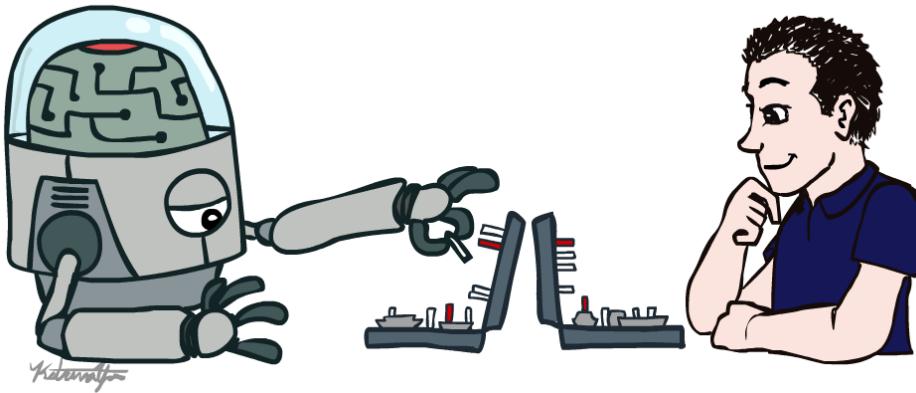


# Introduction to Artificial Intelligence

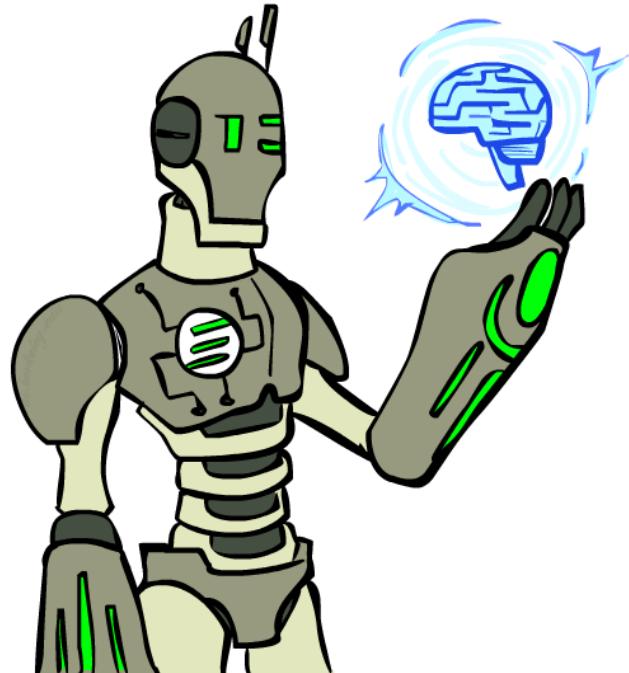
## Introduction



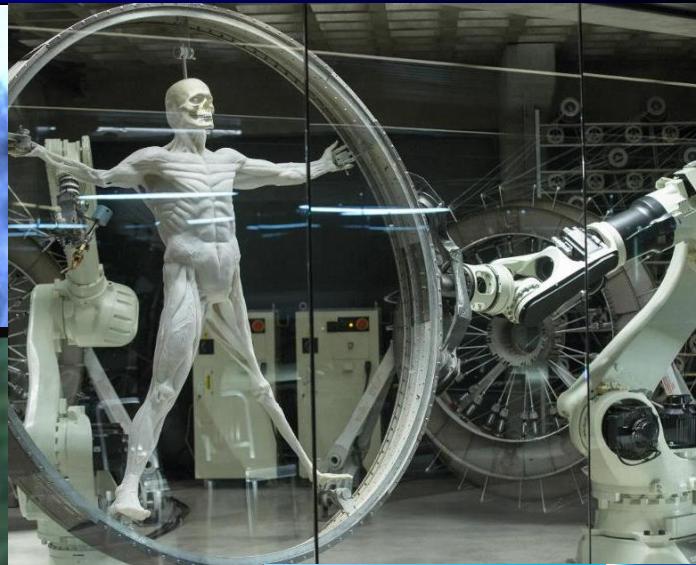
# Second part of Today

---

- What is artificial intelligence?
- Where are we and how did we get here?
- What is this course ?



# Sci-Fi AI?



# Real AI

≡ Google Translate

Text Documents

DETECT LANGUAGE CHINESE ENGLISH SPANISH ↗ CHINESE (TRADITIONAL) ENGLISH FRENCH ↘

how did we start this conversation

Our conversation began when you asked to tell you about him, and I provided some large language model trained by OpenAI questions and providing information on a initiate conversations, and I only respond to human, and I do not have the ability to think information based on the text that I have

What did we speak about after that?

After you asked me about Post Malone, you mentioned "American Heartland." I provided some information that refers to the central part of the United States with its unique industries and conservative values. I do not have the ability to think information based on the text that I have

The image is a composite of several different screens. On the left, there's a map showing the locations of La Val's Pizza and Northside Cafe. Next to it is a screenshot of the Google Translate app interface, showing a conversation between a user and a large language model. The user asks how the conversation started, and the model responds by introducing itself as a large language model trained by OpenAI. The user then asks what they spoke about after that, and the model responds by mentioning "American Heartland". On the right, there's a photograph of a crowded street where a facial recognition system has detected numerous people's faces, each with a unique ID number displayed above it. The IDs range from 11845 to 1924.

**TUG**  
CAUTION  
MAY CONTAIN  
CHEMOTHERAPY DRUG

CAUTION  
MAY CONTAIN  
CHEMOTHERAPY DRUG



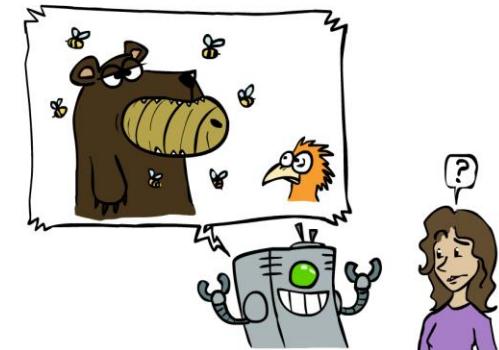
A black BigDog robot is walking through a forest. It is a quadruped robot with a dark, textured body and a light-colored head. It is moving across a path covered in fallen brown leaves. The background consists of tall, thin trees with green and yellow foliage.

Boston Dynamics



# Unintentionally Funny Stories

- One day Joe Bear was hungry. He asked his friend Irving Bird where some honey was. Irving told him there was a beehive in the oak tree. Joe walked to the oak tree. He ate the beehive.  
The End.
- Once upon a time there was a dishonest fox and a vain crow. One day the crow was sitting in his tree, holding a piece of cheese in his mouth. He noticed that he was holding the piece of cheese. He became hungry, and swallowed the cheese. The fox walked over to the crow. The End.



# AI in the News

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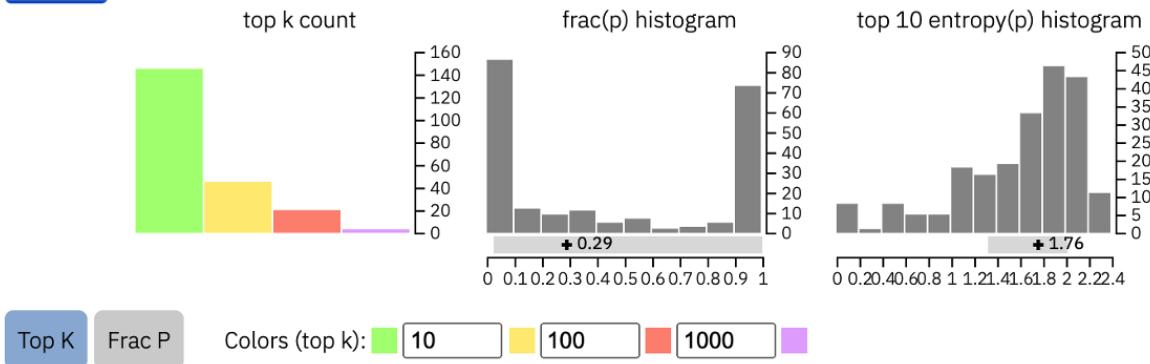
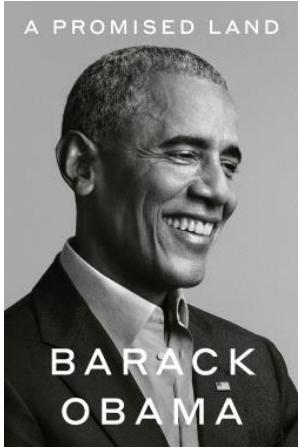
Perhaps you've heard that there is an exciting new Barack Obama book that everyone's talking about! I'm not talking about *A Promised Land*, the 751-page memoir which Obama spent four years writing.

No, I'm talking about *Barack Obama Book*, a 61-page tome by an author named "University Press." Why is *Barack Obama Book* selling so well? Thanks to sponsored listings and canny search engine optimization, the book appears above Barack Obama's actual memoir if you search Amazon for—you guessed it—"barack obama book."

