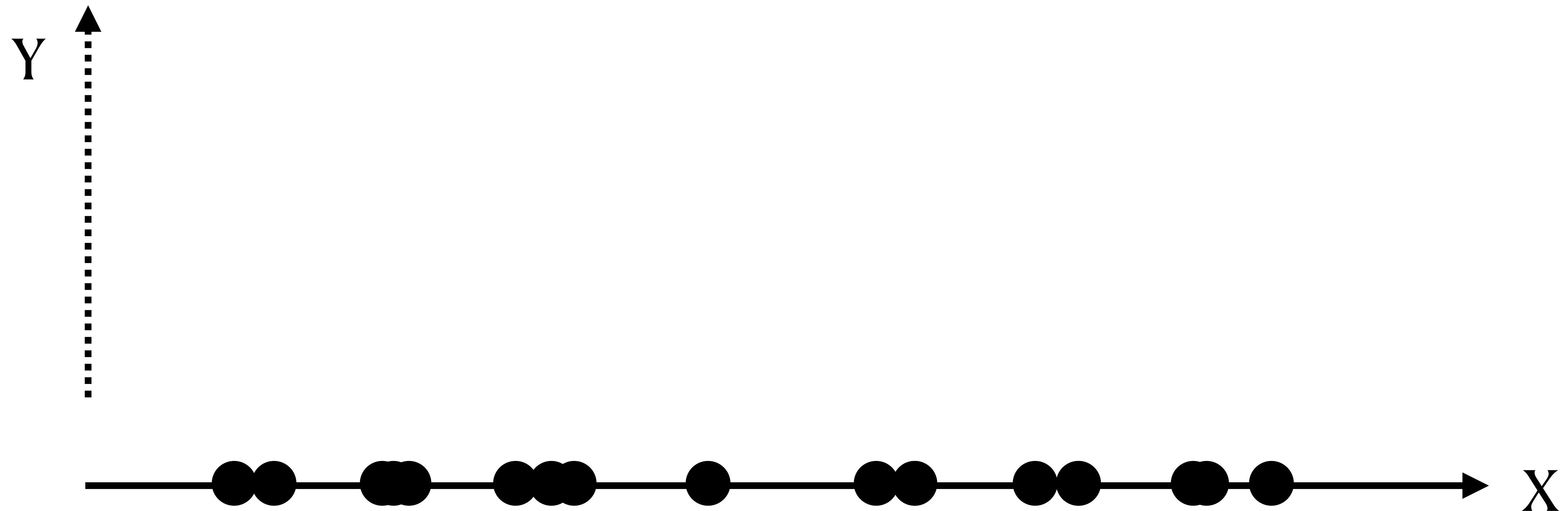
# Sometimes it's about Clustering



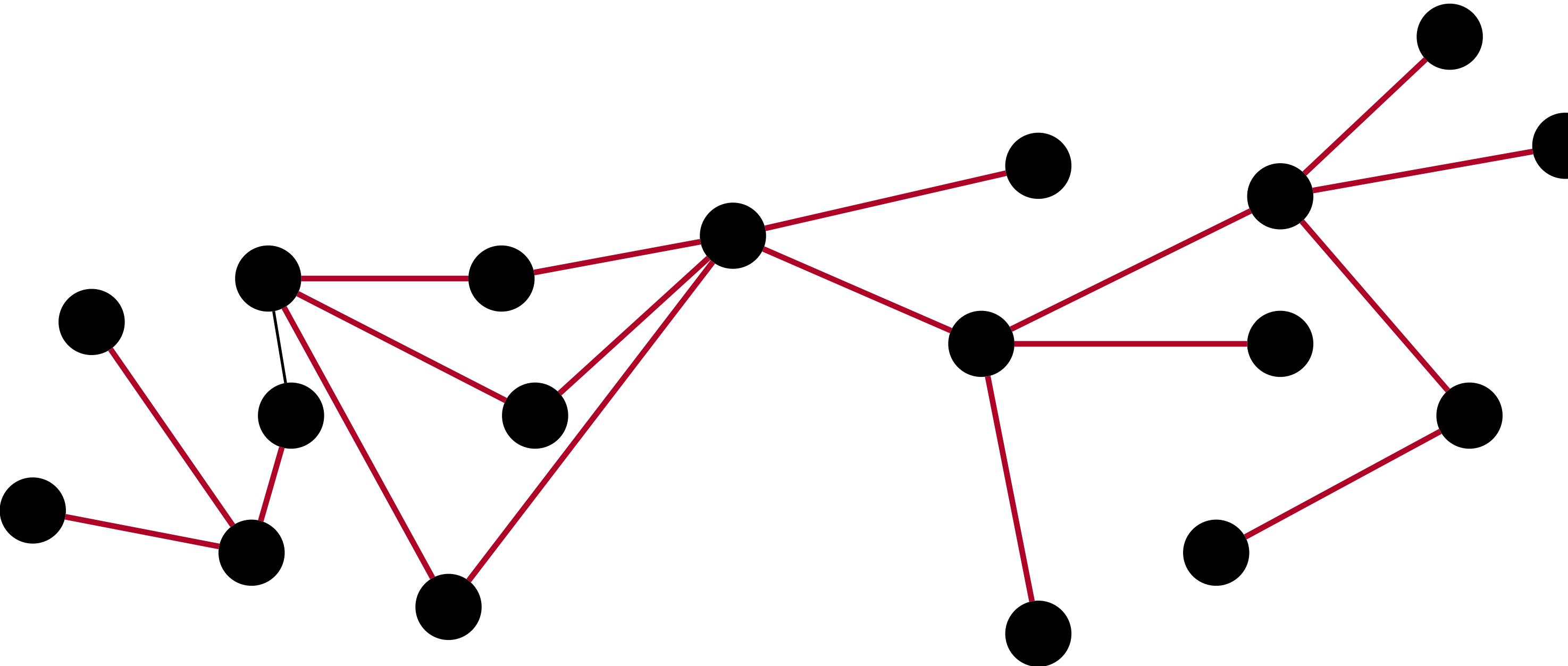
# Sometimes it's about Projection

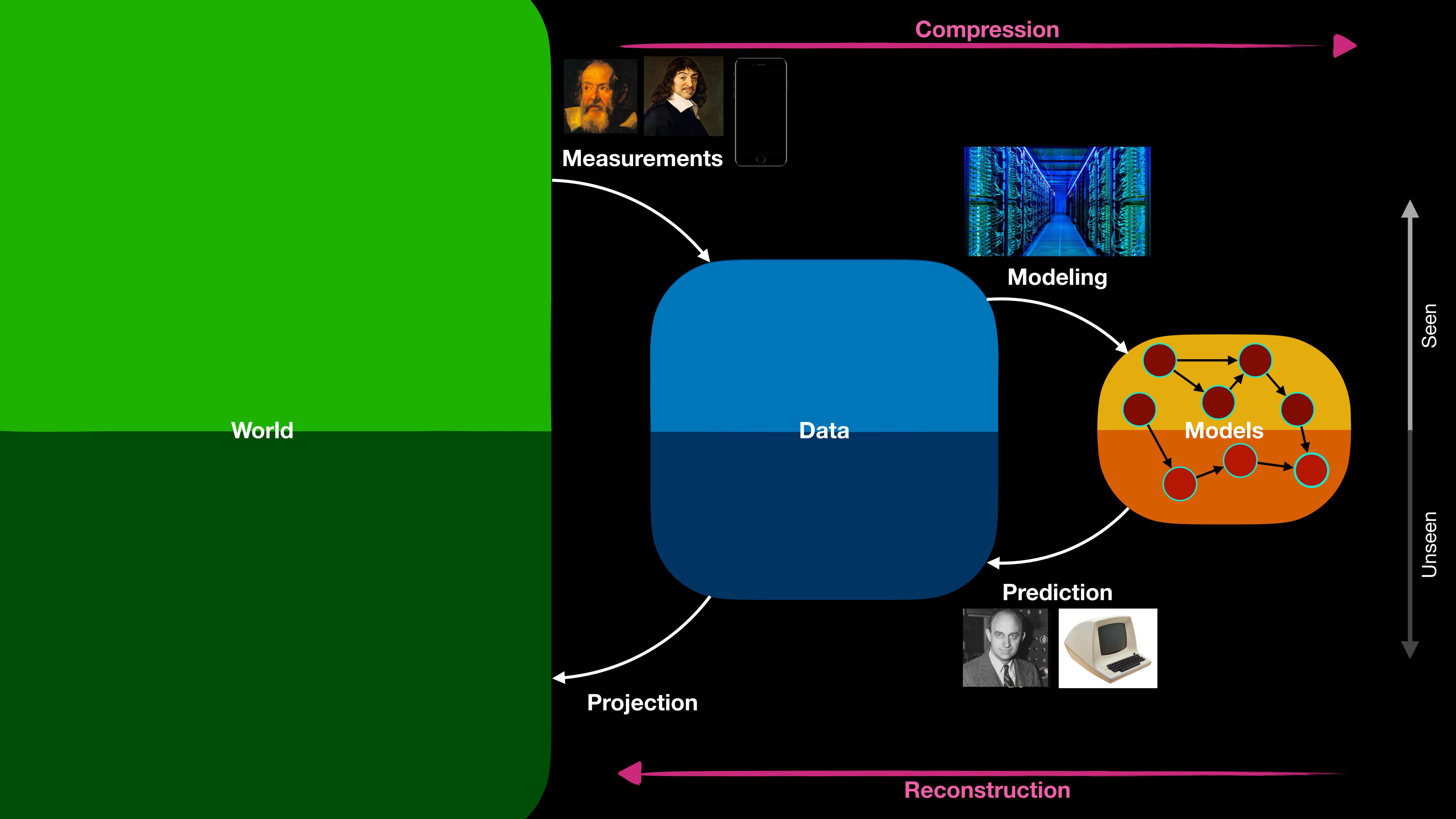


# Sometimes it's about Projection



# Sometimes it's about **Graphs**





# **VI - Course Logistics**

# Course Objectives

- Gain experience in getting computers to **Model the World from Data**
- Master computational and data-driven thinking
- Master the mathematical language of machine learning
- Learn powerful machine learning algorithms
- Use existing machine learning frameworks
- **Have Fun!**

# Course Details

- **Pre-requisites:**
  - MATH 218 or 219 - Linear Algebra
  - MATH 201 - Calculus
  - STAT 230 - Probability and Statistics
  - EECE 230 - Introduction to Programming
- **References:**
  - Stanford's **CS229**: Introduction to Machine Learning Notes
  - **The Elements of Statistical Learning: Data Mining, Inference, and Prediction.**  
*Trevor Hastie, Robert Tibshirani, Jerome Friedman.*

# Course Plan

- Week 1: Introduction, Data analysis
- Week 2: Python/Math recap, Linear Regression
- Week 3: Logistic Regression and Classification
- Week 4: Generative Learning
- Week 5: Kernel Methods
- Week 6: Deep Learning
- Week 7: Generalization and Model Selection
- Week 8-9-10: Unsupervised Learning: PCA, K-Means, GMM,...
