

# CS 480

## *Introduction to Artificial Intelligence*

January 11, 2024

# Announcements / Reminders

- Please follow the Week 01 To Do List instructions

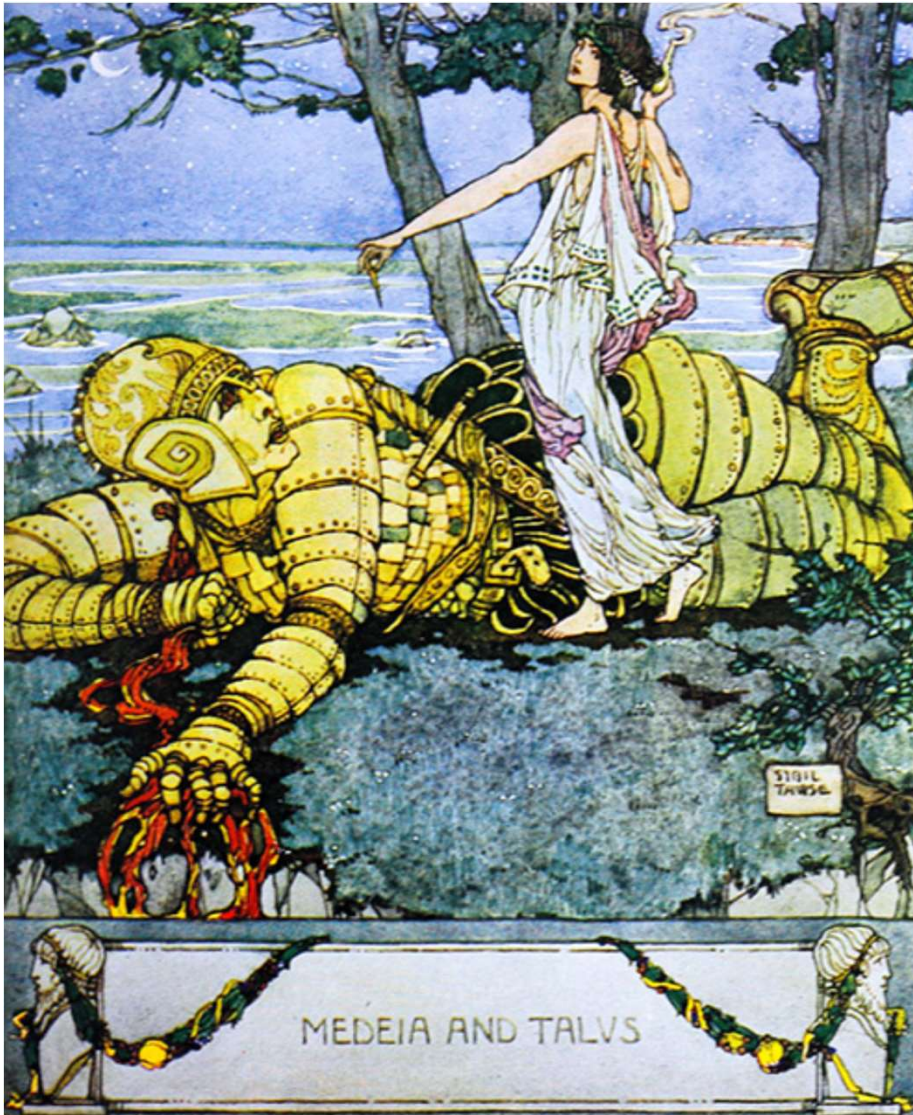
# Plan for Today

- **A Quest for Artificial Intelligence**
- **What is Artificial Intelligence?**
- **Intelligent Agents - Introduction (if time permits)**

# **The quest for Artificial Intelligence**

**Selected ideas and artifacts in human history**

# Talos (around 400 BC)

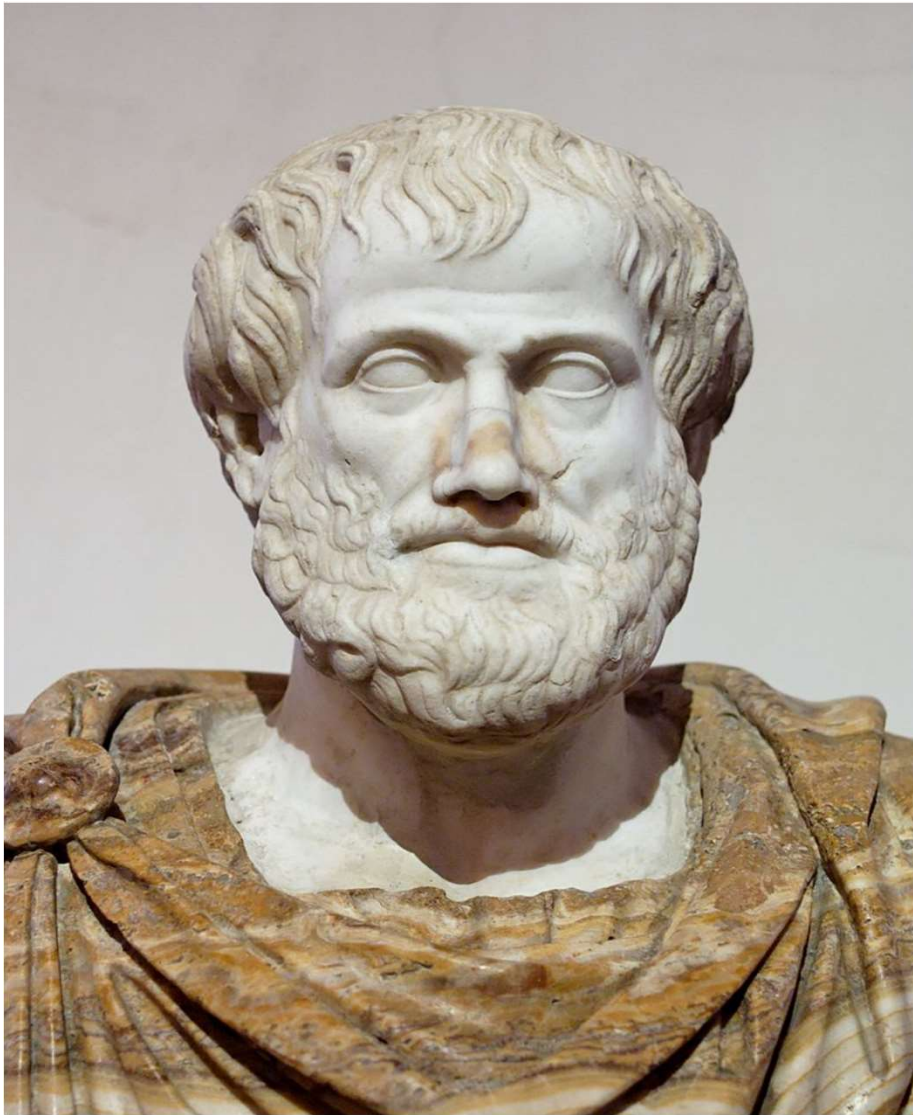


Source: Thomas Bulfinch - "Stories of Gods and Heroes"  
(1920)

In Greek mythology, **Talos** was a huge bronze **automaton** whose task was to protect Europa (the mother of King Minos of Crete). Talos was **programmed** to patrol Crete's shores three times a day.