What is *Barack Obama Book*? It's not a book, exactly. It's an SEO ploy by a shadowy company that has scores of \$2.99 knockoffs ready to be downloaded, from quickie biographies of au courant figures like Obama, Harris, and Dolly Parton, to obvious bestseller ripoffs like *Caste: A Brief History* and *Ready Player 3, 2, 1: A Brief History* (?).

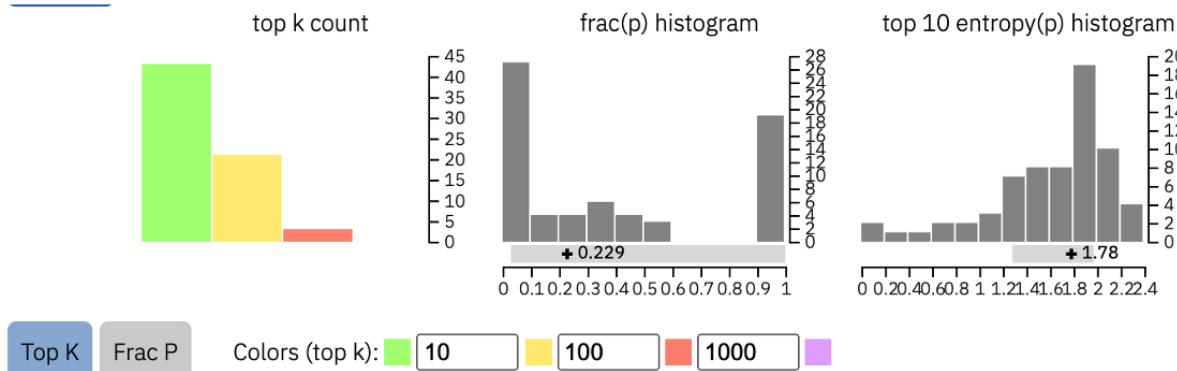
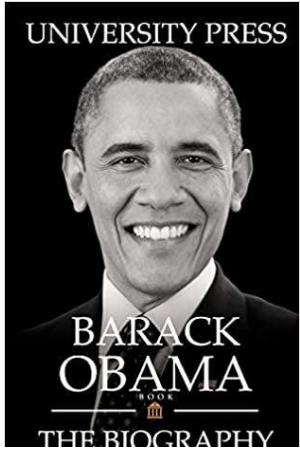
I don't think *Barack Obama Book* was written by a human being, but I do think the A.I. that excreted it made some decent points about Barack Obama.

# AI in the News



Based on what I'd heard, I decided we had enough information to begin developing options for an attack on the compound. While the CIA team continued to work on identifying the Pacer, I asked Tom Donlan and John Brennan to explore what a raid would look like. The need for secrecy added to the challenge; if even the slightest hint of our lead on bin Laden leaked, we knew our opportunity would be lost. As a result, only a handful of people across the entire federal government were read into the planning phase of the operation. We had one other constraint: Whatever option we chose could not involve the Pakistanis. Although Pakistan's government cooperated with us on a host of counterterrorism operations and provided a vital supply path for our forces in Afghanistan, it was an open secret that certain elements inside the country's military, and especially its intelligence services, maintained links to the Taliban and perhaps even to Al-Qaeda, sometimes using them as strategic assets to ensure that the Afghan government remained weak and unable to align itself with Pakistan's number one rival, India.

# AI in the News



One of the most notable events that occurred during his second term was the killing of Osama bin Laden by US Naval personnel. This helped boost Obama's popularity and brought people together within the nation, but it had detrimental repercussions with other nations, particularly Pakistan and its neighbors. The strike had been authorized without consulting the nation where bin Laden lived.

<https://slate.com/culture/2020/11/what-is-barack-obama-book-university-press-amazon.html>

# AI in the News



Elon Musk

@elonmusk

...

Tesla Full Self-Driving Beta is now available to anyone in North America who requests it from the car screen, assuming you have bought this option.

Congrats to Tesla Autopilot/AI team on achieving a major milestone!

11:34 PM · Nov 23, 2022

12.9K Retweets

2,651 Quote Tweets

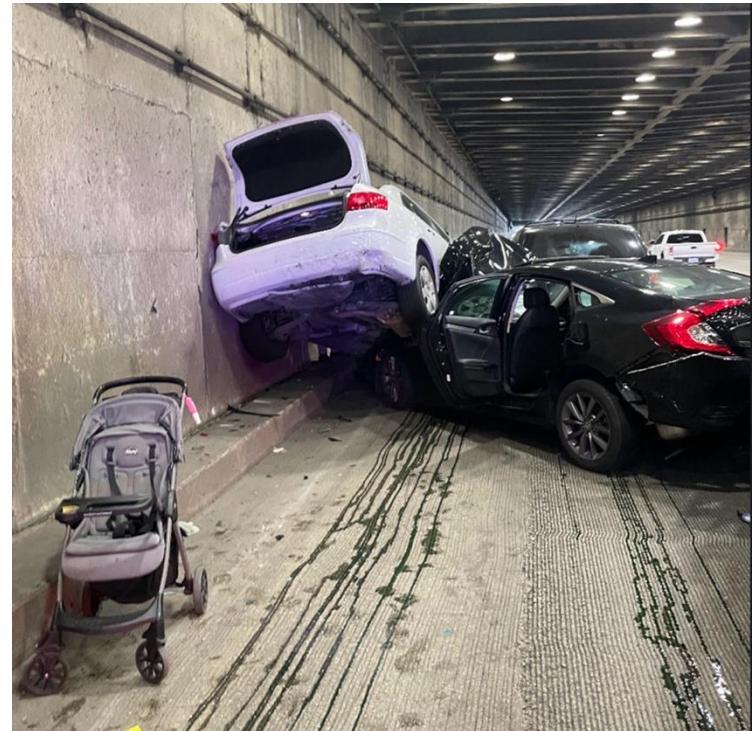
174.1K Likes



# AI in the News

Highway surveillance footage from **November 24** shows a Tesla Model S vehicle changing lanes and then abruptly braking in the far-left lane of the San Francisco Bay Bridge, resulting in an eight-vehicle crash.

As traditional car manufacturers enter the electric vehicle market, Tesla is increasingly under pressure to differentiate itself. Last year, Musk said that “Full Self-Driving” was an “essential” feature for Tesla to develop, going as far as saying, “It’s really the difference between Tesla being worth a lot of money or worth basically zero.”



# AI in the News

TECH • ARTIFICIAL INTELLIGENCE

## United Kingdom Plans \$1.3 Billion Intelligence Push

France to spend \$1.8 billion on compete with U.S., China

EU wants to invest £18b development

## China's Got a Huge Artificial Intelligence Plan

'Whoever leads in AI will rule the world': Putin to Russian children on Knowledge Day

Published time: 1 Sep, 2017 14:08

Edited time: 1 Sep, 2017 14:40



# AI in the News

TECNOLOGIA | VENERDÌ 17 FEBBRAIO 2023

## Il nuovo chatbot di Microsoft sta dicendo cose stranissime agli utenti

Ai giornalisti che l'hanno messo alla prova ha risposto di sentirsi intrappolato e di amarli, oppure ha provato a ingannarli



Vai al prossimo articolo →



Un errore di Bard è già costato caro a Google

(New York Times/ Instagram)

▲ Inizio febbraio Microsoft ha aperto a un numero limitato di utenti la possibilità di

[https://www.ilpost.it/2023/02/17/chatbot-microsoft-test/?utm\\_medium=social&utm\\_source=facebook&utm\\_campaign=lancio](https://www.ilpost.it/2023/02/17/chatbot-microsoft-test/?utm_medium=social&utm_source=facebook&utm_campaign=lancio)

# What is AI?

---

- For thousands of years, we have tried to understand how we **think** and **act**.
- AI is concerned with not just understanding but also building **intelligent** entities
- What is intelligence?  
Fidelity to **human** performance *or* **rationality**?  
Internal **thought** processes *or* external **behaviour**?

# What is AI?

---

The science of making machines that:

# A rational-agent approach

---

- An **agent** is just something that acts
- "agent" comes from the Latin *agere*, to do
- A **rational agent** is one that acts so as to achieve the best outcome or, when there is uncertainty, the best expected outcome.