- Week 11: Reinforcement Learning
- Week 12-13: Advanced Topics, LLMs, AI Ethics, etc.
- Week 14: Project and Mini-Hackathon

# Course Details

- **Office Hours and Contact:**
  - Bechtel 418: Thursday 2-4pm
  - Email: [jb50@aub.edu.lb](mailto:jb50@aub.edu.lb)
- Lecture Schedule:
  - TTh: 11-12:30 am
  - There will be practical problem solving lab days: **bring your laptops!**
- Getting Assistance:
  - Teaching Assistants: Elie Hachem, Issar Amro
  - You'll get a **Slack** invitation

# Grades

- **Grades Distribution:** (detailed distribution might vary)
  - Homework Assignments (25%)
  - Midterm, Final and Quizzes (35%)
  - Project and Participation (40%)
- **Homework policy:** discuss the homework, help each other understand the material, **BUT** write the solution on your own. Copied assignments will be penalized.
- **Project:** Find a topic, groups of 2 to 3, put code on **GitHub**, make a **product**, poster session.
- See course policy on website:

# Generative AI Policy

- Let's start with a basic question: why are you here?
  - Acquire the confidence to **think on your own and create a better future**
  - Learn **problem solving** across many disciplines
  - Learn how to use **tools** (programming language, etc., and most recently LLMs)
- Given these goals, can you use LLMs in this course?
  - **YES!** You **have** to use them in the future to solve some complex problems or accelerate your work. Treat them as smart friends with a lot of knowledge; and like friends they make mistakes. So, always keep a (very) healthy amount of skepticism in mind.
  - **BUT**, it might make you **dumber** if you use it lazily: For example, if it does all the thinking for you, copy paste its answers without understanding. In this case, you will make it much easier for it to replace you in the future.
  - Your future's at stake and it's your responsibility to make sure that you're learning.

# Tips for effectively using LLMs

- **Learn how to ask good questions:** before consulting an LLM, try to solve and, whenever possible, define the problem on your own. Use LLMs to empower your thinking process, not replace it.
- **Cross-check with reliable sources:** Corroborate LLM-generated information with trusted sources whenever possible. Knowing when to trust LLM content is the same as learning how to trust social media posts. It's critical thinking. It comes down to having a good model of the world (in your head), to know what is plausible, and when you should ask more questions.
- **Learn from it:** if the LLM provides a solution, take the time to understand the steps and rationale behind it. You can effectively learn anything if you ask the right questions, and you're curious enough.