CS496: Introduction to Machine Learning

(Selected Topic in CS)

Course Introduction

Nopadon Juneam

About the Course

- **Course description**:
  - This course provides a broad introduction to the field of Machine Learning (ML).
- **Course objectives:**
  - To teach you basic skills to decide which ML algorithm to use for what problem, code up your own ML algorithm and evaluate and debug it.

Pre-requisites

- Students are expected to have the following background:
  - Knowledge of programming skills to write a program using Python/Numpy.
  - Knowledge of basic Data Structures and Algorithms.
  - Familiarity with Probability Theory and Statistics.
  - Familiarity with Multivariable Calculus and Linear Algebra.

Logistics

- Google classroom: dc4pwox (for class code)
  - Online class alternating physical class are planned until midterm (changes may be made upon the future university's policy).
  - For online class, each lecture video will be about ~1 hr long, and will be posted on Google classroom on the day before the actual class day.
  - Live discussion session for Q&A (about ~0.5 hr long) will be arranged on the class day.
- My office hours: Thursday 10.00-12.00; SC45-772

Course Topics (not in order)

- Supervised Learning Setup
- Nearest Neighbors
- Perceptron
- Estimating Probabilities from data
- Bayes Classifier and Naive Bayes
- Logistic Regression
- Gradient Descent
- Linear Regression
- Support Vector Machine
- Neural Networks
- Deep Learning
- Model Selection
- Etc.

Course Materials (1)

- We will follow the materials from the following courses:
  - (Mostly) Cornell's University's CS4780 Fall 2018 (https://www.cs.cornell.edu/courses/cs4780/2018fa/)
  - (Partially) Stanford University's CS229 Summer 2020 (http://cs229.stanford.edu/syllabus-summer2020.html)
  - (Partially) University of Toronto's CS411 Fall 2017 (https://www.cs.toronto.edu/~jlucas/teaching/csc411/)

Course Materials (2)

- Suggested reading:
  - Kevin Murphy's book "Machine Learning: A Probabilistic Perspective" (https://www.amazon.com/Machine-Learning-Probabilistic-Perspective-Computation/dp/0262018020)
  - CS229 Lecture notes by Andrew Ng (http://cs229.stanford.edu/summer2020/cs229-notes1.pdf)

Course Structure

- 15 weeks
- **Assignments**: 40%(independent)
- **Midterm exam:** 20%
- **Final exam:** 20%
- **Project:** 20%(group of two)

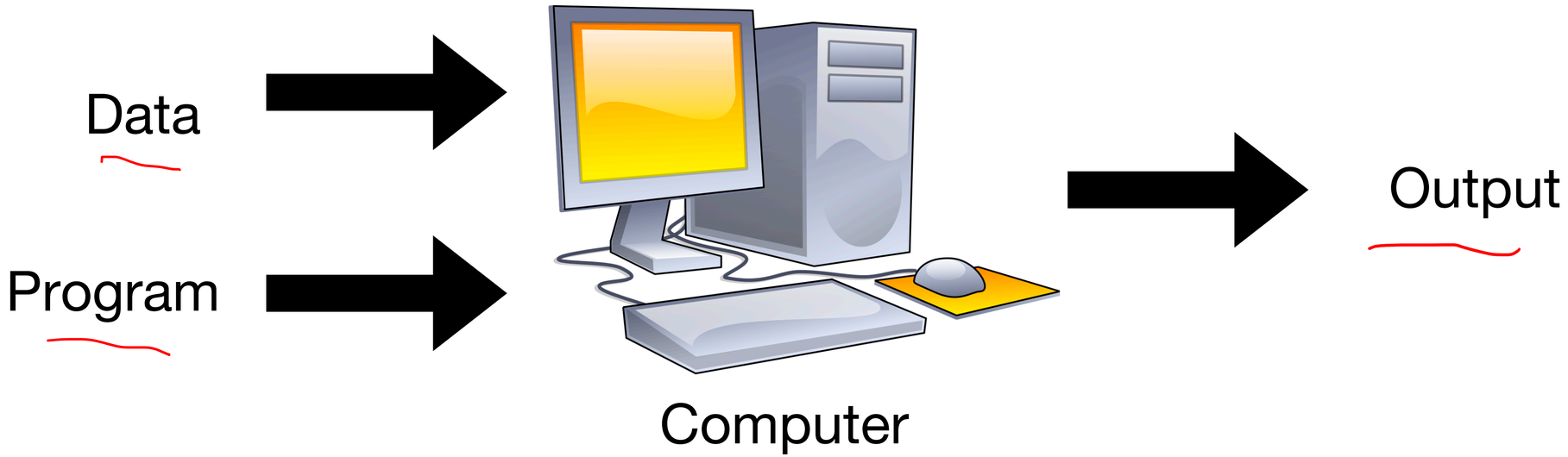
A	Curve-based evaluation
B+	
B	
C+	
C	
D+	
D	
F	< 50%

- ** A minimum of 50% will be needed to be scored to pass the course.

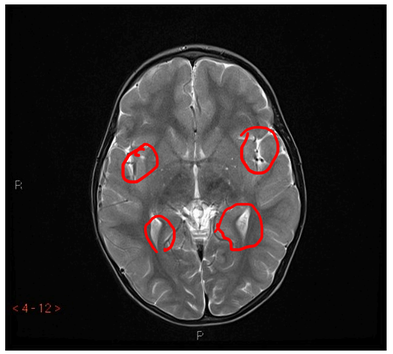
Part I

Machine Learning?

Traditional Computer Science



Problem Type of Concern



Decide whether a patient has Alzheimer given his MRI image.