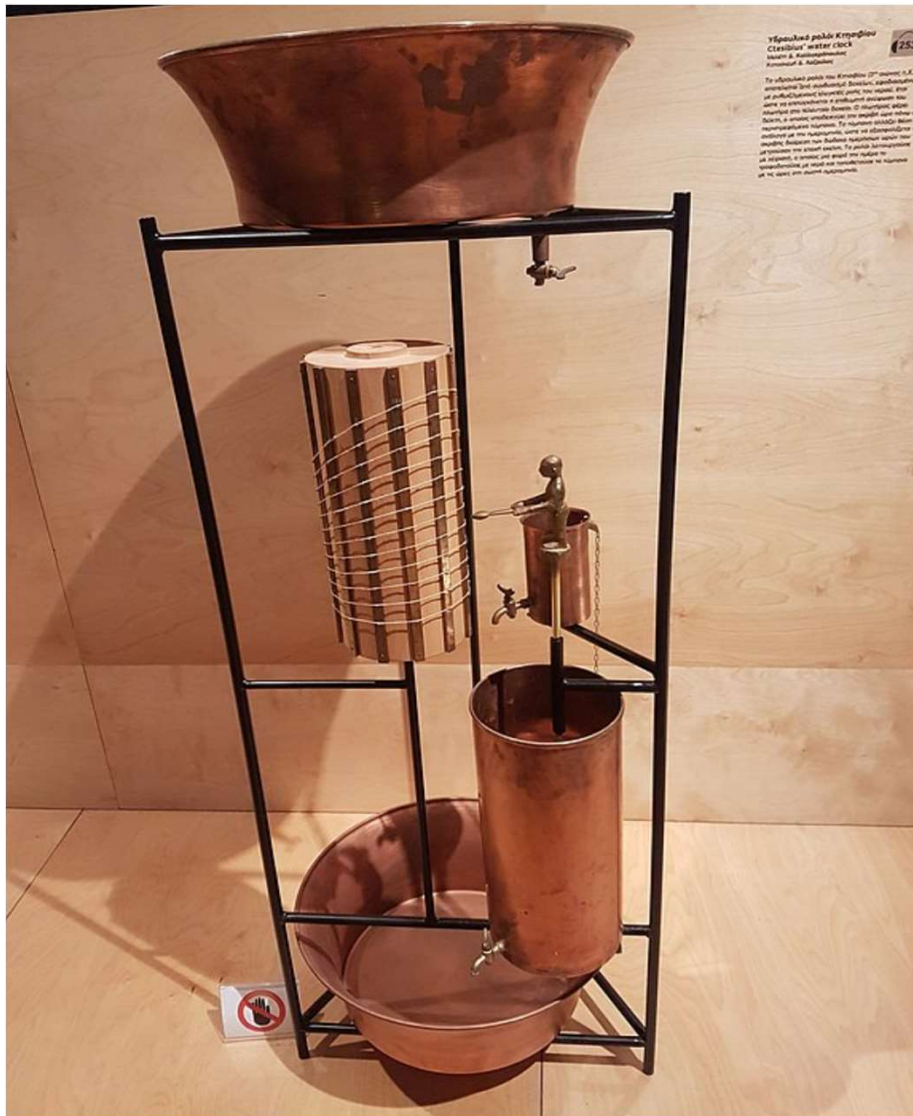
# Aristotle's Ideas (around 350 BC)



Source: <https://en.wikipedia.org/wiki/Aristotle>

In “Politics” the Greek philosopher Aristotle wrote: “There is only one condition in which we can imagine managers not needing subordinates, and masters not needing slaves. This condition would be that **each instrument could do its own work, at the word of command or by intelligent anticipation (...)**”

# Water Clock (around 250 BC)



Greek inventor Ktesibios's water clock employed a **regulator in the form of feedback-control** float that maintained constant water flow to measure time. It is an early example of a **self-regulating feedback control system**. A system capable to respond to changes in its environment.

Source:

[https://commons.wikimedia.org/wiki/File:Ctesibius%27s\\_water\\_clock,\\_3rd\\_century\\_BC,\\_Alexandria\\_\(reconstruction\).jpg](https://commons.wikimedia.org/wiki/File:Ctesibius%27s_water_clock,_3rd_century_BC,_Alexandria_(reconstruction).jpg)



# Abacus (around 190 BC)



Source: <https://en.wikipedia.org/wiki/Abacus>

The abacus is an ancient **calculating tool** allowing humans to **perform fast calculations in commerce and engineering**. It consists of rows of movable objects representing digits and **can be considered the ancestor to the computer**.



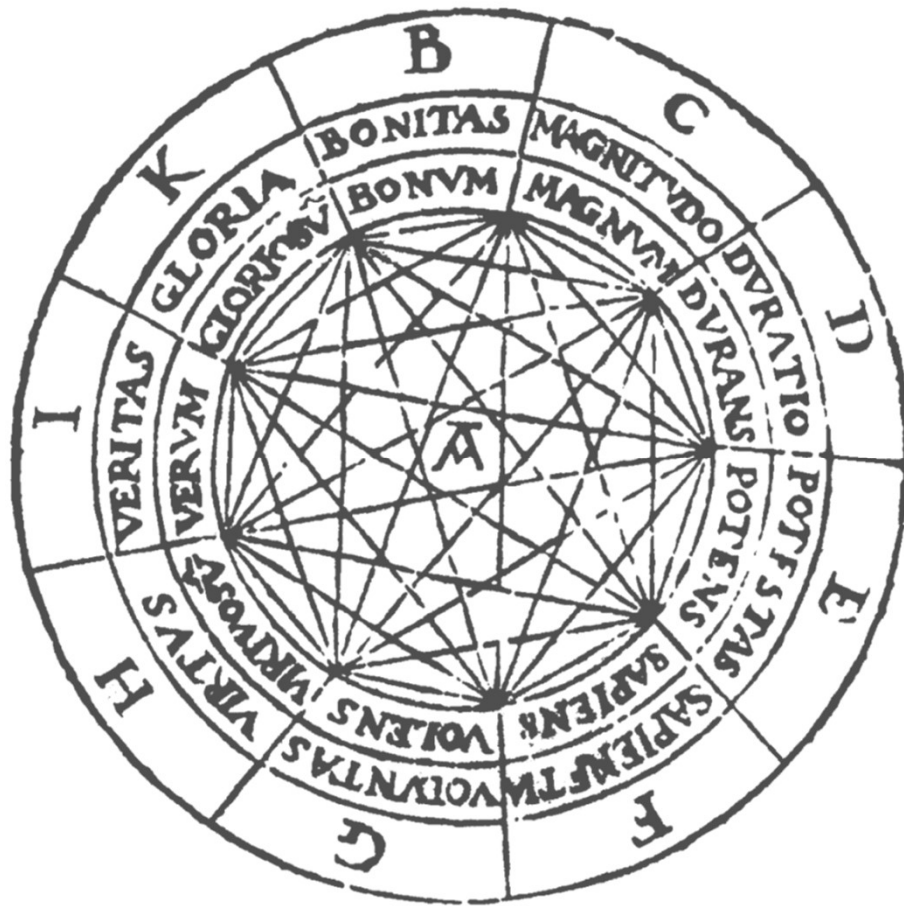
# Antikythera (around 125 BC)



The Antikythera Mechanism is an ancient **geared computing device** that was used to calculate astronomical positions.

*Interactive model of Antikythera mechanism. Source:  
<https://www.archaeology.wiki/blog/2017/06/23/new-interactive-model-antikythera-mechanism/>*

# Llull's Ars Magna (around 1305)



Catalan philosopher Ramon Llull in his book “Ars Magna”. It was an attempt to use logic to **artificially produce new knowledge by generating combinations of elemental truths** (a fixed set of preliminary ideas). Some consider it an **early step towards a “thinking machine”**.