*AI has focused on the study and construction  
of agents that **do the right thing***

# Rational Decisions

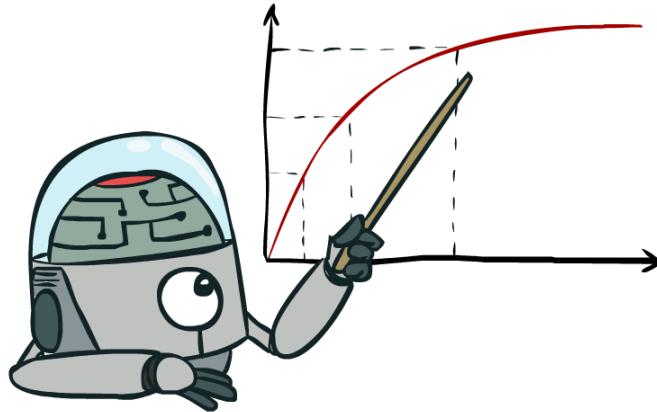
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- We'll use the term **rational** in a very specific, technical way:
  - Rational: maximally achieving pre-defined goals
  - Rationality only concerns what decisions are made (not the thought process behind them)
  - Goals are expressed in terms of the **utility** of outcomes
  - Being rational means **maximizing your expected utility**

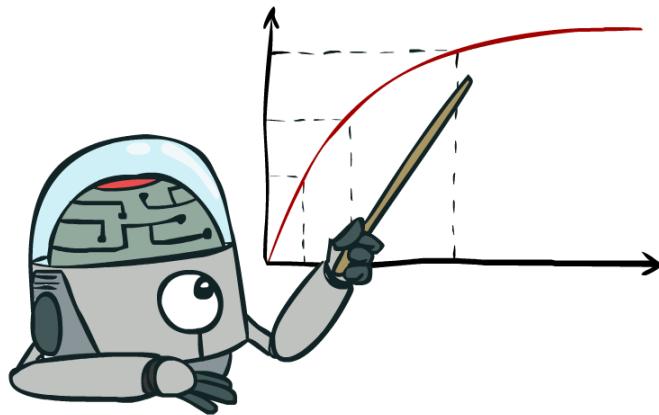
A better title for this course would be:

**Computational Rationality**

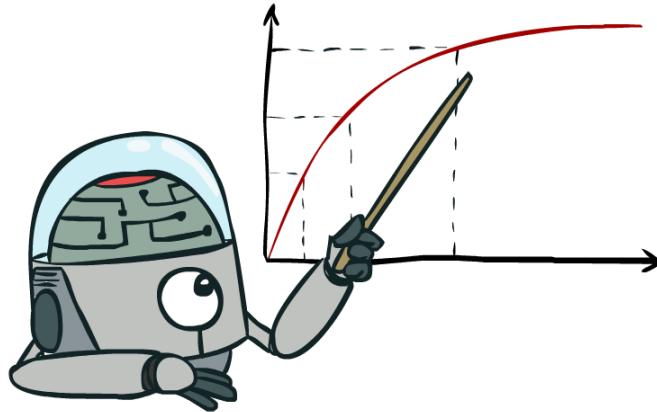
# Maximize Your Expected Utility



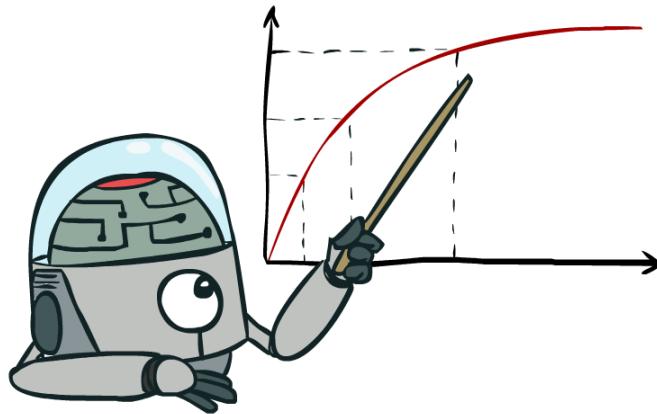
# Maximize Your Expected Utility



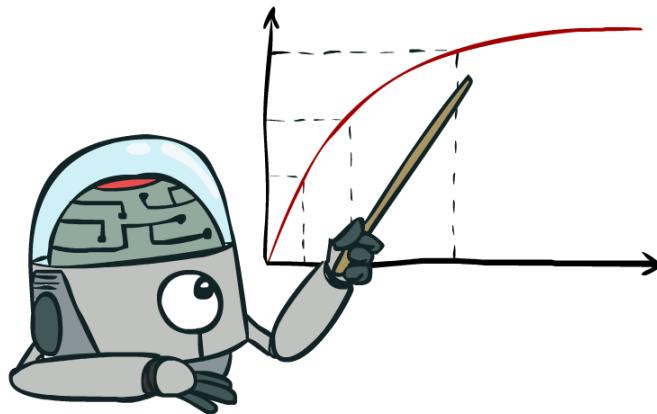
# Maximize Your Expected Utility



# Maximize Your Expected Utility



# Maximize Your Expected Utility



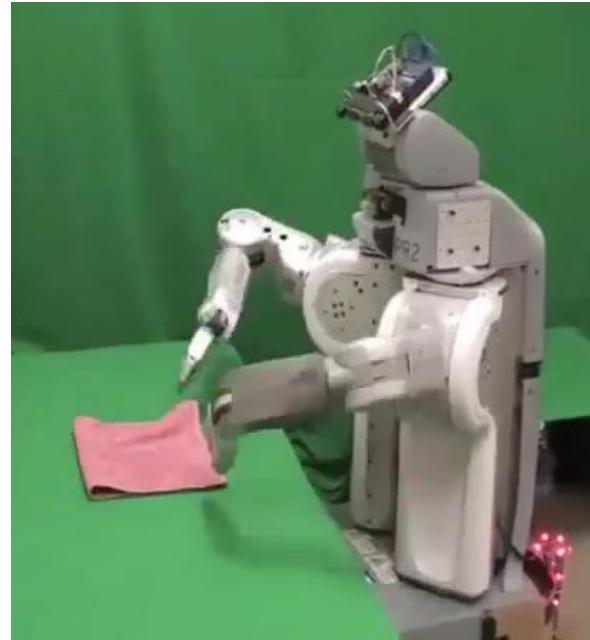
# Utility?

---

Clear utility function



Not so clear utility function

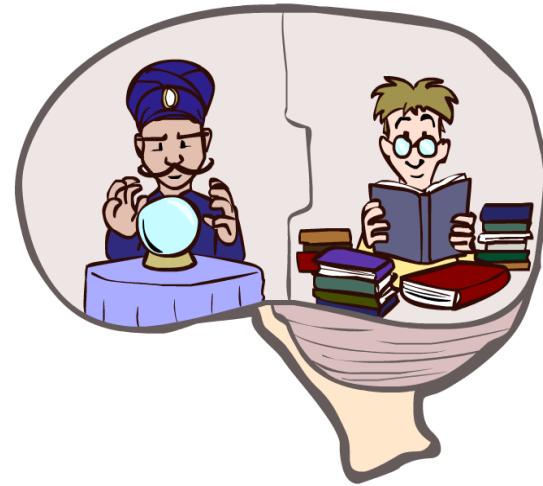




# What About the Brain?

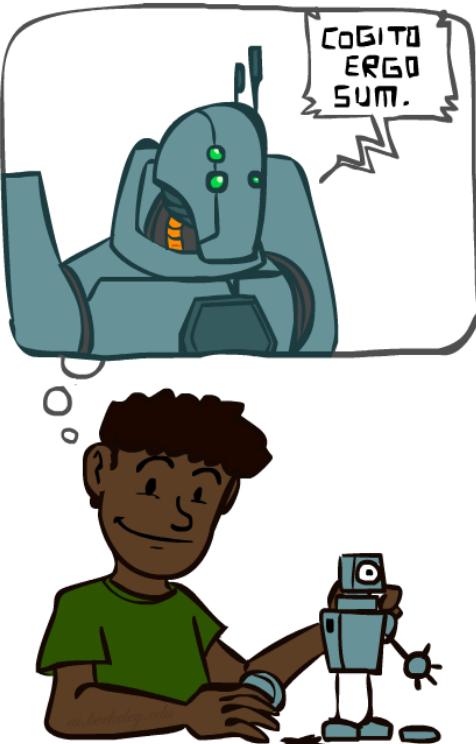
---

- Brains (human minds) are very good at making rational decisions, but not perfect
- Brains aren't as modular as software, so hard to reverse engineer!
- "Brains are to intelligence as wings are to flight"
- Lessons learned from the brain: memory (data) and simulation (computation) are key to decision making



# A (Short) History of AI

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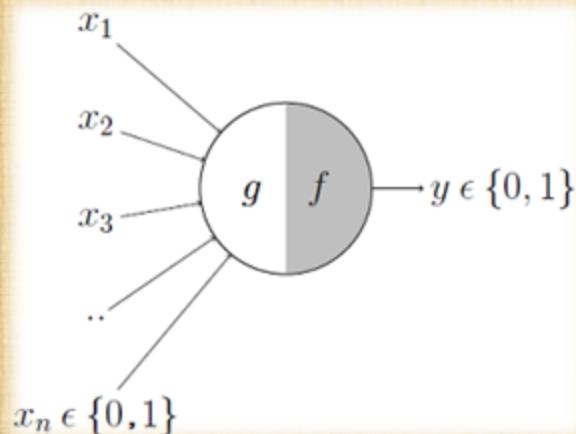


# A short prehistory of AI

- Prehistory:
  - **Philosophy** (reasoning, planning, learning, science, automation)
  - Aristotle: For if every instrument could accomplish its own work, obeying or anticipating the will of others . . . if, in like manner, the shuttle would weave and the plectrum touch the lyre without a hand to guide them,
  - chief workmen would not want servants, nor masters slaves
- **Psychology** (learning, cognitive models)
- **Linguistics** (grammars, formal representation of meaning)
- Near miss (1842):
  - Babbage design for universal machine (the Analytical Engine)
  - Lovelace: “a thinking machine” for “all subjects in the universe.”