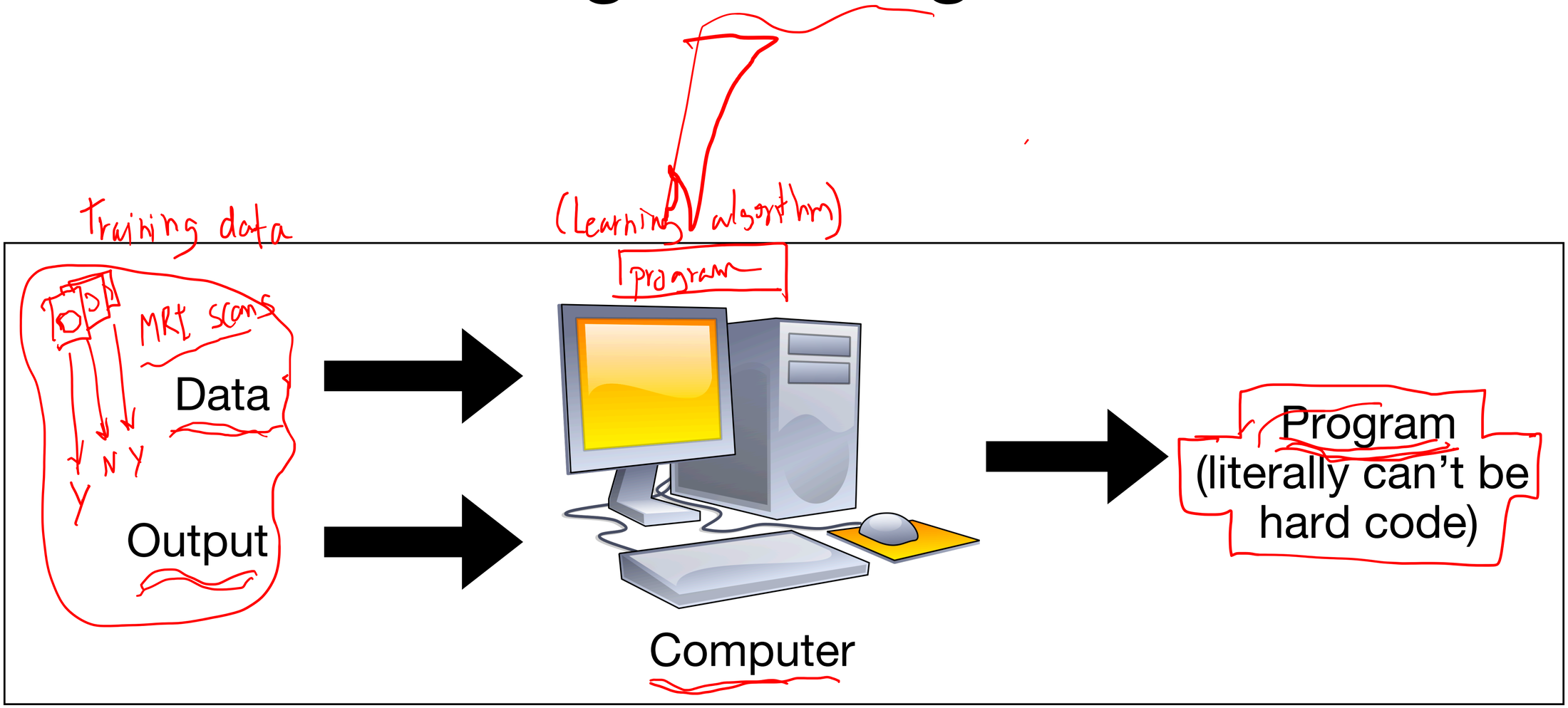
Data (input)

Program?

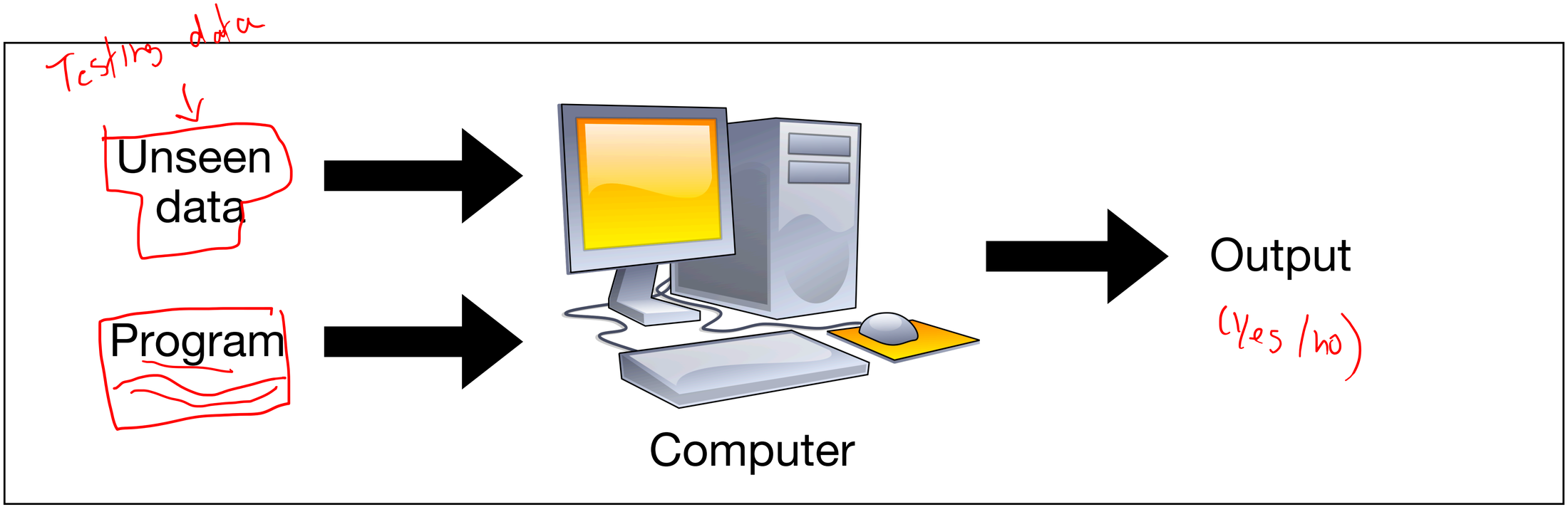
Computer

Output (yes/no)