Source:

[https://commons.wikimedia.org/wiki/File:Ramon\\_Llull\\_-\\_Ars\\_Magna\\_Fig\\_1.png](https://commons.wikimedia.org/wiki/File:Ramon_Llull_-_Ars_Magna_Fig_1.png)

# da Vinci's Knight (around 1495)

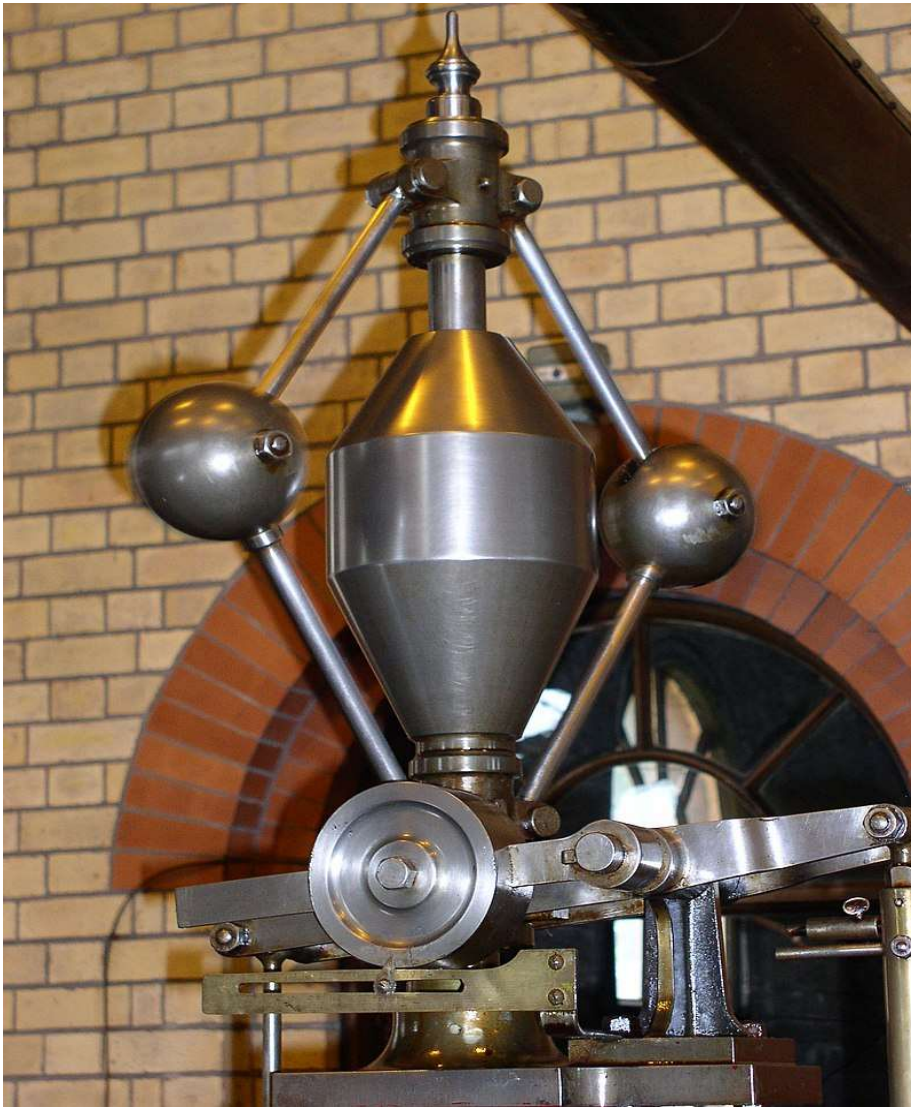


Source: [https://en.wikipedia.org/wiki/Leonardo%27s\\_robot](https://en.wikipedia.org/wiki/Leonardo%27s_robot)

Leonardo da Vinci's **robot** ("automaton knight") designed, and likely constructed, **could stand, sit, raise its visor, and move each arm independently**. It was operated by a system of **pulleys and cables** and was a result of da Vinci's interest in engineering and human anatomy.



# Watt's Governor (1788)

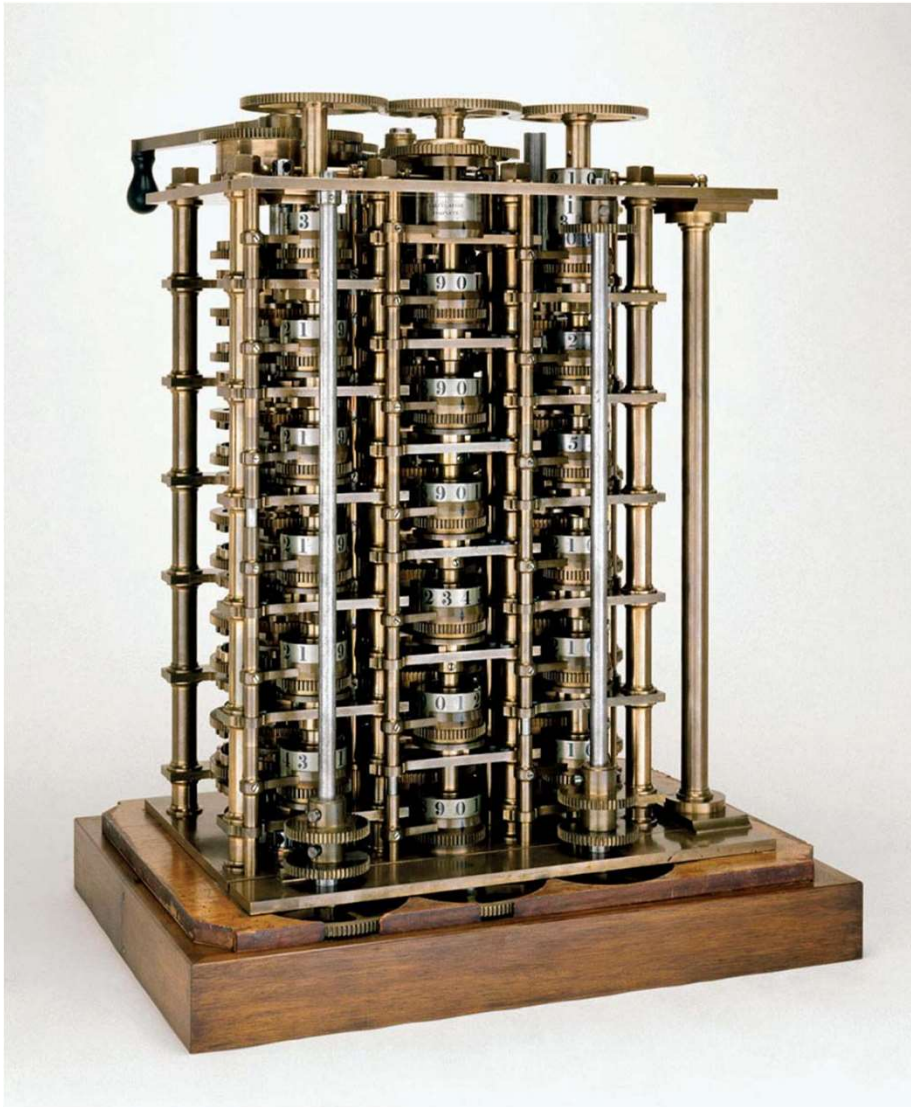


Source: [https://en.wikipedia.org/wiki/Centrifugal\\_governor](https://en.wikipedia.org/wiki/Centrifugal_governor)

A centrifugal governor is **a specific type of governor with a feedback system that controls the speed of an engine by regulating the flow of fuel or working fluid**, so as to **maintain a near-constant speed**. It uses the principle of **proportional control**.



# Babbage's Difference Engine (1822)



Charles Babbage, an English polymath, is by some considered to be the “**father of the computer**”. He designed the **first mechanical computer**, called the **difference engine**, meant to calculate mathematical tables. A functioning difference machine was built in 1991.

