CS 480

Introduction to Artificial Intelligence

August 26th, 2021

Announcements / Reminders

- Please follow the Week 01 To Do List instructions (if you haven't already):
  - Go through the Syllabus,
  - Setup Python environment on your computer
  - READ the assigned material

BEST JOBS U.S.News & WORLD REPORT 2021

Software Developer

#2 in **100 Best Jobs**

Software developers need to be innovative, creative and, of course, technical in order to succeed in this field. They might write new code or fix bugs in code to make it work better. **READ MORE »**

PROJECTED JOBS
316,000

MEDIAN SALARY
$107,510

EDUCATION NEEDED
Bachelor's

Statistician

#6 in **100 Best Jobs**

Statistics is the science of using data to make decisions. This is relevant in almost all fields of work and there are many opportunities for employment. **READ MORE »**

PROJECTED JOBS
14,800

MEDIAN SALARY
$91,160

EDUCATION NEEDED
Master's

Data Scientist

#8 in **100 Best Jobs**

Data scientists use technology to glean insights from large amounts of data they collect. **READ MORE »**

PROJECTED JOBS
10,300

MEDIAN SALARY
$94,280

EDUCATION NEEDED
Bachelor's

Source: https://money.usnews.com/careers/best-jobs/rankings/the-100-best-jobs

Plan for Today

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

The quest for Artificial Intelligence

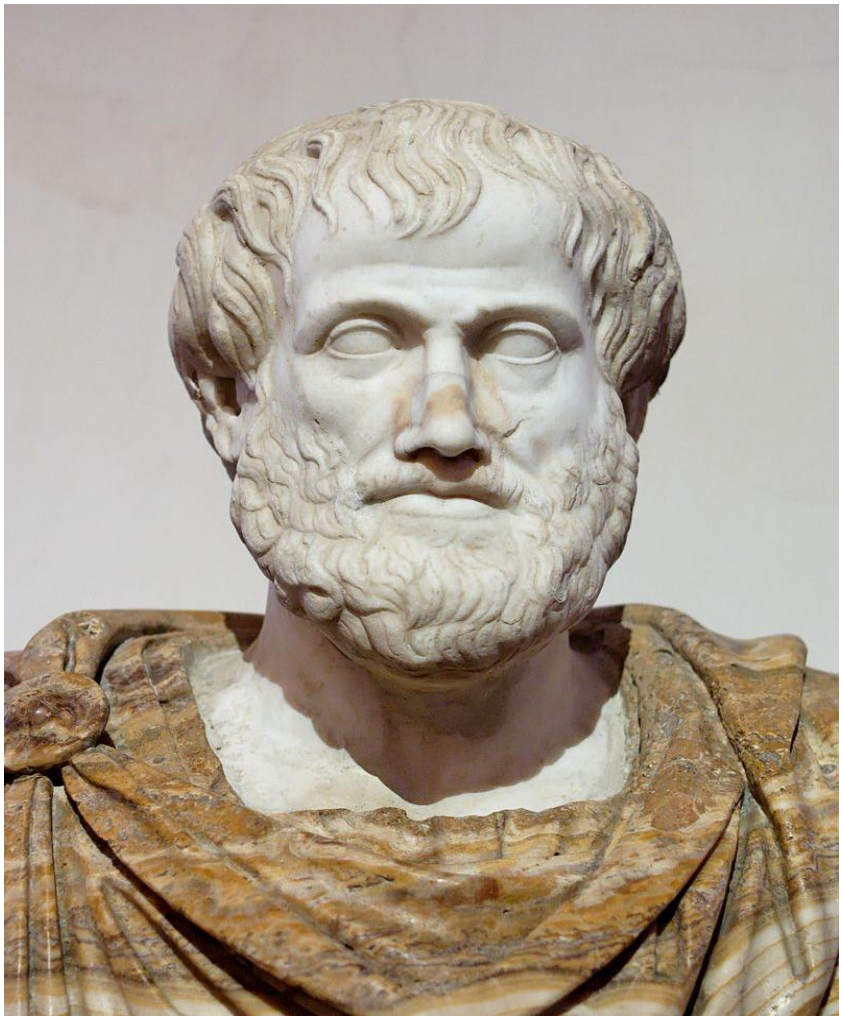
Selected ideas and artifacts in human history

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.