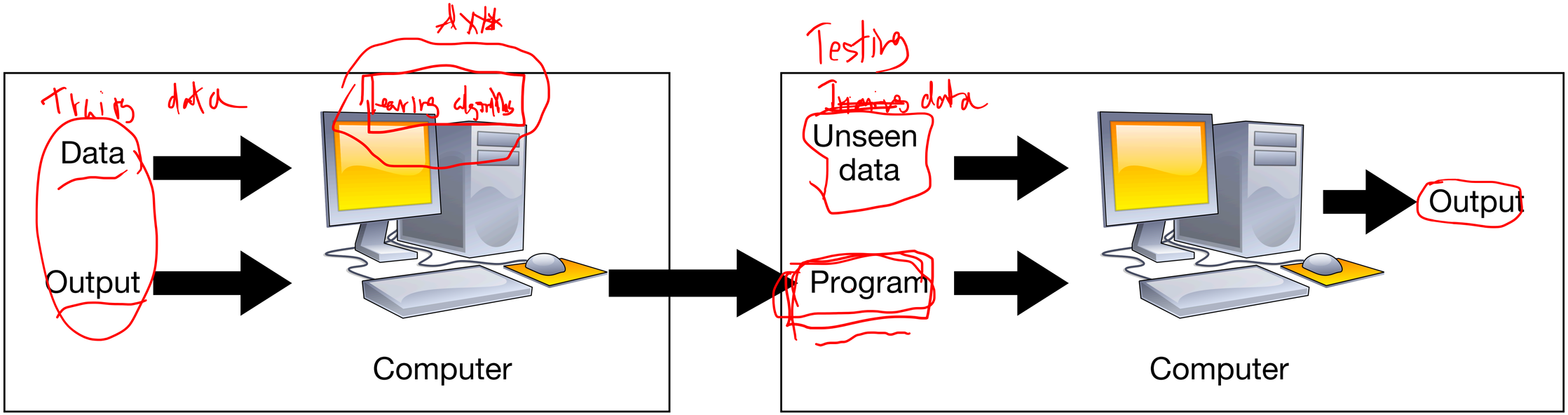
Machine Learning: Training



Machine Learning: Testing



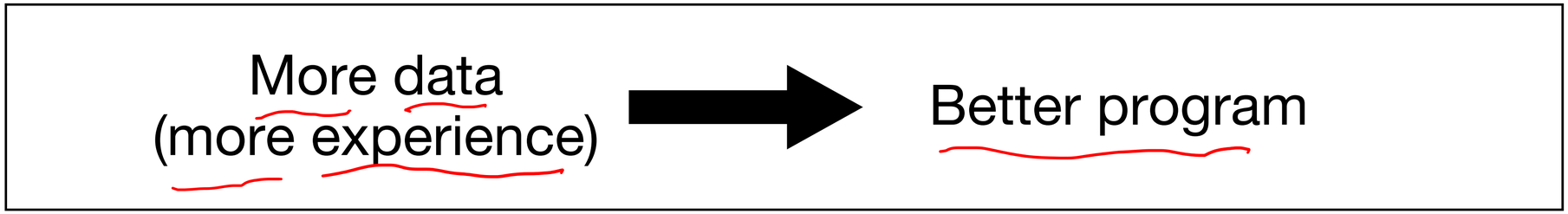
Machine Learning Approach

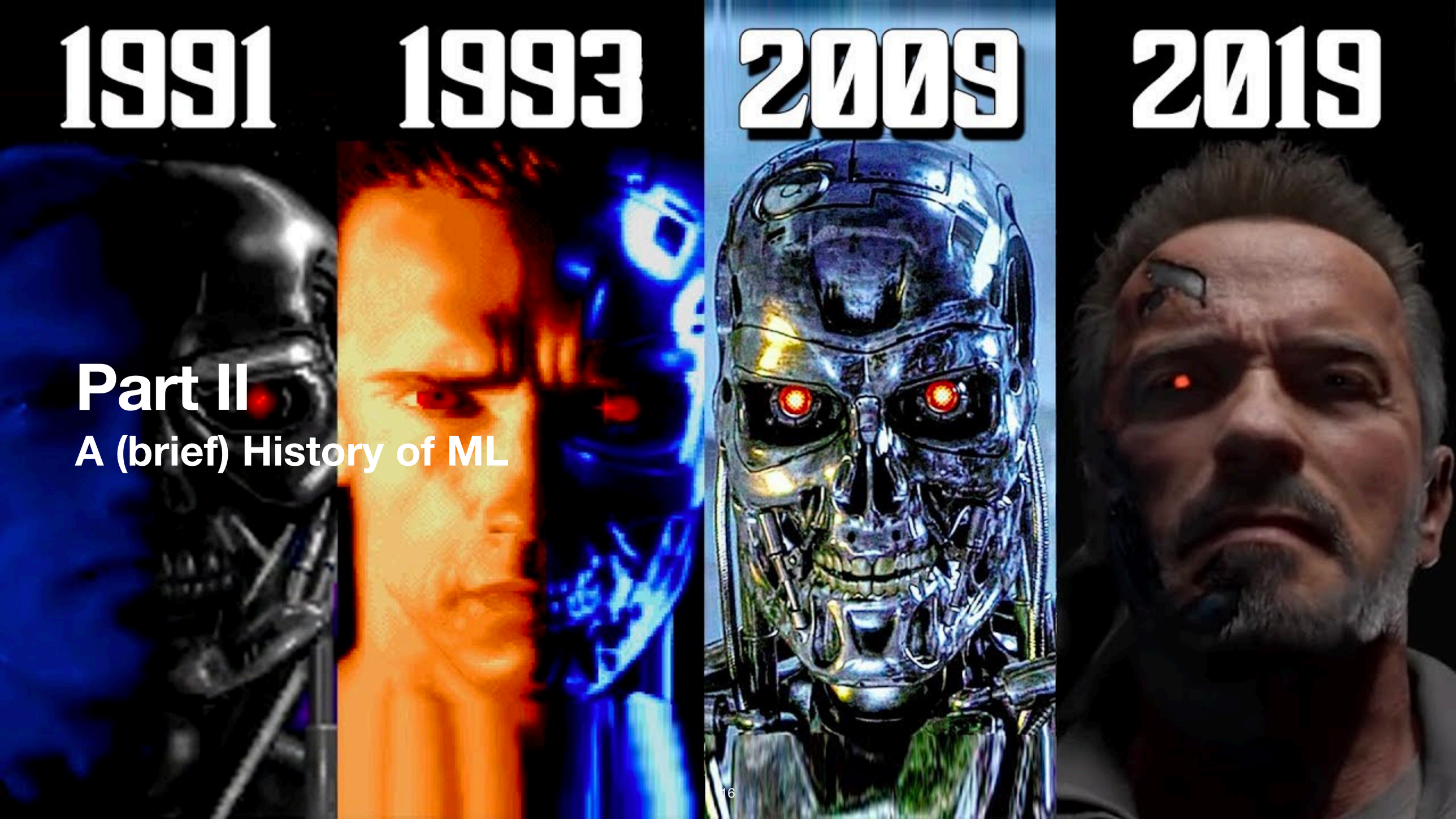


At first, this seems a crazy idea!!

Machine Learning's Definitions

- **Formal:** (Tom Mitchell 1997) A computer program is said to learn from