Source: <https://www.britannica.com/biography/Charles-Babbage>

# Boolean Algebra (1854)

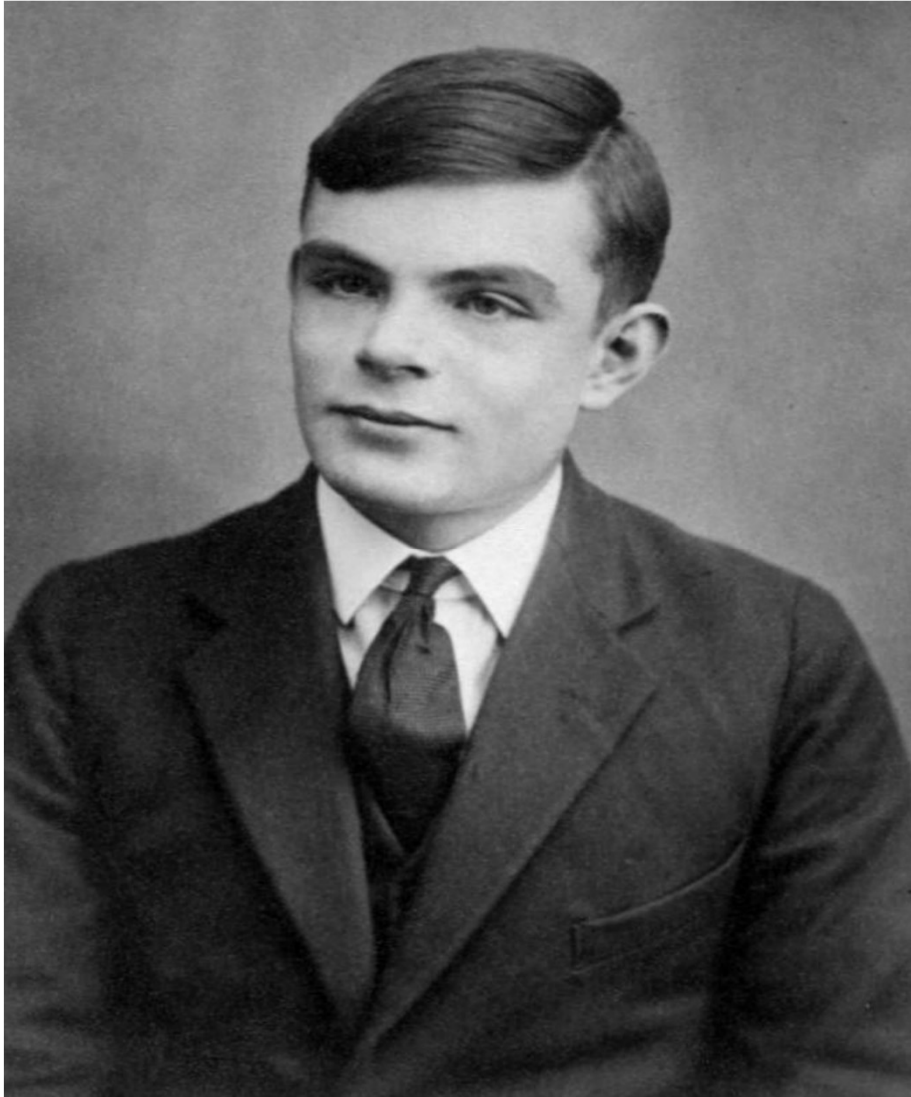


Source: [https://en.wikipedia.org/wiki/George\\_Boole](https://en.wikipedia.org/wiki/George_Boole)

George Boole, an English mathematician, was interested in “investigating the **fundamental laws of those operations of the mind by which reasoning is performed**”. He tried to reduce logic to a simple algebra of two values, 0 and 1 (false and true), and three basic operations: **and**, **or**, and **not**. Modern electronics and computers are based on it,



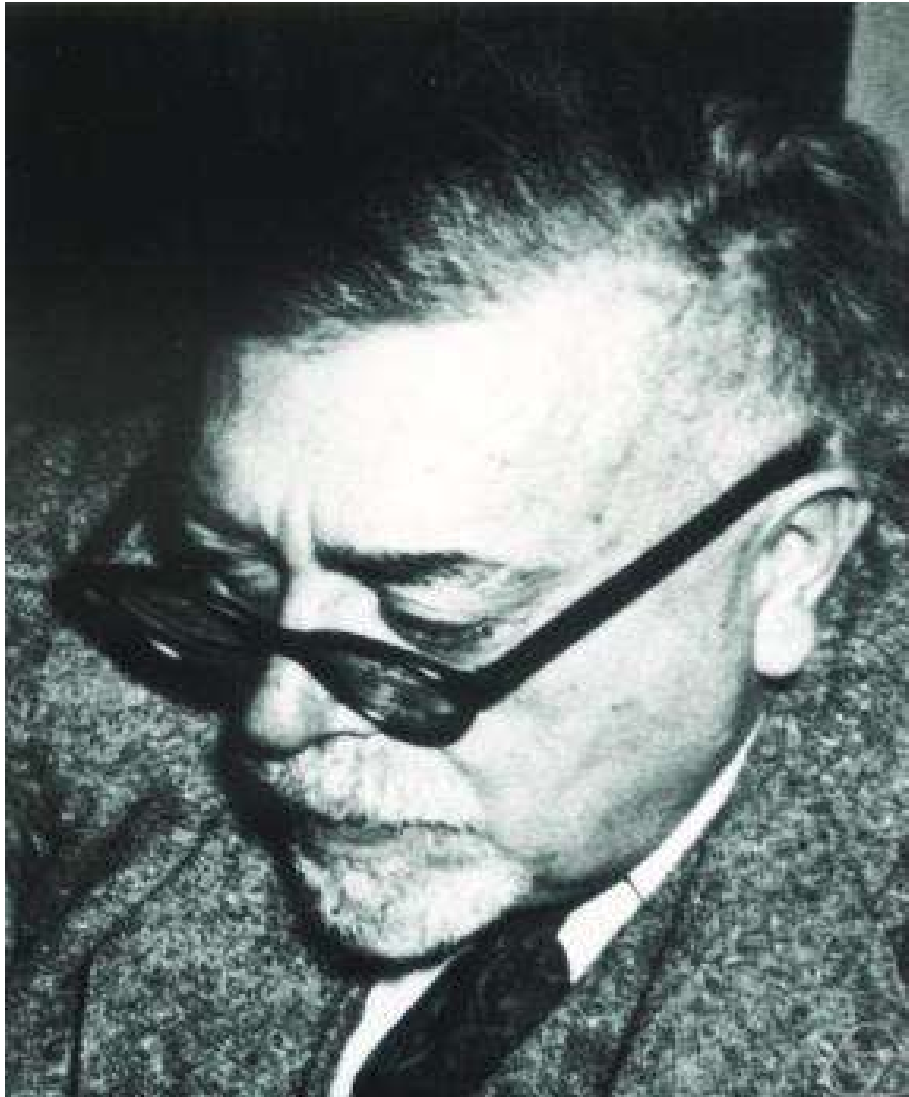
# Turing Machine (1936)



Source: [https://en.wikipedia.org/wiki/Alan\\_Turing](https://en.wikipedia.org/wiki/Alan_Turing)

A Turing machine is a **mathematical model of computation describing an abstract machine that manipulates symbols** on a strip of tape according to a table of rules. Despite the model's simplicity, it is **capable of implementing any computer algorithm.**