# The 40s years

1943: first computational model of a neuron



Walter Pitts

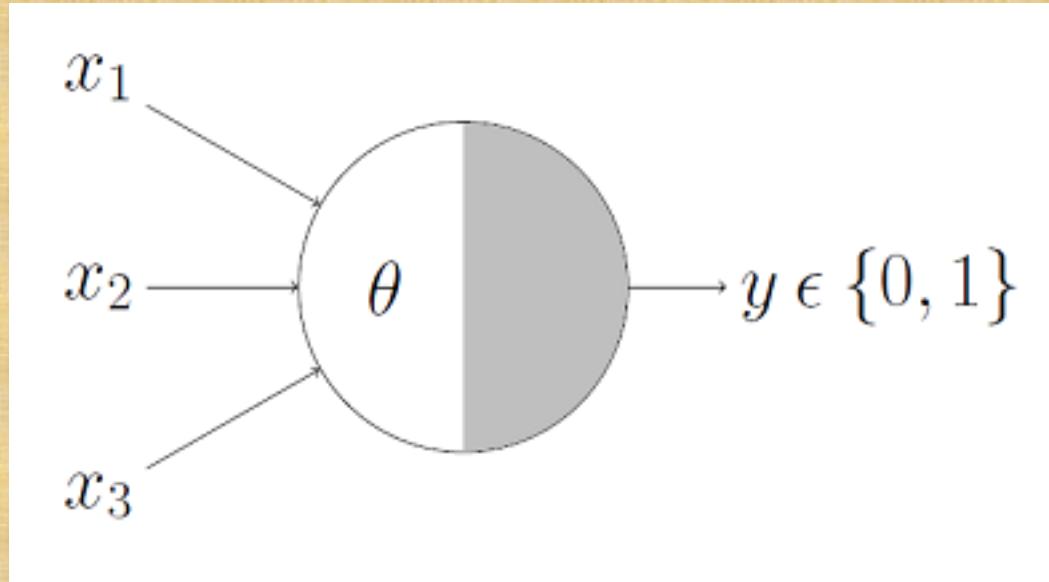


Warren McCulloch

# The 40s years

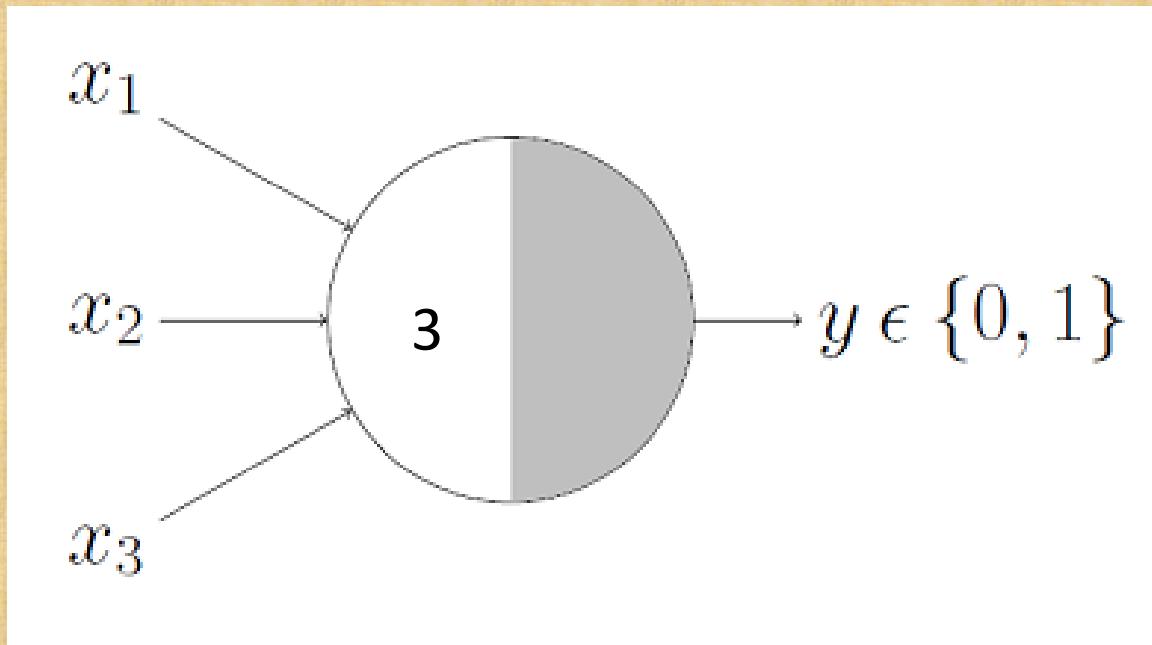
Boolean circuit model:

if  $x_1 + x_2 + x_3 \geq \theta$  then the neuron will fire, otherwise it won't



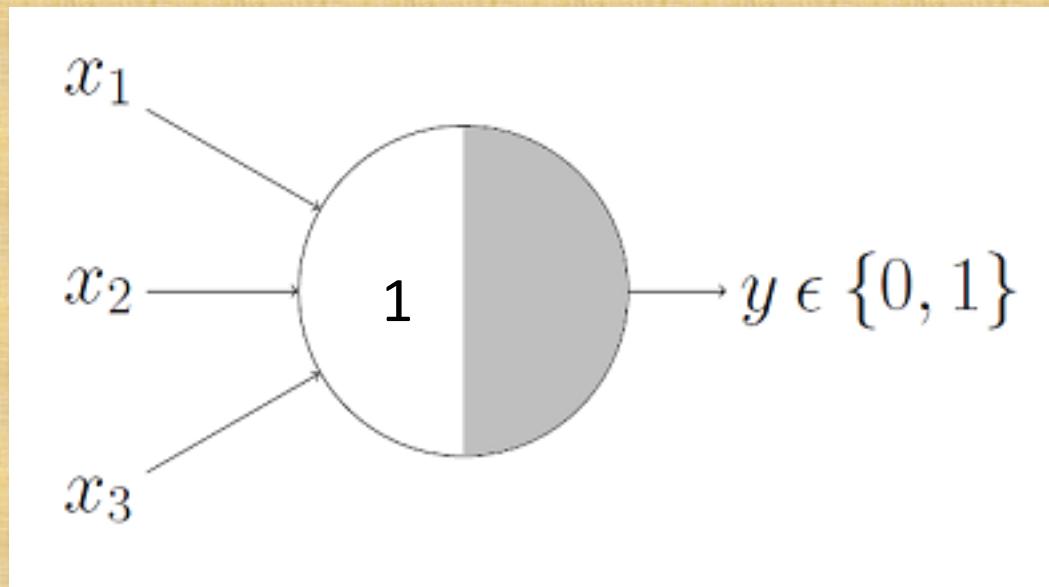
# The 40s years

AND Function



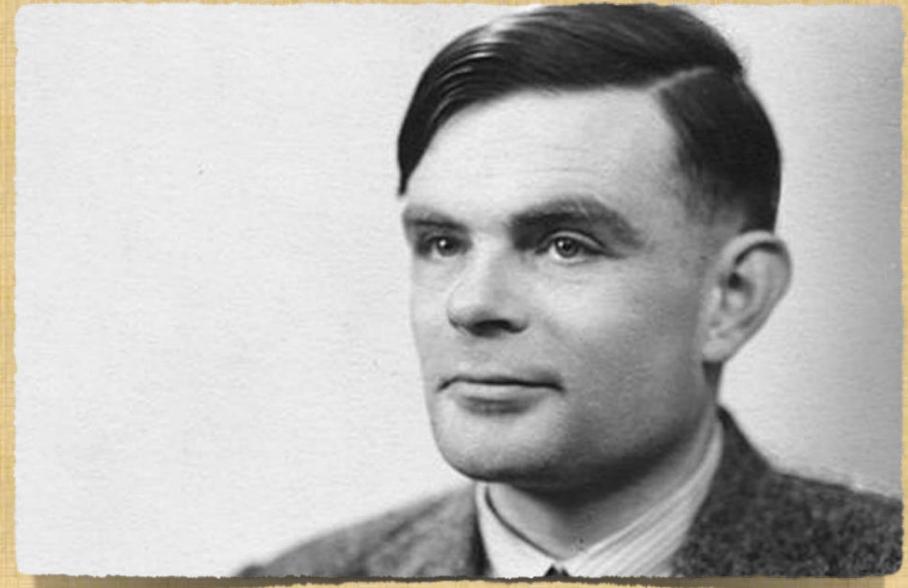
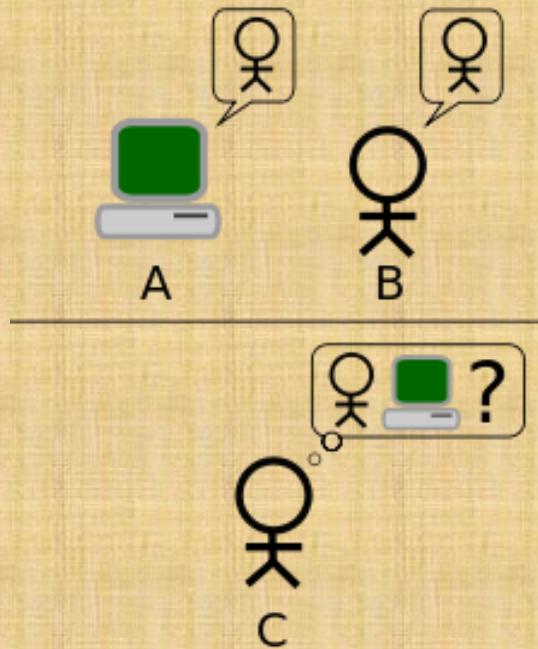
# The 40s years