experience *E* with respect to some class of tasks *T* and performance measure *P*, if its performance at tasks in *T*, as measured by *P*, improves with experience *E*.
- **Informal:** Algorithms that improve on some tasks with experience.





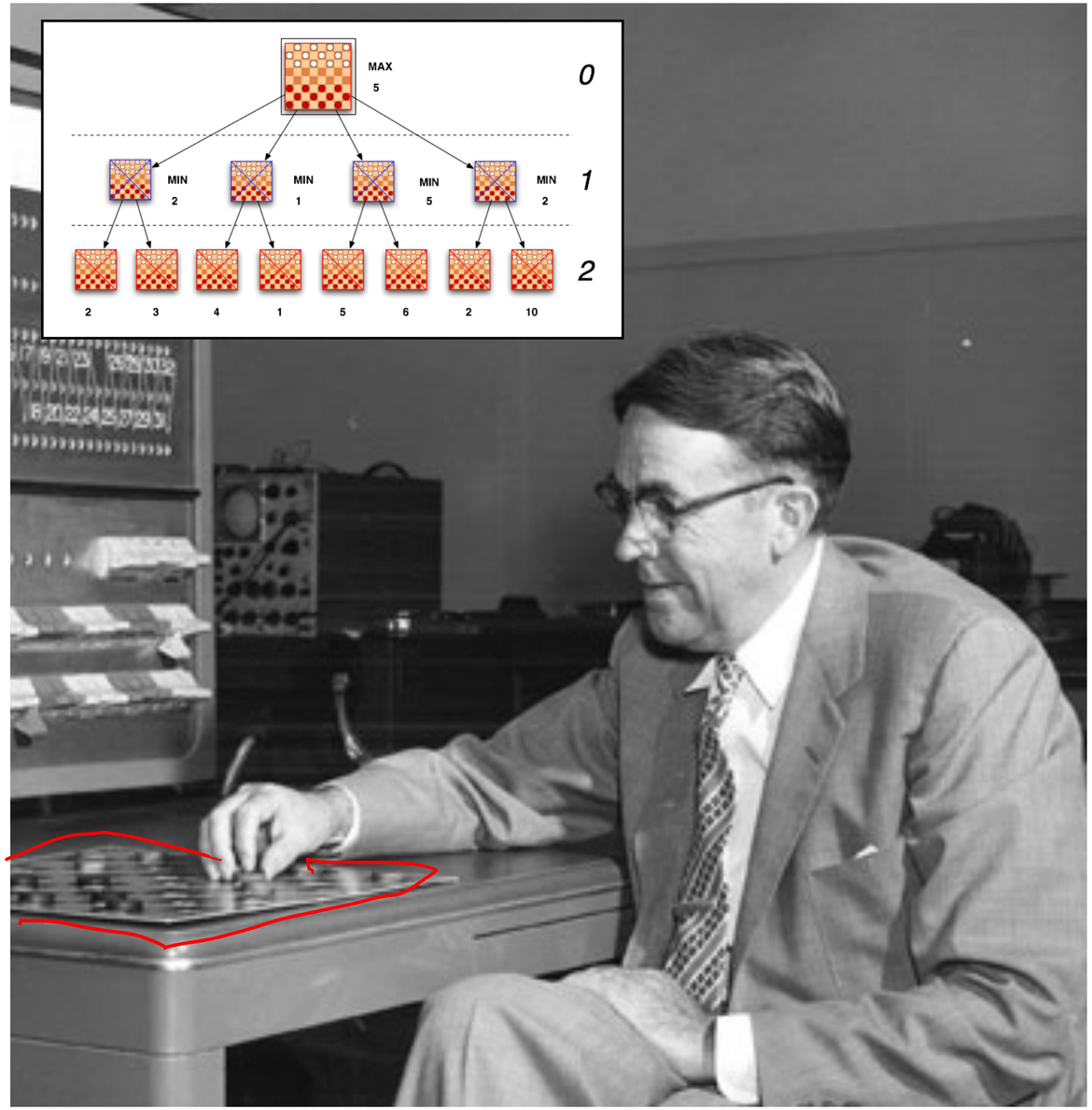
Part II

A (brief) History of ML

Samuel's Checker Player

(1952)