# Cybernetics (1940s – ...)

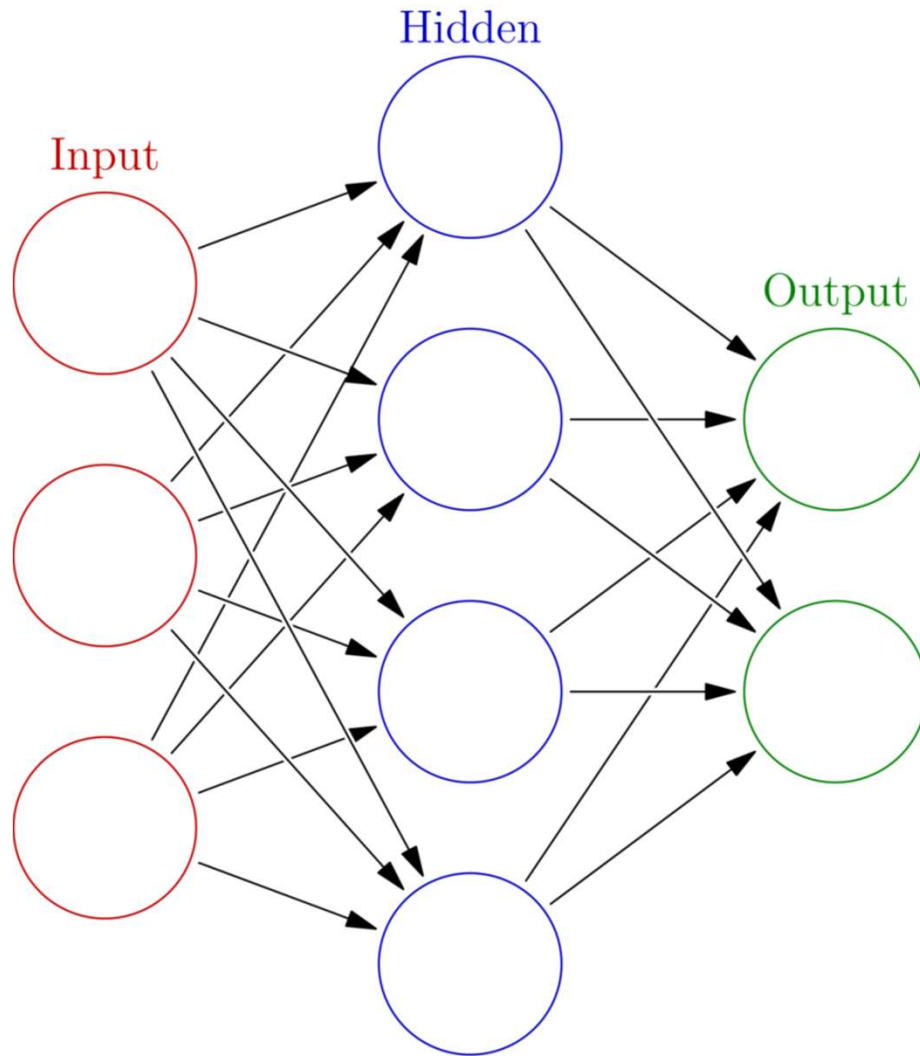


Norbert Wiener, who popularized Cybernetics. Source:  
[https://en.wikipedia.org/wiki/Cybernetics#/media/File:Norbert\\_wiener.jpg](https://en.wikipedia.org/wiki/Cybernetics#/media/File:Norbert_wiener.jpg)

Cybernetics is concerned with **circular causal processes** however they are embodied, including in **ecological, technological, biological, cognitive and social systems** and also in the context of practical activities such as **designing, learning, managing**, etc.



# Artificial Neural Network (1943)

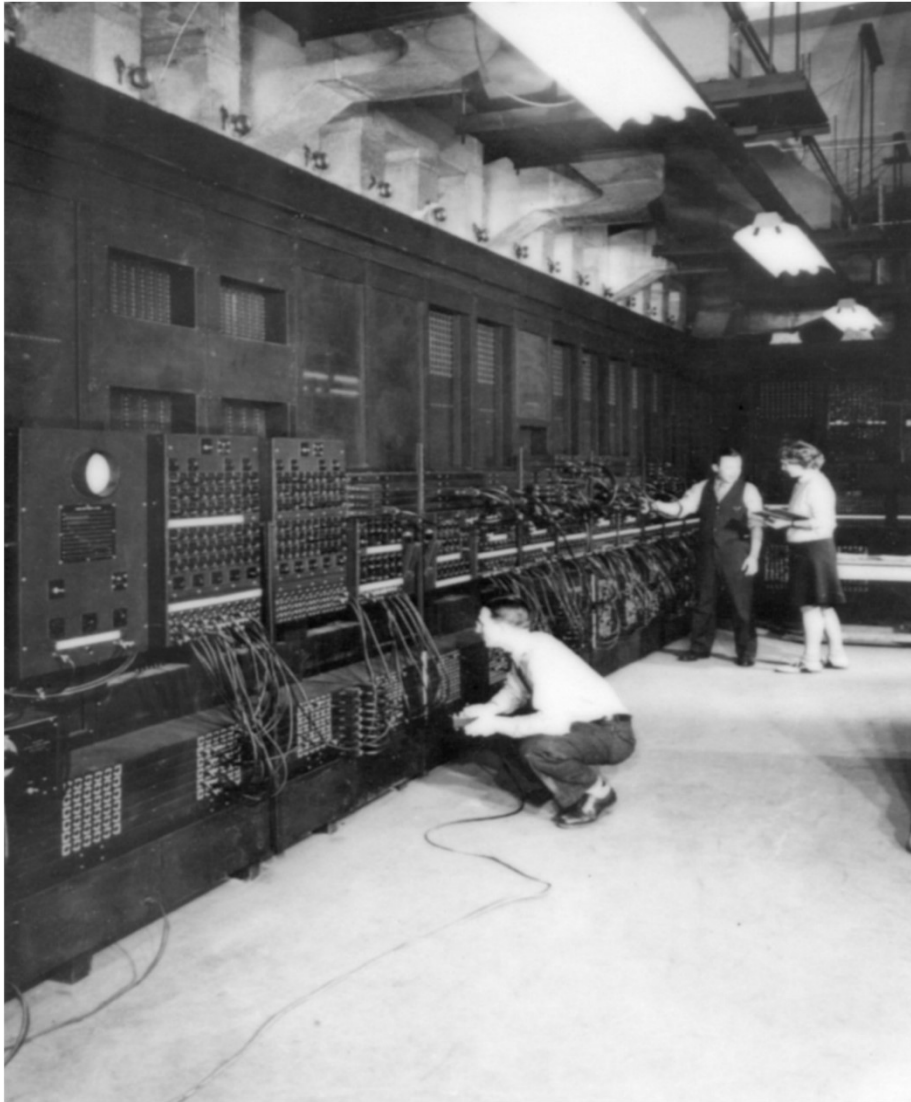


First computational models of an **Artificial Neural Network** (loosely inspired by biological neural networks) were proposed by Warren McCulloch and Walter Pitts in 1943. Their ideas are a **key component of modern day machine and deep learning.**

Source:

[https://en.wikipedia.org/wiki/Artificial\\_neural\\_network](https://en.wikipedia.org/wiki/Artificial_neural_network)

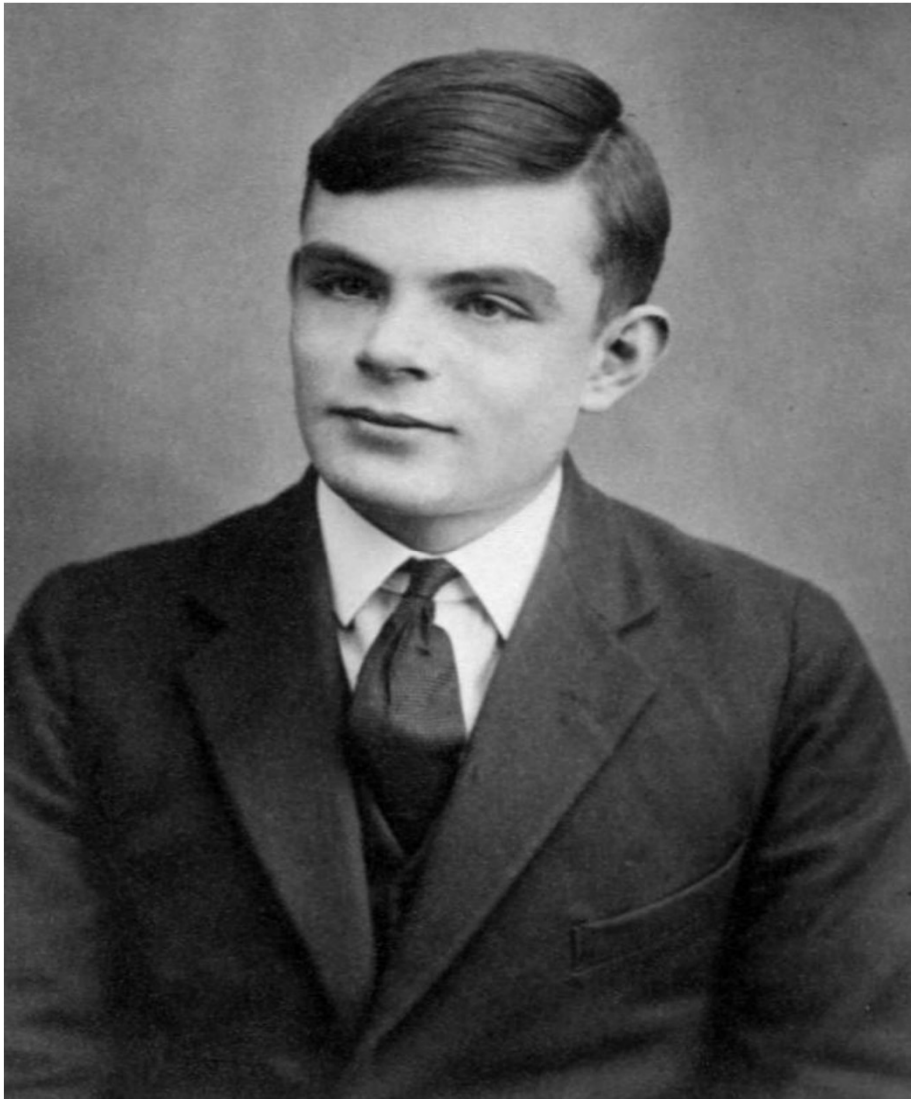
# ENIAC (1946)



ENIAC (Electronic Numerical Integrator and Computer) was **the first programmable, electronic, general-purpose digital computer**. It was designed to calculate US Army artillery firing tables, but its first important application was in the design of the hydrogen bomb.