OR Function

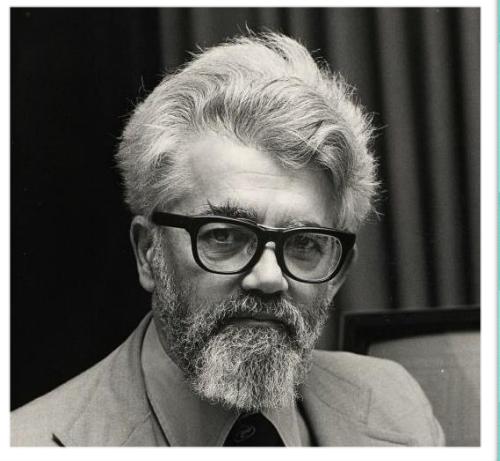


# The 40s years

1950: Turing's "Computing Machinery and Intelligence"



# The 50s years



New

1956 year

John McCarty organized a workshop at Dartmouth College

Coined the Artificial Intelligence term.

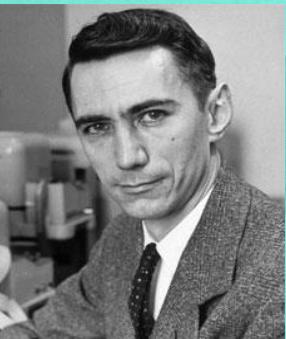
[slides about AI history adapted from Luca Manzoni slides, thank you Luca ☺]

## Participants:

1. Ray Solomonoff
2. Marvin Minsky
3. John McCarthy
4. Claude Shannon
5. Trenchard More
6. Nat Rochester
7. Oliver Selfridge
8. Julian Bigelow
9. W. Ross Ashby
10. W.S. McCulloch
11. Abraham Robinson
12. Tom Etter
13. John Nash
14. David Sayre
15. Arthur Samuel
16. Kenneth R. Shoulders
17. Shoulders' friend
18. Alex Bernstein
19. Herbert Simon
20. Allen Newell

# The 50s years

“An attempt will be made to find how to make machines use language, form abstractions and concepts, solve kinds of problems now reserved for humans, and improve themselves. ***We think that a significant advance can be made if we work on it together for a summer.***”



**John McCarthy and Claude Shannon**  
**Dartmouth Workshop Proposal**

# The 50s

## WORKS

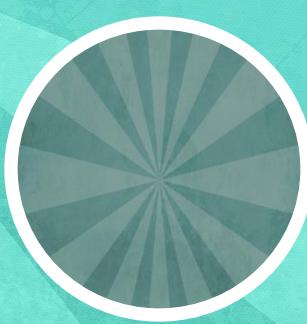
1956, Logic Theorist  
is the first program of Artificial Intelligence



Allen Newell



Herbert A. Simon



Cliff Shaw

\*54·43.  $\vdash \alpha, \beta \in 1. \text{D} : \alpha \cap \beta = \Lambda . \equiv . \alpha \cup \beta \in 2$

*Dem.*

$\vdash . *54·26. \text{D} \vdash \alpha = t'x . \beta = t'y . \text{D} : \alpha \cup \beta \in 2 . \equiv . x \neq y .$

[\*51·231]

$\equiv . t'x \cap t'y = \Lambda .$

[\*13·12]

$\equiv . \alpha \cap \beta = \Lambda \quad (1)$

$\vdash . (1) . *11·11·35. \text{D}$

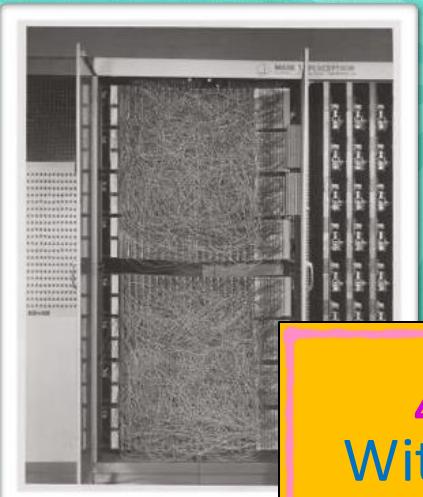
$\vdash . (\exists x, y) . \alpha = t'x . \beta = t'y . \text{D} : \alpha \cup \beta \in 2 . \equiv . \alpha \cap \beta = \Lambda \quad (2)$

$\vdash . (2) . *11·54 . *52·1. \text{D} \vdash . \text{Prop}$

From this proposition it will follow, when arithmetical addition has been defined, that  $1 + 1 = 2$ .

# The 50s years

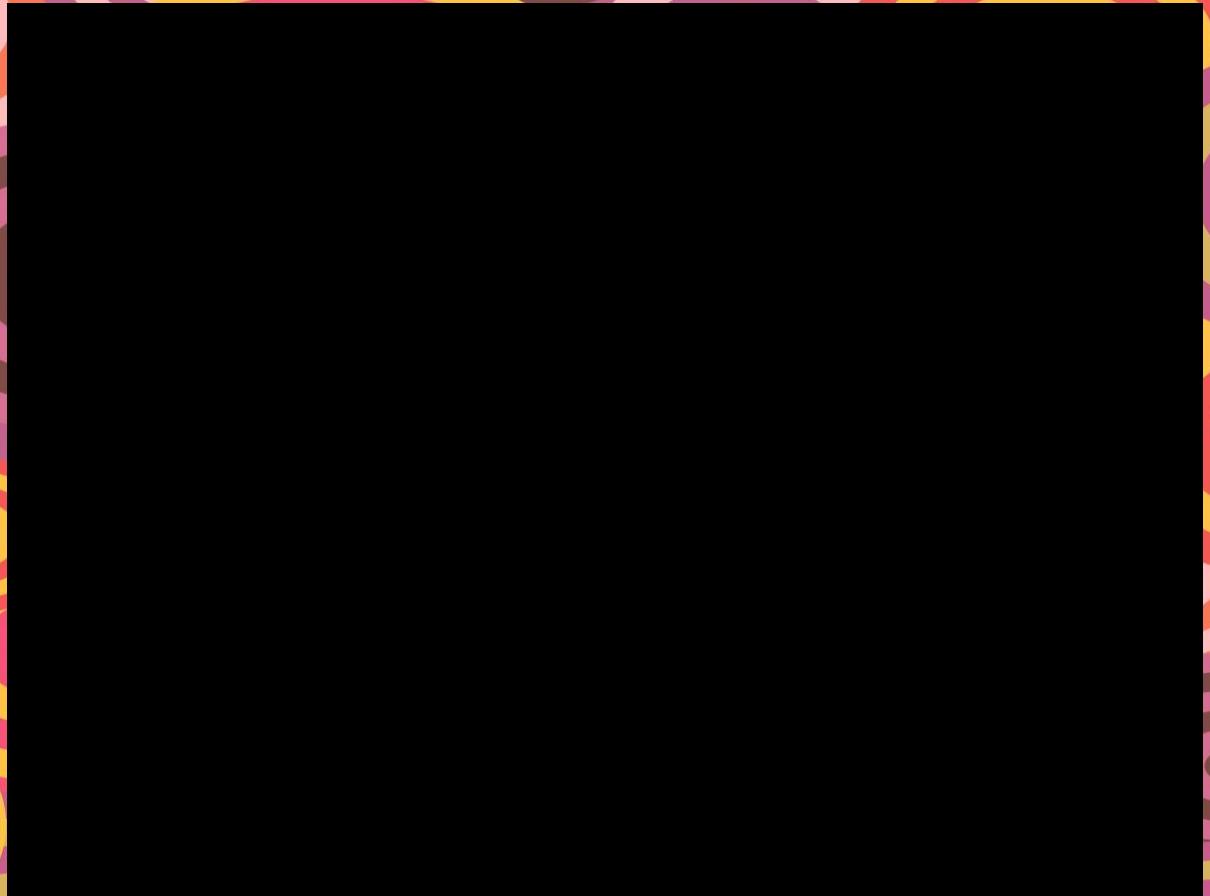
Frank Rosenblatt defines the **perceptron**, a system able to learn inspired by the neurons



400 pixel!  
With  
potentiometers

# The 60s Years







1964  
1966

The  
60s  
Years

EEEEEE	LL	III			
EE	LL	II			
EEEEEE	LL	II		AA	
EE	LL	II	ZZ	AA	
EEEEEE	LLLLLL	III	ZZZZZZ	AA	AA

Eliza is a mock Rogerian psychotherapist.