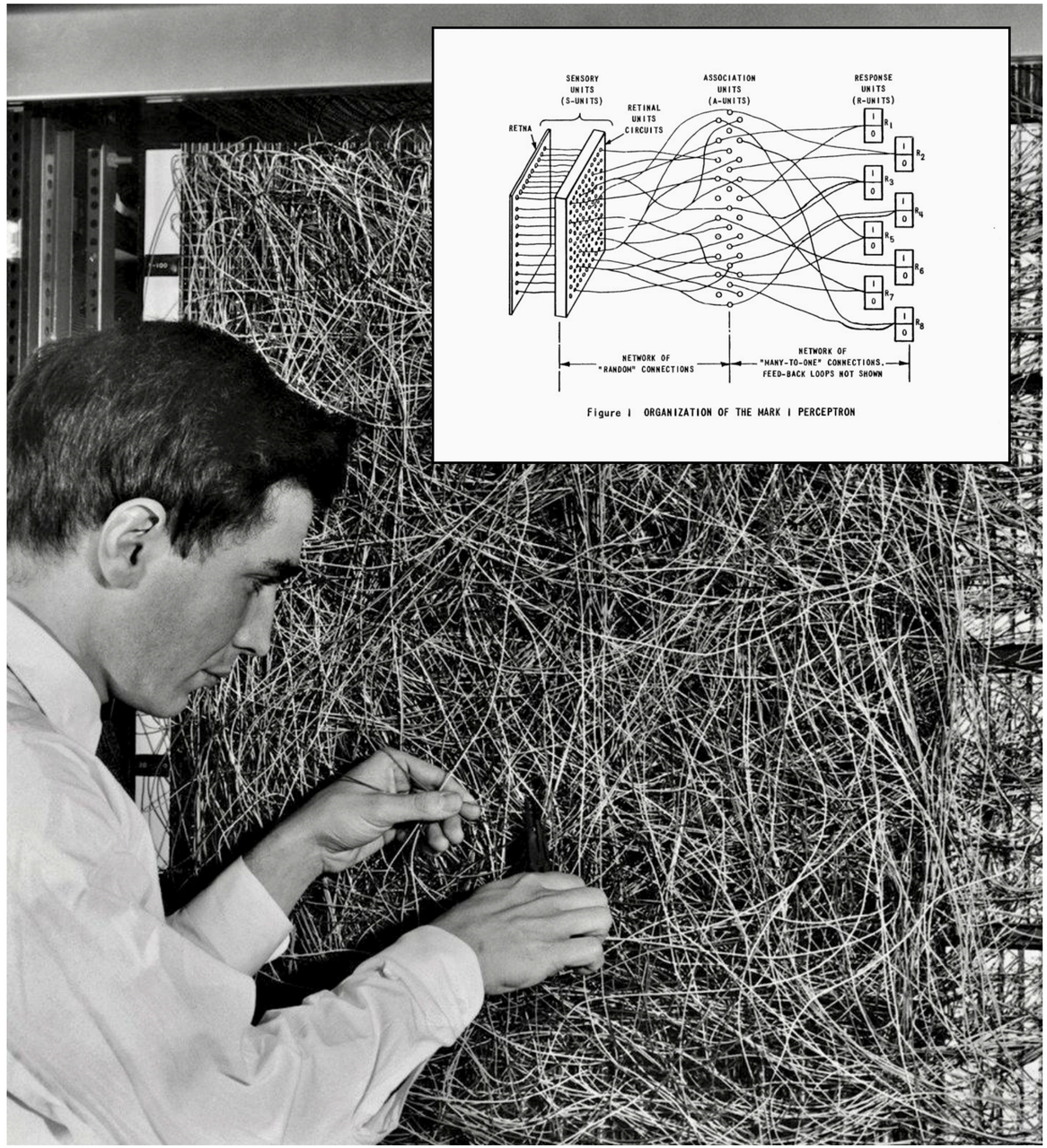
- The first algorithm that learned from experience.
- Basically, Shannon's minimax algorithm (traditional AI).
- Player improved over time.
- Already a solved problem.



Perceptron

By Frank Rosenblatt (1957)

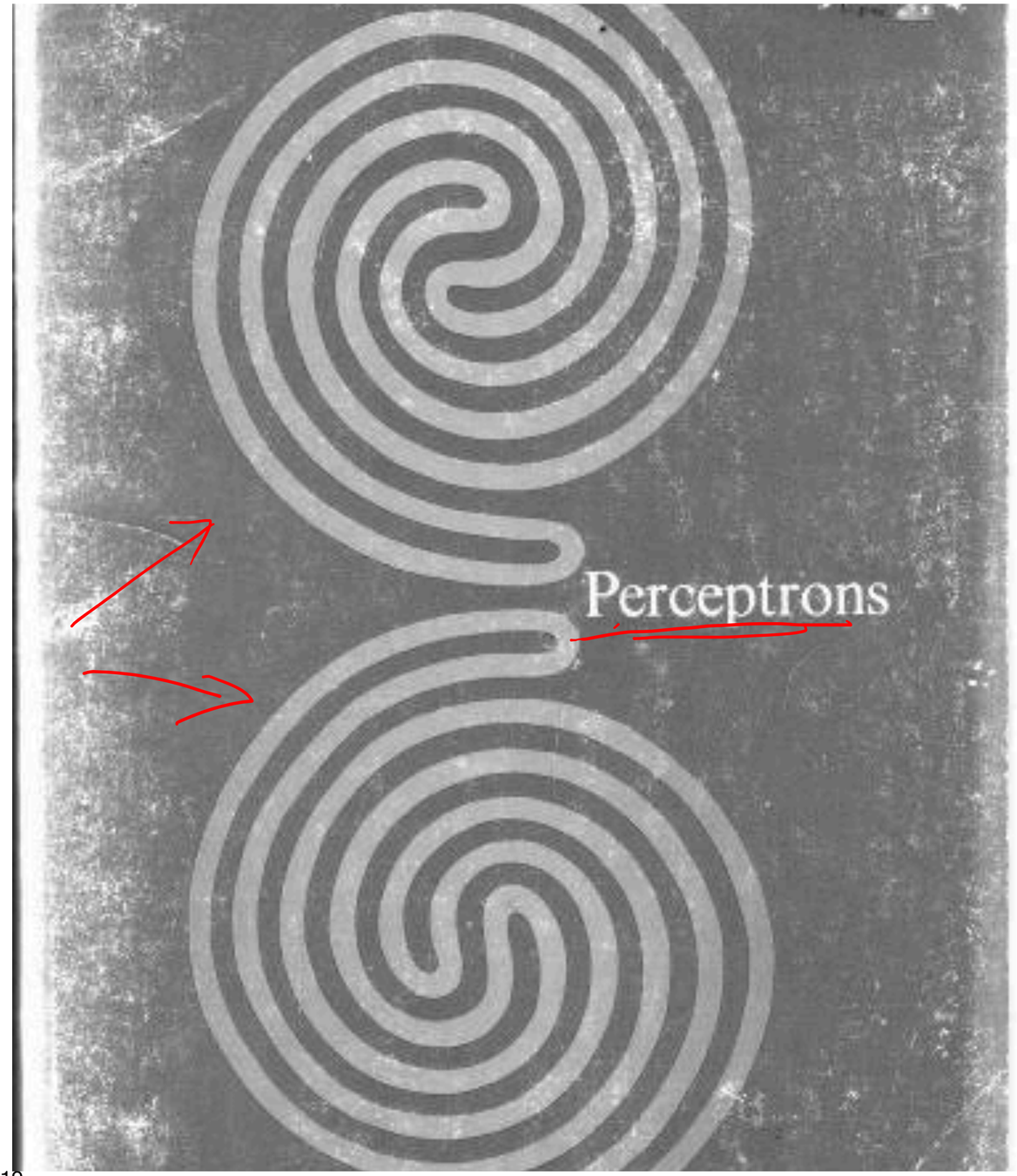
- A learning algorithm used until today (evolved to Neural Networks and Deep Learning).
- Revolutionary at the time.
- Needed computers with high computational power which none existed.
- A huge wave of excitement came after.