Source: <https://news.engin.umich.edu/2021/02/75-years-of-the-eniac/>

# Turing Test (1950)

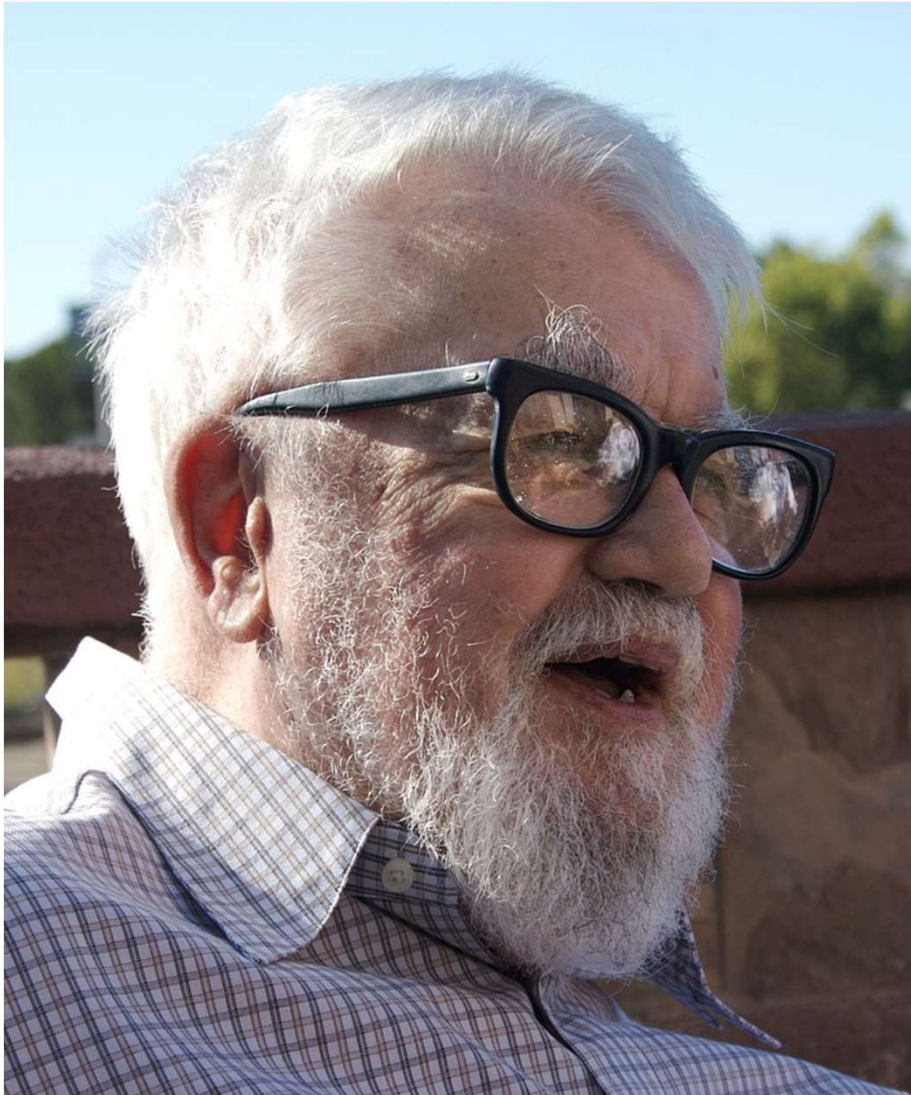


Source: [https://en.wikipedia.org/wiki/Alan\\_Turing](https://en.wikipedia.org/wiki/Alan_Turing)

In 1950, English computer scientists **Alan Turing** suggested that if a computer behaves the same way as a human, we might as well call it intelligent. A Turing Test is a test where a machine and human respond, in text, to typed questions of human judges who cannot see who is responding.



# Darthmouth AI Workshop (1956)



The Dartmouth Summer Research Project on Artificial Intelligence was the **first AI-related conference** and where the term **Artificial Intelligence** was coined.

*John McCarthy, who coined the term AI. Source:  
[https://en.wikipedia.org/wiki/John\\_McCarthy\\_\(computer\\_scientist\)](https://en.wikipedia.org/wiki/John_McCarthy_(computer_scientist))*



**Have you noticed  
any key themes?**

# ELIZA Chatbot

**ELIZA: a very basic Rogerian psychotherapist chatbot**

Talk to Eliza by typing your questions and answers in the input box.

> Hello, I am Eliza. I'll be your therapist today.