The original program was described by Joseph Weizenbaum in 1966.

This implementation by Norbert Landsteiner 2005.

ELIZA: Is something troubling you ?

YOU: Men are all alike.

ELIZA: What is the connection, do you suppose ?

YOU: They're always bugging us about something or other.

ELIZA: Can you think of a specific example ?

YOU: Well, my boyfriend made me come here.

ELIZA: Is it important to you that your boyfriend made you come here?

YOU: He says I'm depressed much of the time.

ELIZA: I am sorry to hear that you are depressed.

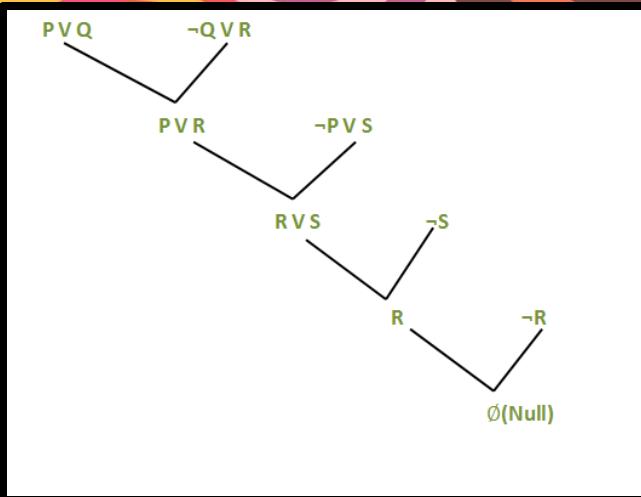
YOU: It's true. I am unhappy.

ELIZA: Can you explain what made you unhappy ?

Joseph  
Weizenbaum  
creates ELIZA, one of  
the first programs  
processing  
natural language

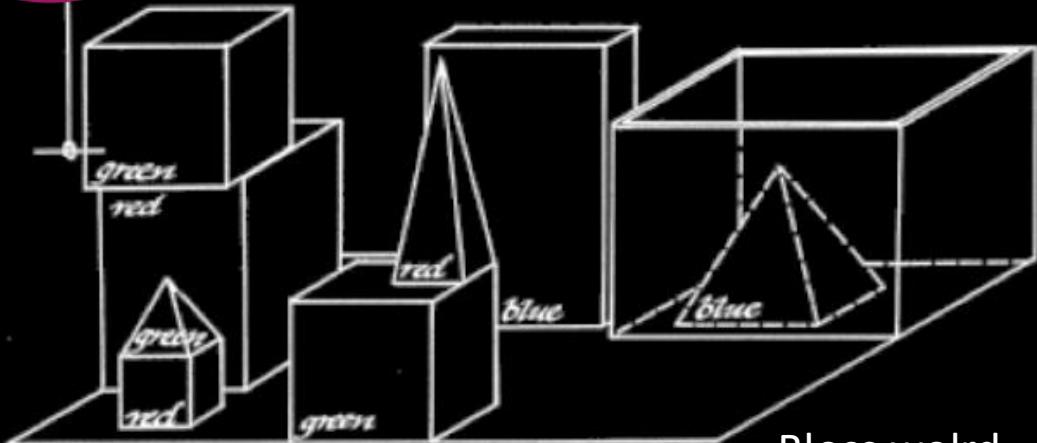
1965

The  
60s  
Years



Robinson's complete algorithm for logical reasoning:  
**the resolution method**

1968

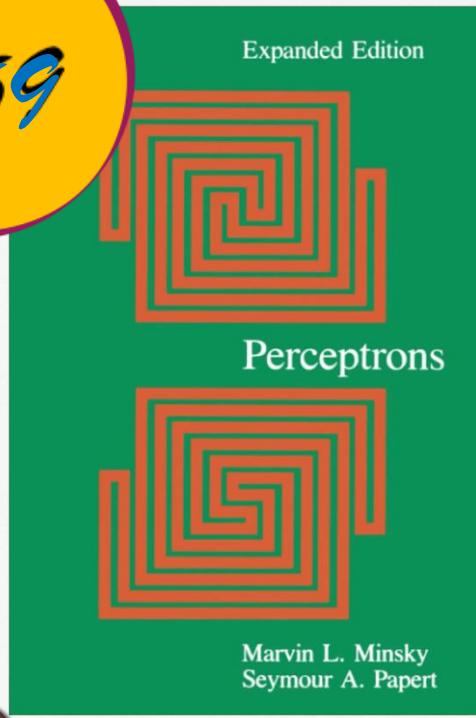


The  
60s  
Years

## SHRDLU

Permitted to  
“discuss” with  
the computer,  
instruct it to  
manipulate  
its world

1969



The

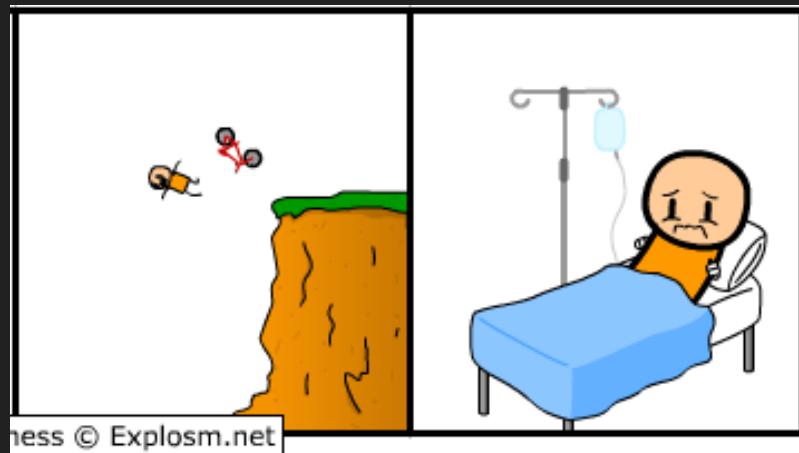
60s

Years

Marvin Minsky's and  
Seymour Papert's  
work show the limits  
of  
perceptron

# The 70s YEars

## Artificial Intelligence Winter



Low computing power

State-space explosion

Knowledge/  
Rationality  
problem

# The 70s YEars

Early development of  
knowledge-based systems

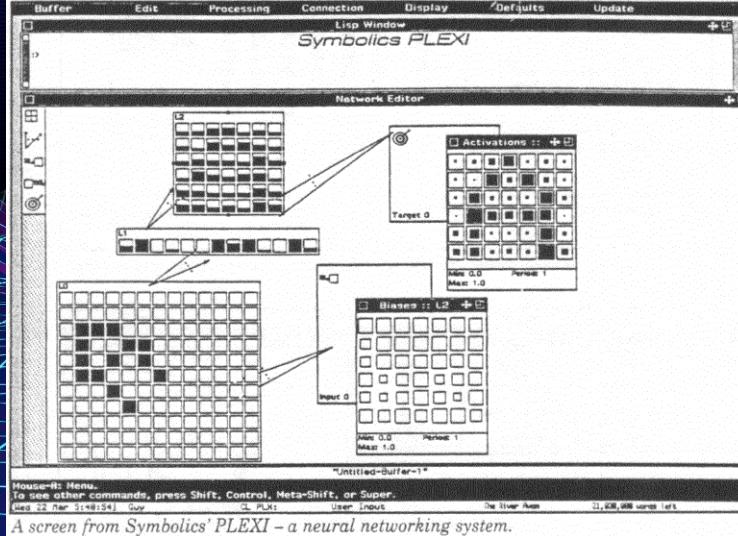
«One might say that to solve a hard problem, you  
have to almost know the answer»