AI Winter

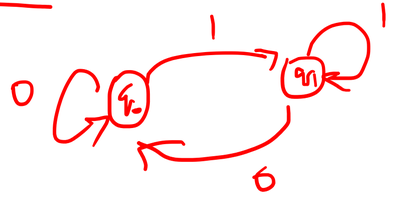
By Minsky & Papert (1969)

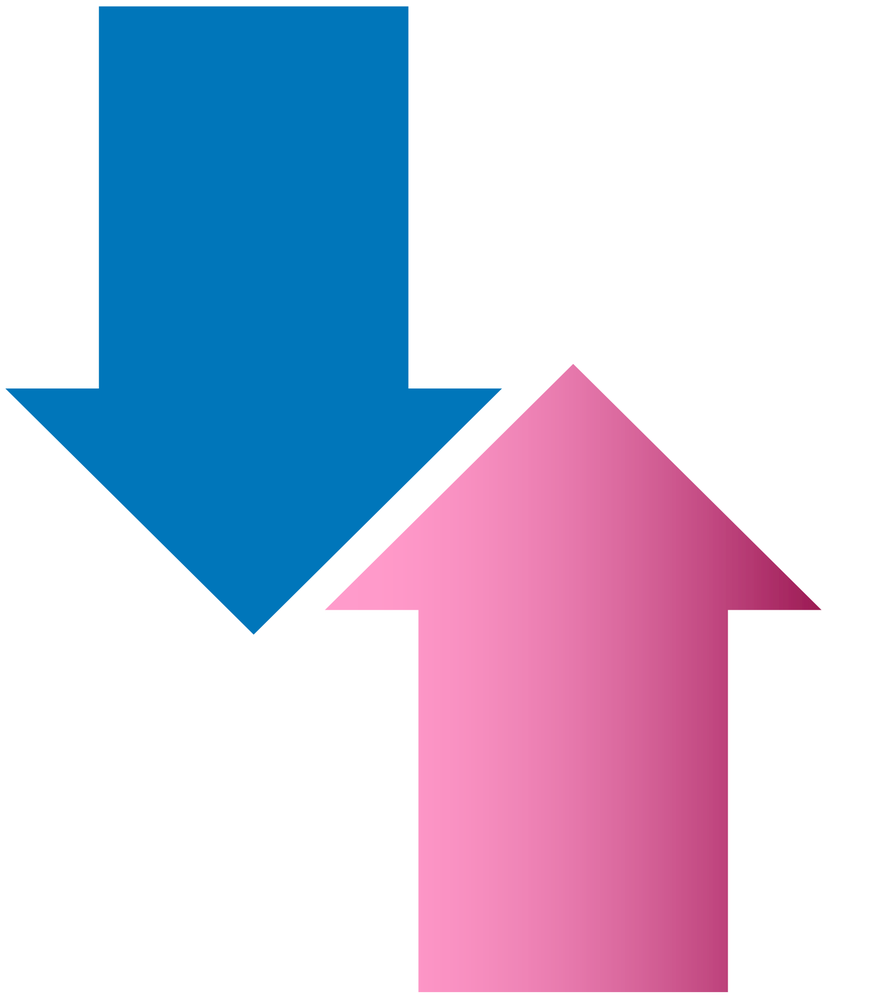
- “Killed” AI paper (Single-layer perceptron can’t do XOR)
- Burst huge expectation bubble
- Caused funding for AI research to collapse for decades



Rebirth as “Machine Learning”

- Originally: A name game to get funding.
- Profound difference:
  - **AI:** Focus on humans.
  - **ML**: Learn something from data.
    - More practical, smaller goals.
    - Based on “Statistics, Optimization, not Logics.”