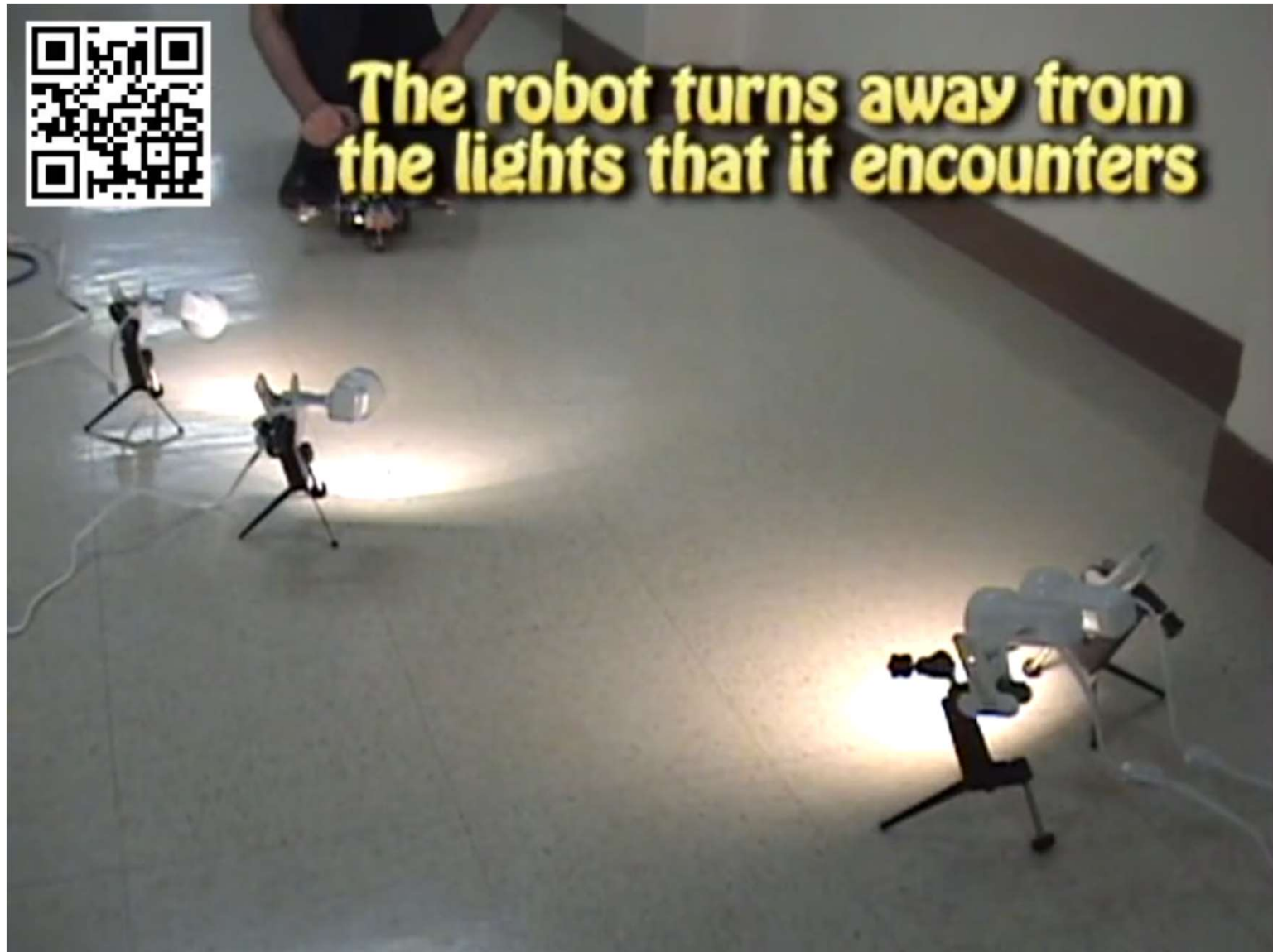
TYPE HERE

Source: <https://web.njit.edu/~ronkowitz/eliza.html>

# ELIZA Chatbot: The Idea

- **Draw the patient out by reflecting patient's statements back at them**
- **Rare type of conversation in which one can "assume the pose of knowing almost nothing of the real world"**

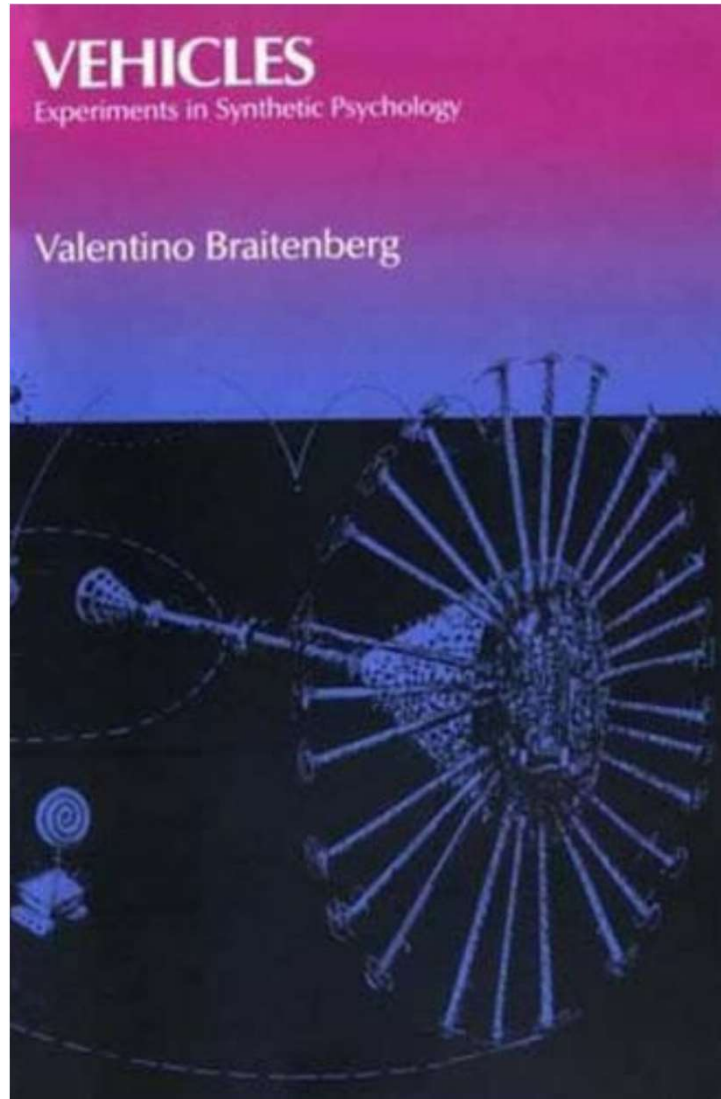
# Is this intelligence?



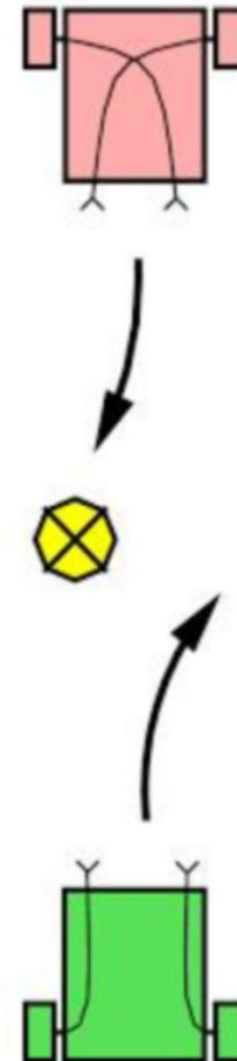
Source: <https://www.youtube.com/watch?v=yUVcl5Pw2o4>



# Braitenberg's Vehicles



Valentino Braitenberg - "Vehicles. Experiments in Synthetic Psychology" (The MIT Press)



# What is Artificial Intelligence?

# AIMA Textbook Definition

## Artificial Intelligence:

The field of artificial intelligence, or AI, is concerned with not just understanding but also **building intelligent entities - machines that can compute how to act effectively and safely in a wide variety of novel situations.**



# Oxford English Dictionary Definition

## Artificial Intelligence:

The theory and development of **computer systems** able to perform **tasks normally requiring human intelligence**, such as visual perception, speech recognition, decision-making, and translation between languages.

*Source: <https://www.oxfordreference.com/view/10.1093/oi/authority.20110803095426960>*

# IBM Website Definition

## Artificial Intelligence:

Artificial intelligence leverages **computers** and **machines** to **mimic the problem-solving and decision-making capabilities of the human mind.**

*Source: <https://www.ibm.com/cloud/learn/what-is-artificial-intelligence>*

**But what is Intelligence?**



# Oxford English Dictionary Definition

## Intelligence:

The ability to **learn, understand** and **think in a logical way about things**; the ability to **do this well**.

*Source: [https://www.oxfordlearnersdictionaries.com/us/definition/american\\_english/intelligence](https://www.oxfordlearnersdictionaries.com/us/definition/american_english/intelligence)*

# R. J. Sternberg Definition

## Intelligence according to R. J. Sternberg:

Intelligence is the **cognitive ability** of an individual to **learn from experience**, to **reason well**, to **remember important information**, and to **cope with the demands of daily living**.

*Source: R. J. Sternberg- "In Search of the Human Mind" (1994). pp 395-396*

# **Further questions:**

**How do you decide if someone or something is intelligent?**

**Are animals intelligent?**

**If animals are intelligent, how do you measure their intelligence?**

**Are we the most intelligent beings?**



# Turing Test

## Turing test

During the Turing test, the human questioner asks a series of questions to both respondents. After the specified time, the questioner tries to decide which terminal is operated by the human respondent and which terminal is operated by the computer.