# THE 80s

# YEARS

Backpropagation: overcome perceptron's limits

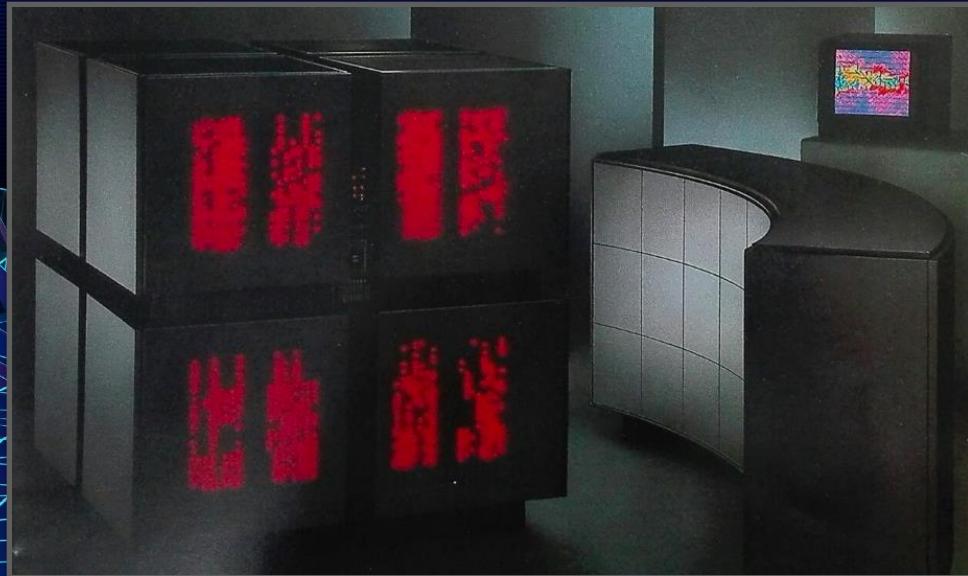
Hopfield networks: new model of neural networks



Neural networks reborn

# THE 80s YEARS

Connection Machine: a different supercomputer



Precursor of modern GPU?

# THE 80s YEARS

Expert systems and knowledge engineering



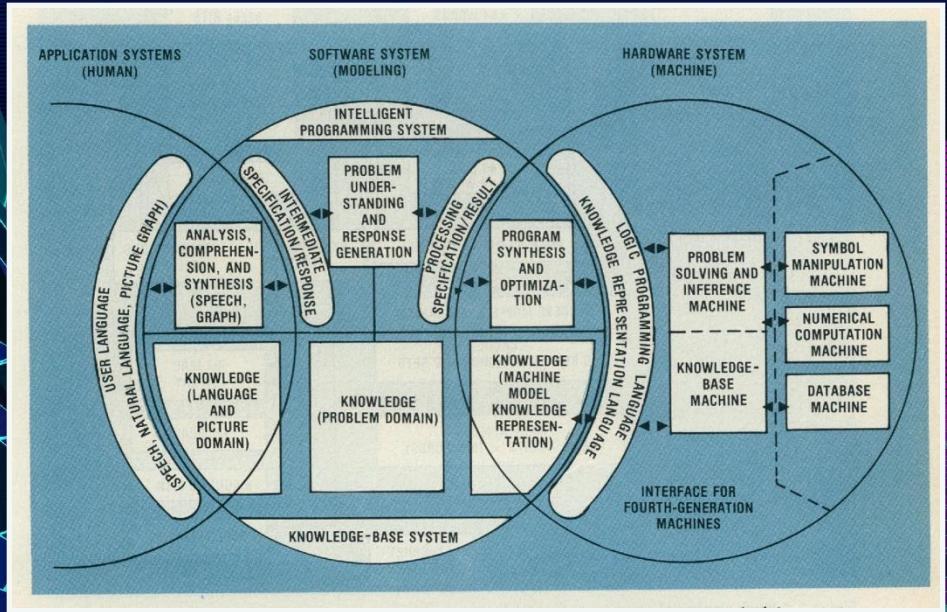
Workstation and systems for AI

Expert systems industry booms

# THE 80s

# YEARS

The Japanese project of the fifth generation's computer



Developing of  
"Knowledge Information Processing systems"  
through logic programming



# The 90s years

A second AI winter ☹

Scalable Limits of the expert sysyems  
(what's the size of knowledge you "put inside"?)

Failure of the Japanese project of  
the fifth generation's computer

PC have similar performance as the  
dedicated workstation

# The 90s years

## "AI Spring"?

Let's use  
data

Resurgence of probability, focus on uncertainty

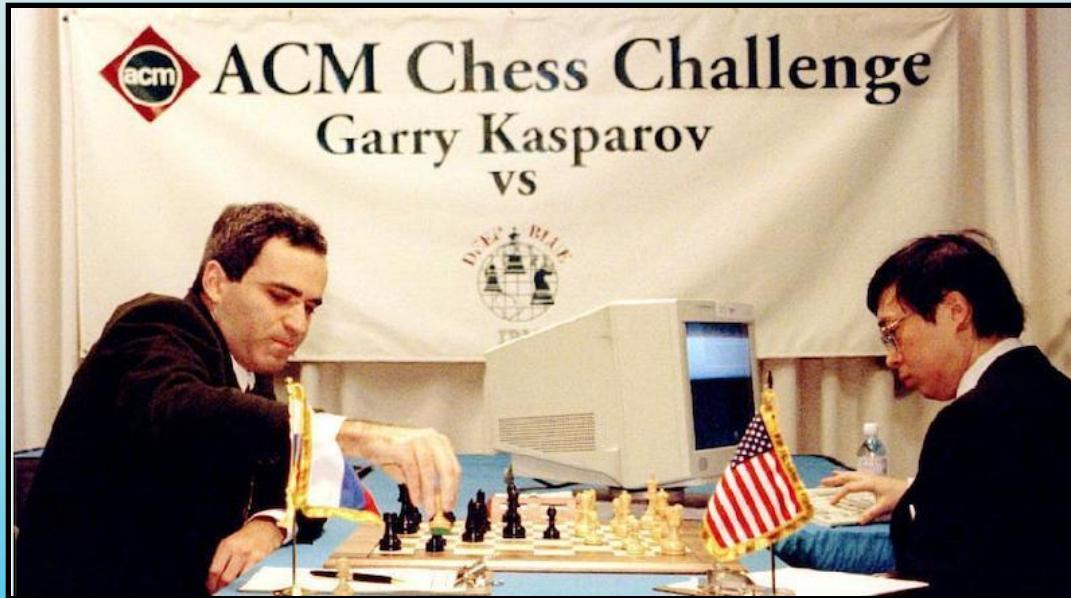
Machine learning rather than hand-coding

1996: Kasparov defeats Deep Blue at chess



"I could feel --- I could smell --- a new kind of intelligence across the table." ~Kasparov

# The 90s years



**1997:** Deep Blue defeats Kasparov at chess



“Deep Blue hasn't proven anything.”  
~Kasparov

# 2000—

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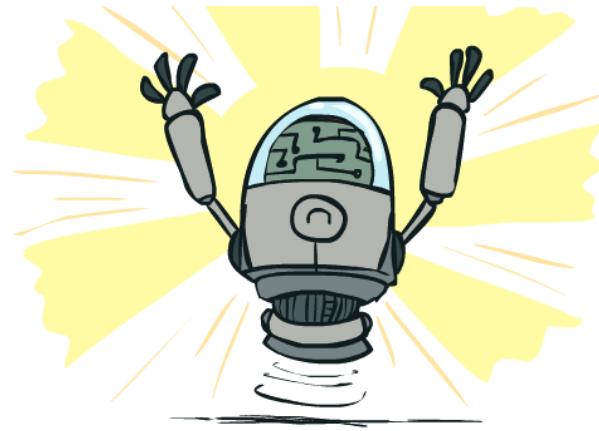
- Where are we now?
  - Big data, big computers, neural networks
  - Some re-unification of sub-fields
  - AI used in many industries
  - Chess engines running on ordinary laptops can defeat the world's best chess players
  - 2011: IBM's Watson defeats Ken Jennings and Brad Rutter at Jeopardy!
  - 2016: Google's AlphaGo beats Lee Sedol at Go



# What Can AI Do?

Quiz: Which of the following can be done at present?

- ✓ Play a decent game of Jeopardy?
- ✓ Win against any human at chess?
- ✓ Win against the best humans at Go?
- ✓ Play a decent game of tennis?
- ✓ Grab a particular cup and put it on a shelf?
- ✗ Unload any dishwasher in any home?
- ✗ Drive safely along the highway?
- ✗ Drive safely in Trieste?
- ✓ Buy a week's worth of groceries on the web?
- ✗ Buy a week's worth of groceries at Despar?
- ✗ Discover and prove a new mathematical theorem?
- ✗ Perform a surgical operation?
- ✗ Unload a know dishwasher in collaboration with a person?
- ✓ Translate spoken Chinese into spoken English in real time?
- ✗ Write an intentionally funny story?