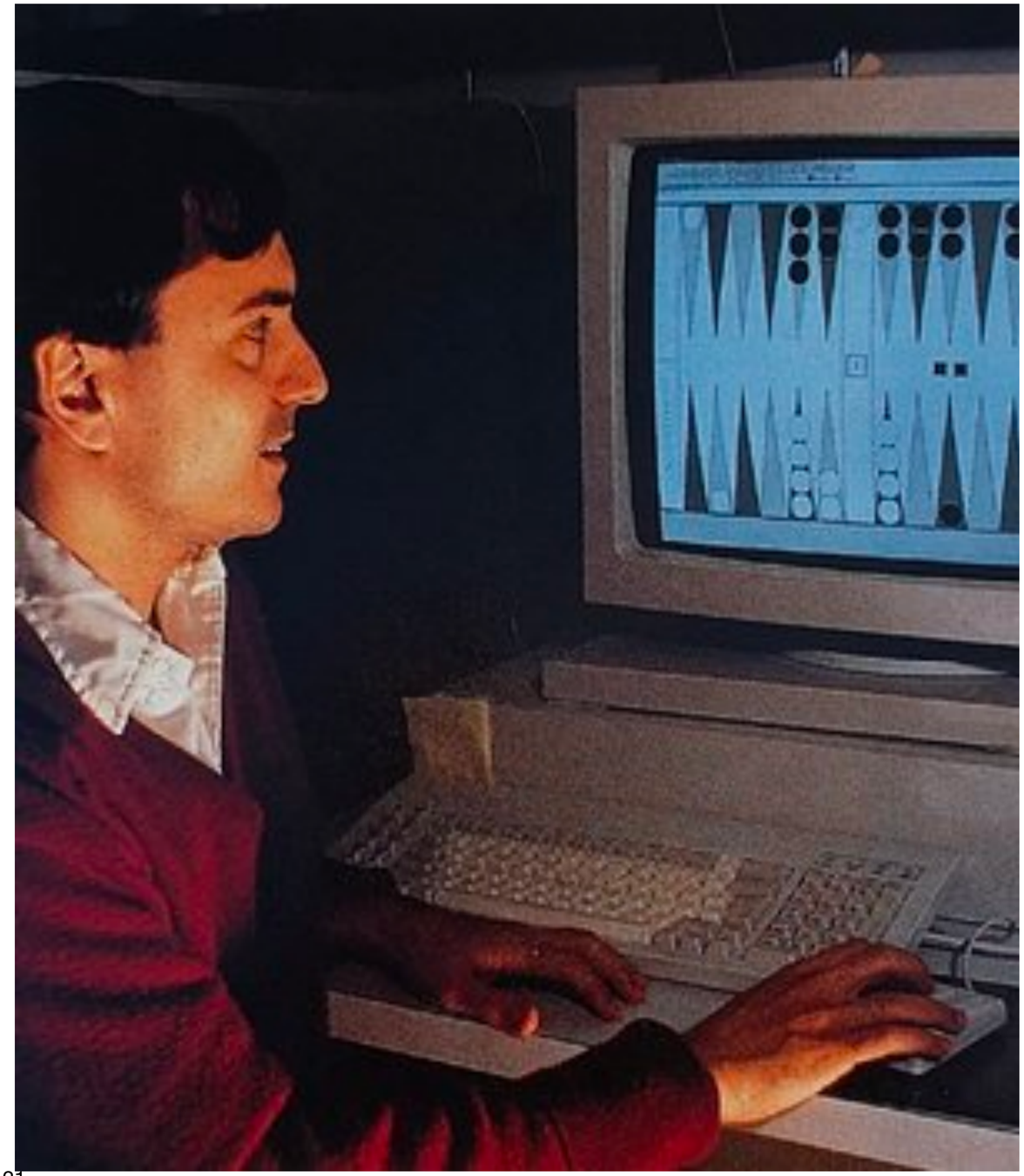




TD-Gammon

By Gerald Tesauro (1992)

- IBM’s Backgammon player
- Taught a neural network to play Backgammon against itself 100K+ games and beat world champion.
- Revealed advances in the theory of Backgammon play.



Deep Blue

By IBM (1997)

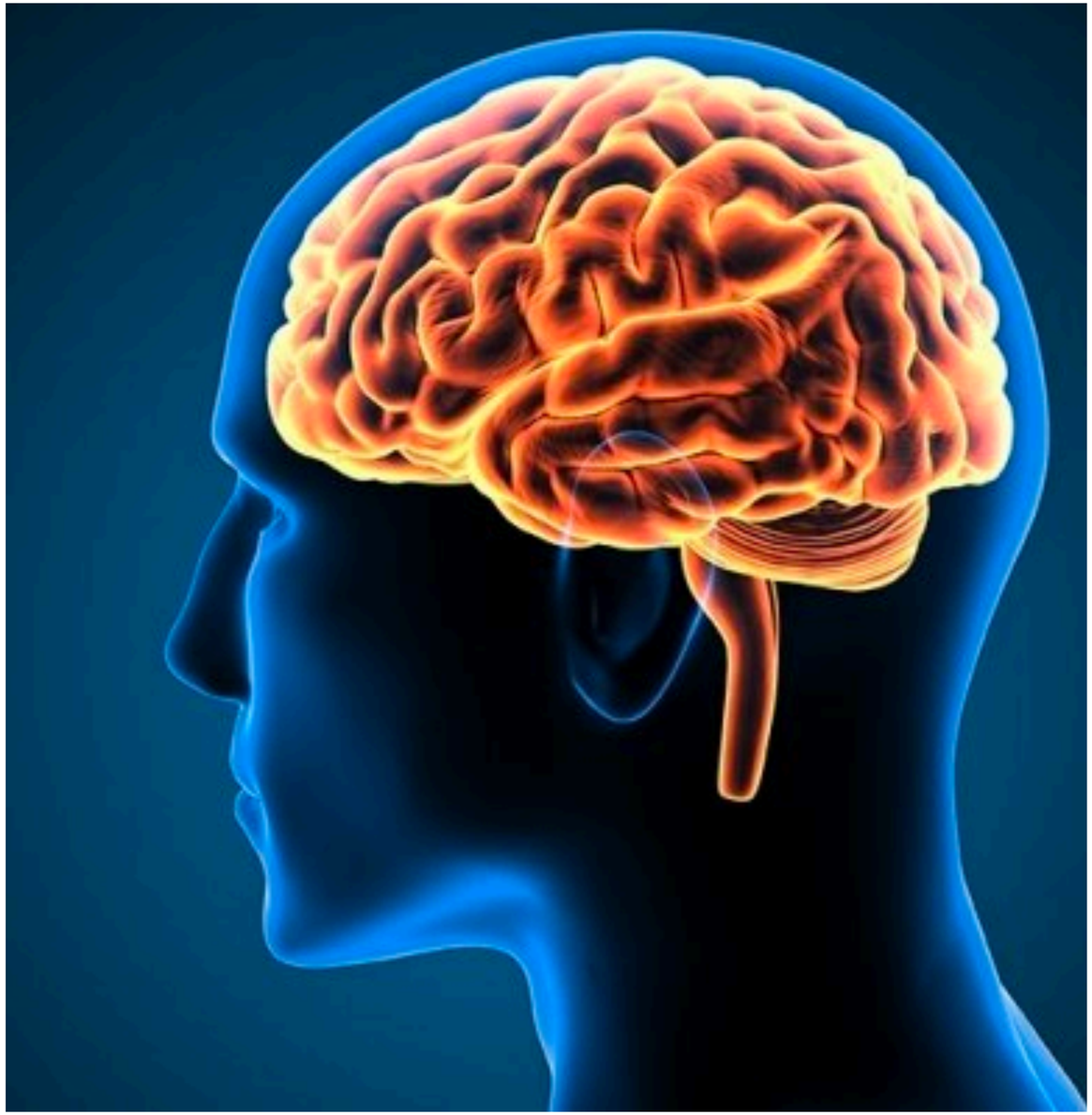
- Won against Garry Kasparov (Russian's world champion in chess).