■ QUESTION TO RESPONDENTS ■ ANSWERS TO QUESTIONER

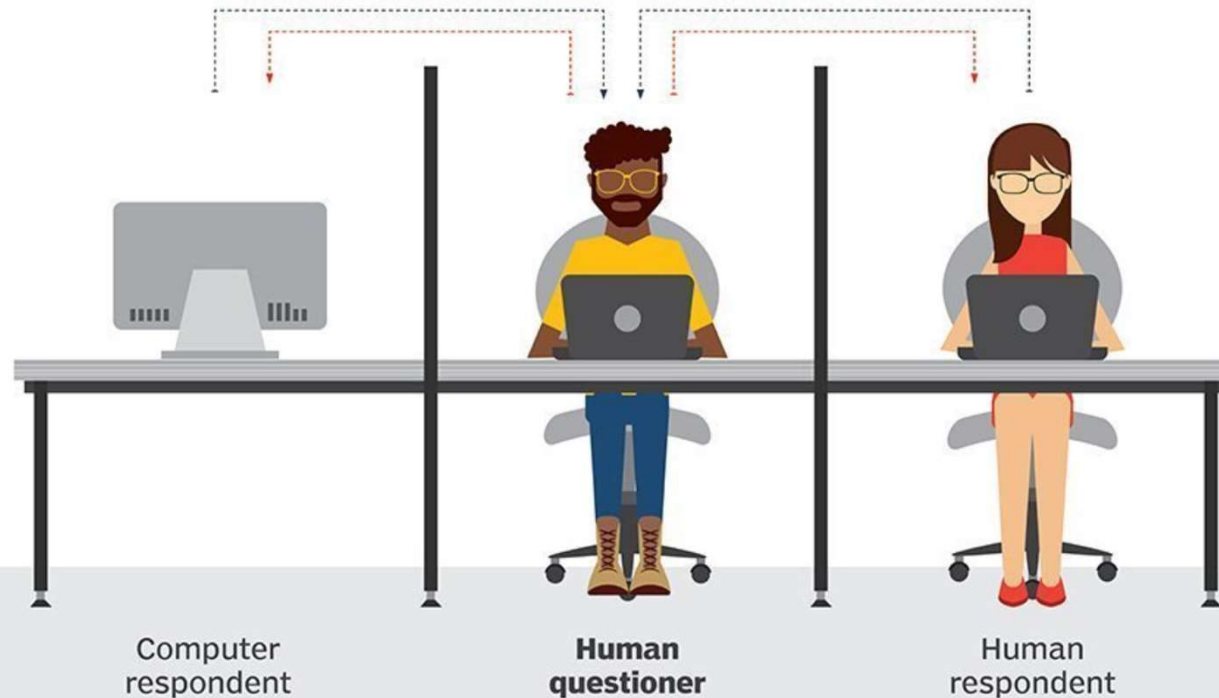


ILLUSTRATION: G5TUDIO GROUP/ADOBE STOCK

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Source: <https://searchenterpriseai.techtarget.com/definition/Turing-test>

# CAPTCHA: Machines vs. Humans

Table 3: Humans vs. bot solving time (seconds) and accuracy (percentage) for different CAPTCHA types.

CAPTCHA Type	Human		Bot	
	Time	Accuracy	Time	Accuracy
reCAPTCHA (click)	3.1-4.9	71-85%	1.4 [63]	100% [63]
Geetest	28-30	N/A	5.3 [70]	96% [70]
Arkose	18-42	N/A	N/A	N/A
Distorted Text	9-15.3	50-84%	<1 [77]	99.8% [39]
reCAPTCHA (image)	15-26	81%	17.5 [45]	85% [45]
hCAPTCHA	18-32	71-81%	14.9 [44]	98% [44]

Source: <https://arxiv.org/pdf/2307.12108.pdf>

**What questions would you  
suggest for a Turing test?**

**(we'll make it a Blackboard discussion)**

# Narrow / Strong / Super AI

## **Narrow / Weak AI:**

AI solutions programmed / dedicated to solve specific, “narrow” problems.

## **General / Strong AI:**

AI that matches humans.

## **Super AI:**

AI that surpasses human intelligence.



# Strong AI (As Seen on TV!):



## Weak AI:

Well... currently available AI

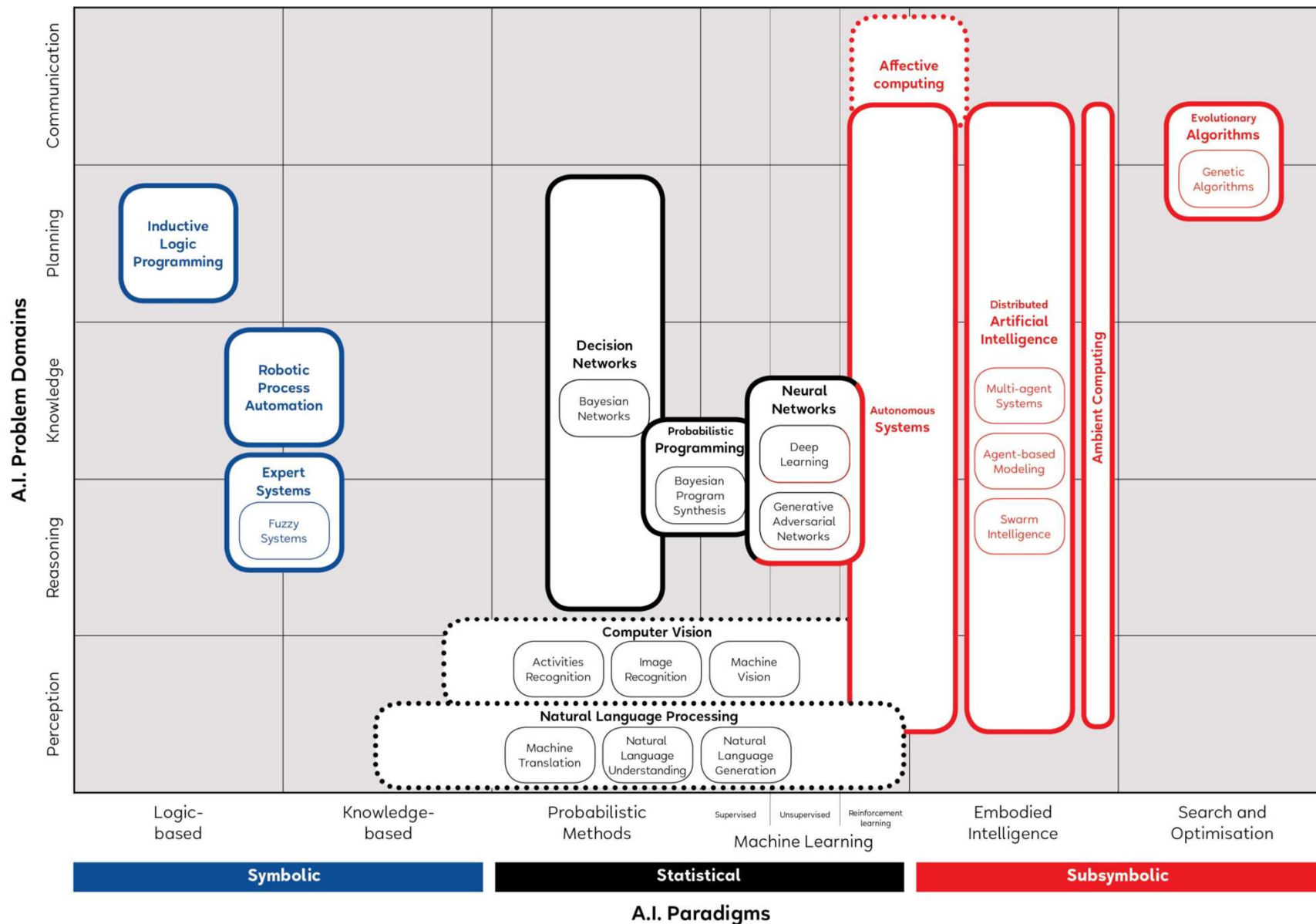
# AI Progress - Games Perspective

**AI wins (with champions in most cases):**

- **Checkers: 1994**
- **Othello / reversi: 1997**
- **Chess: 1997**
- **Scrabble: 2006**
- **Jeopardy: 2011**
- **Go: 2016**
- **Shogi: 2017**
- **Two-player no-limit hold'em poker: 2017**
- **Starcraft: 2019 [not with best players]**

**What was needed to win?**

# AI Knowledge Map



Source: <https://francesco-ai.medium.com/ai-knowledge-map-how-to-classify-ai-technologies-6c073b969020>

# Identifying Problems Suitable for AI

**Most** AI problems will exhibit the following three characteristics:

- tend to be large,
- computationally complex and cannot be solved by a straightforward algorithm,
- tend to require a significant amount of human expertise to be solved



# Solving Problems: A Structure