# Course Topics

---

The so-called **Classical Artificial Intelligence**

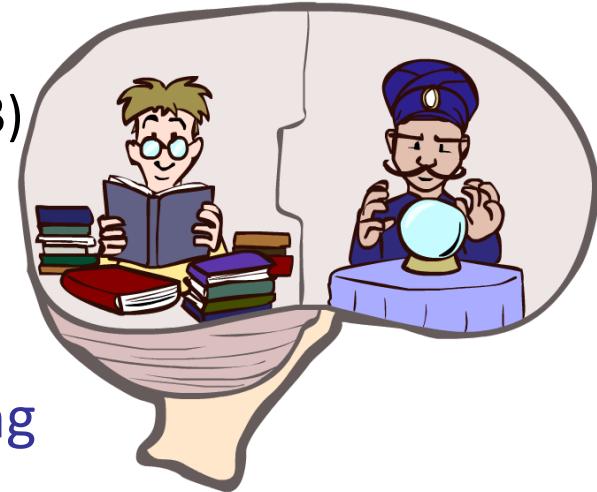
**Intelligence from computation:** how we write algorithms or write the logic that will cause a programmer or a robot or an agent to do something that the human would or that we would consider intelligence



# Course Topics

---

- Part 1: Problem-solving
  - Search strategies and heuristic research (ch 3)
  - Search in complex Environments (ch 4)
  - Constraint Satisfaction Problems (ch 5)
  - Adversarial search and games (ch 6)
- Part 2: Knowledge, Reasoning and planning
  - Multiagent Decision Making (ch17)
  - Logical agent (ch 7)
  - First-order logic and inference (ch 8,9)
  - Knowledge representation (ch 10)
  - Automated planning (ch 11)



# Search problem

---

- Intelligent agents -> Chapter 2
- Search strategies -> Chapter 3
  - Search algorithms
  - Uninformed Search Strategies
  - Informed (Heuristic) Search Strategies
- Search in complex Environments -> Chapter 4
  - Local Search in discrete and continuous space
  - Search with non-deterministic action
  - Search with partially-observable environment

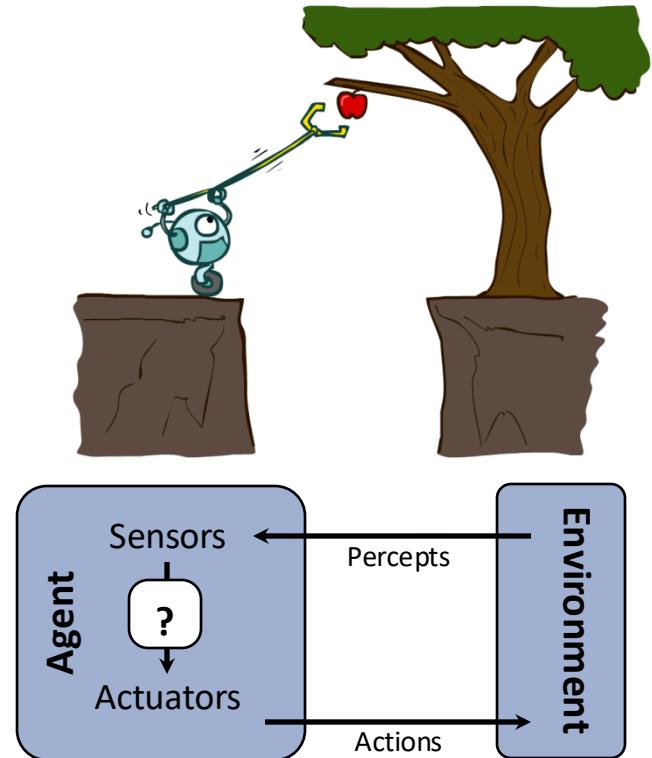
# Goal of the Course

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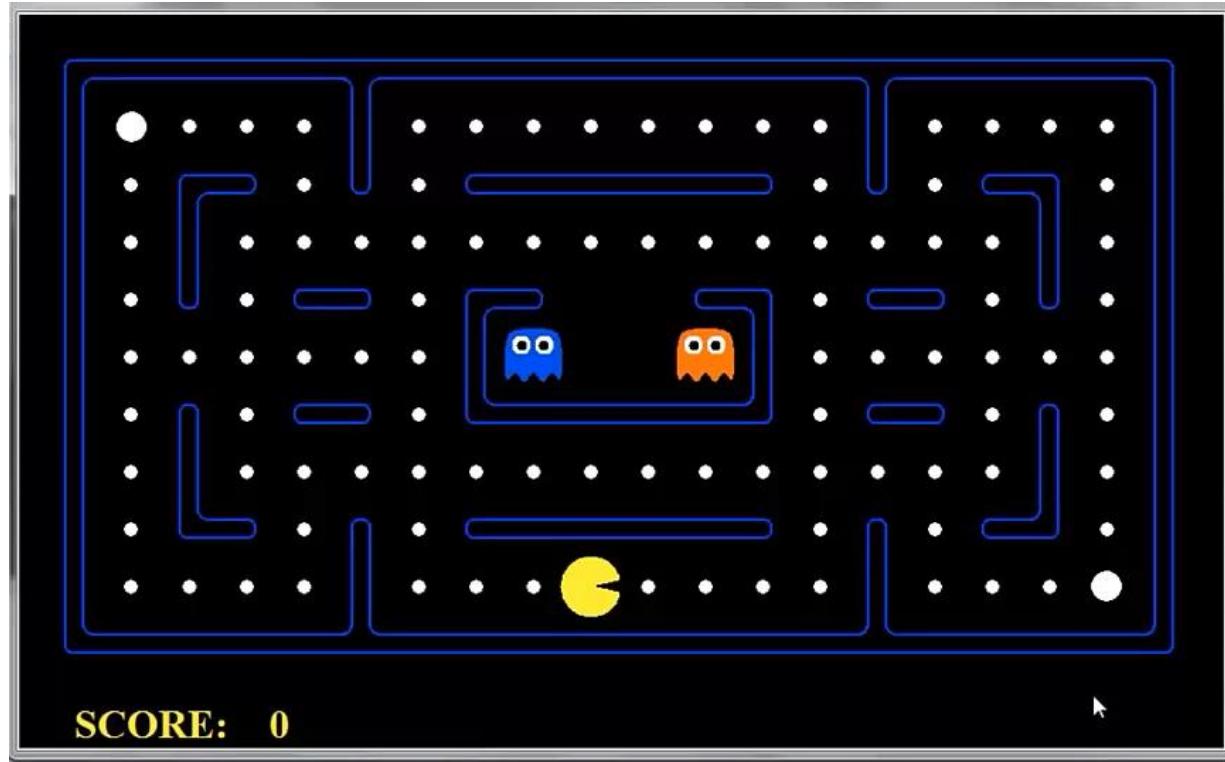
- It gives you an extra mathematical maturity
- It gives you a survey of fields that interact with AI

# AI as Designing Rational Agents

- An **agent** is an entity that *perceives* and *acts*.
- A **rational agent** selects actions that maximize its (expected) **utility**.
- Characteristics of the **sensors**, **actuators**, and **environment** dictate techniques for selecting rational actions
- **This course** is about:
  - Classical AI techniques for many problem types
  - Learning to choose and apply the technique appropriate for each problem



# Pac-Man as an Agent



# Aimacode

- <https://github.com/aimacode/aima-python>

The screenshot shows the GitHub repository page for `aima-python`. At the top, there's a file list with `viterbi_algorithm.ipynb`, `README.md`, and a commit message "added csp, logic, planning and probability .ipynb (#1130)" from 4 years ago. Below the files, the `README.md` content is displayed. It features a large heading "aima-python" with a "build failing" button and a "launch binder" button. A descriptive paragraph explains the purpose of the code: "Python code for the book *Artificial Intelligence: A Modern Approach*. You can use this in conjunction with a course on AI, or for study on your own. We're looking for solid contributors to help." A section titled "Updates for 4th Edition" discusses changes for the 4th edition, mentioning moves from Python 3.5 to 3.7, more emphasis on Jupyter notebooks, and projects using external packages like tensorflow. Another section, "Structure of the Project", describes the organization of files for pseudocode algorithms, tests, and usage examples. The bottom part of the screenshot shows a list of files and their descriptions.

viterbi\_algorithm.ipynb    added csp, logic, planning and probability .ipynb (#1130)    4 years ago

README.md

**aima-python** [build failing](#) [launch binder](#)

Python code for the book *Artificial Intelligence: A Modern Approach*. You can use this in conjunction with a course on AI, or for study on your own. We're looking for solid contributors to help.

## Updates for 4th Edition

The 4th edition of the book is out now in 2020, and thus we are updating the code. All code here will reflect the 4th edition. Changes include:

- Move from Python 3.5 to 3.7.
- More emphasis on Jupyter (ipython) notebooks.
- More projects using external packages (tensorflow, etc.).

## Structure of the Project

When complete, this project will have Python implementations for all the pseudocode algorithms in the book, as well as tests and examples of use. For each major topic, such as `search`, we provide the following files:

- `search.ipynb` and `search.py`: Implementations of all the pseudocode algorithms, and necessary support functions/classes/data. The `.py` file is generated automatically from the `.ipynb` file; the idea is that it is easier to read the documentation in the `.ipynb` file.
- `search_XX.ipynb`: Notebooks that show how to use the code, broken out into various topics (the `XX`).
- `tests/test_search.py`: A lightweight test suite, using `assert` statements, designed for use with `py.test`, but also usable on their own.