Today

- ML is everywhere:
  - Web search (personalized search engine)
  - Spam Filter (filter emails you don’t want)
  - Autonomous cars (soon)
  - Etc.

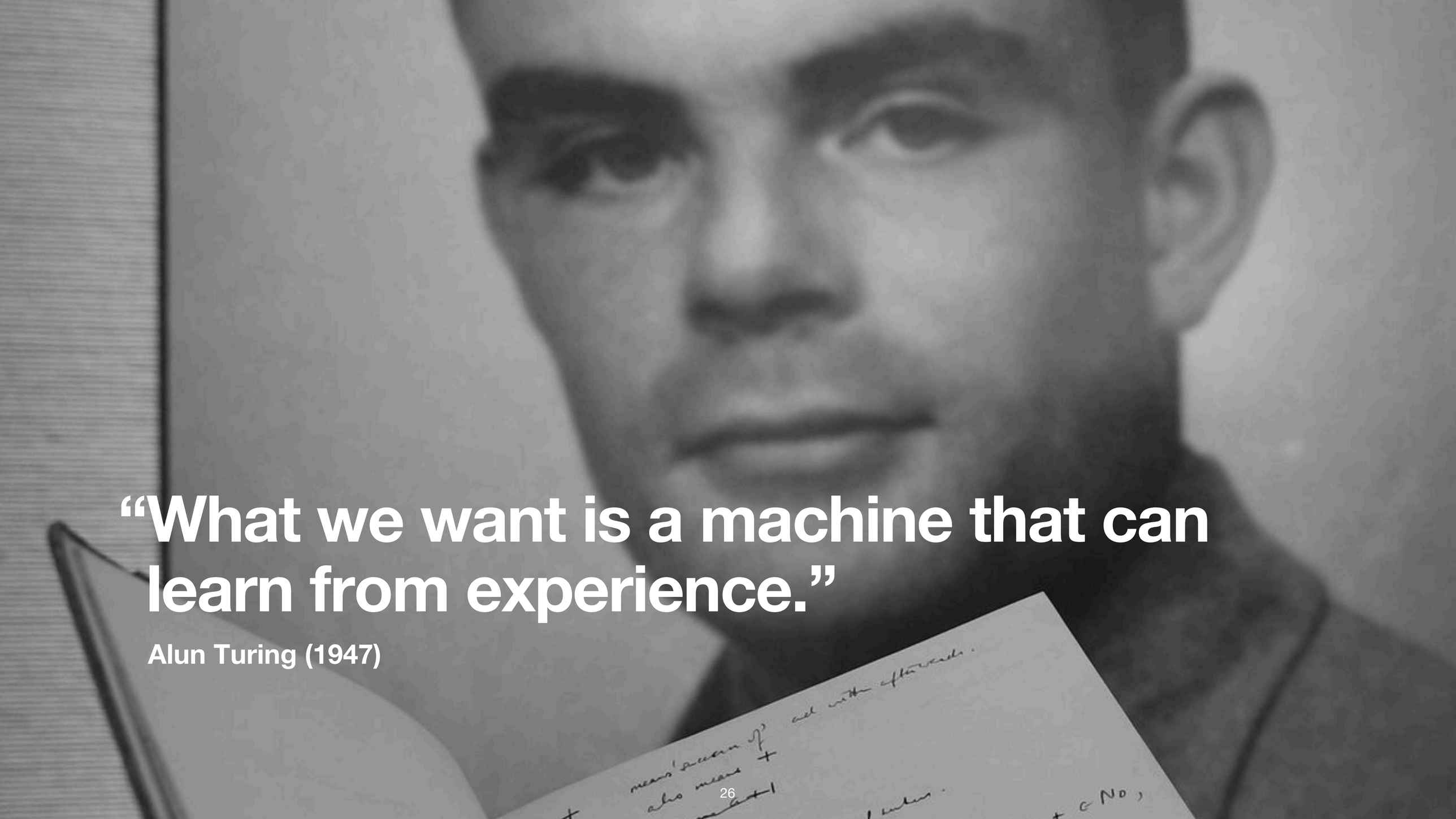
When will it stop?

- Well, human brain is one big ML. (We can still do a lot better !!)
- Designing new ML algorithms is very hard. Only very few people can design them.
- But many people can use them.



Types of Machine Learning

- **Supervised learning:** Given labeled examples, find the right prediction of an unlabeled example.
  - E.g. Given annotated images, learn to detect faces.
- **Unsupervised learning:** Given data, try to discover similar patterns, structure, sub-spaces.
  - E.g. Automatically group news articles by topics.
- **Reinforcement learning:** Try to learn from delayed feedback.
  - E.g. UAV learns to fly.



“What we want is a machine that can learn from experience.”

Alun Turing (1947)