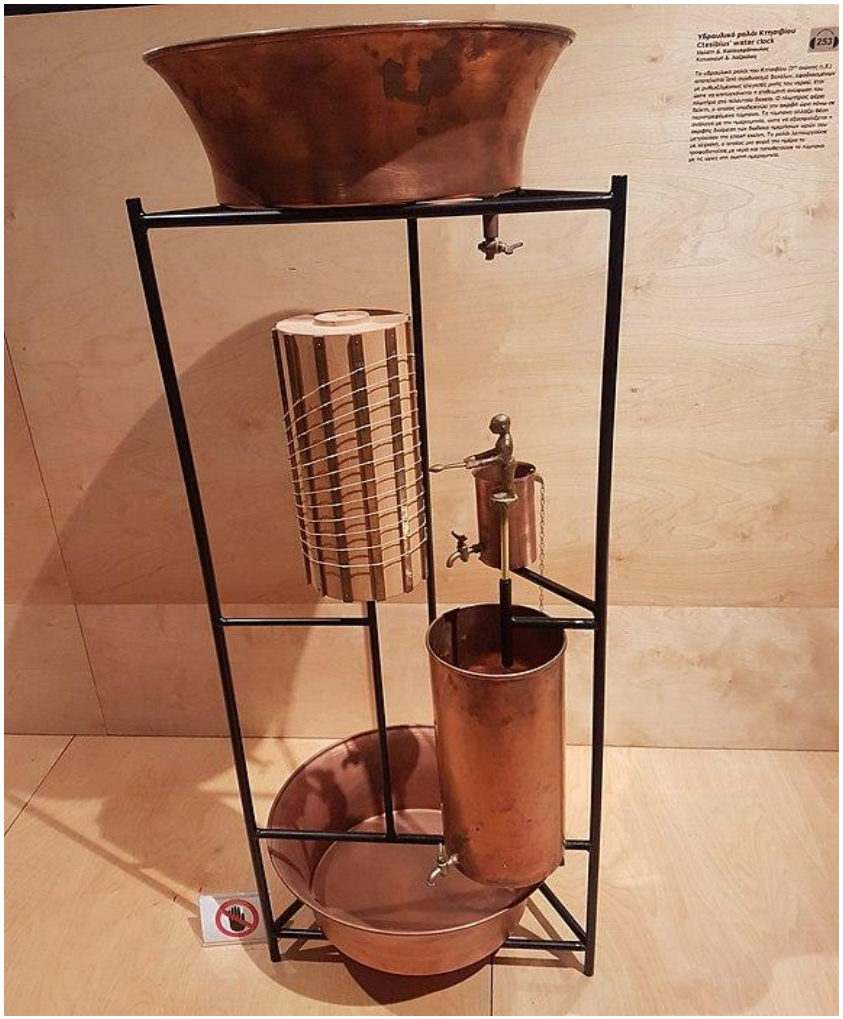
Aristotle's Ideas (around 350 BC)



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** (...)"

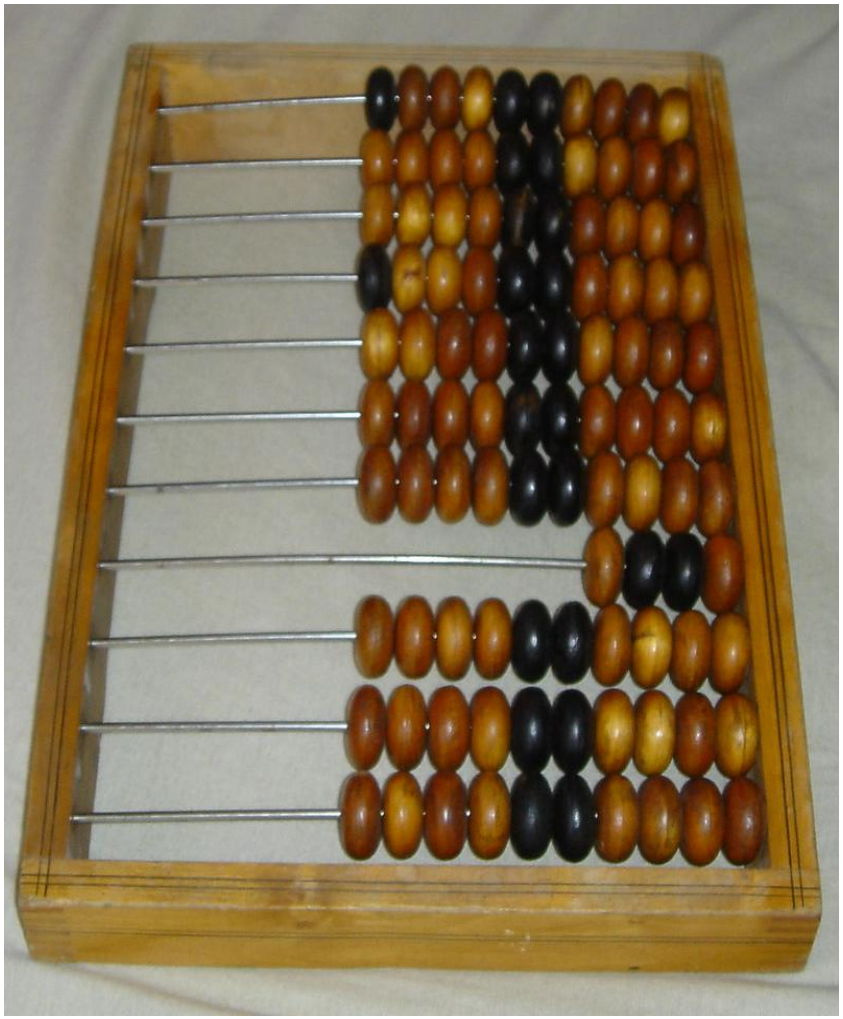
Water Clock (around 250 BC)



Source: https://commons.wikimedia.org/wiki/File:Ctesibius%27s_water_clock,_3rd_century_BC,_Alexandria_(reconstruction).jpg

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**.

Abacus (around 190 BC)



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

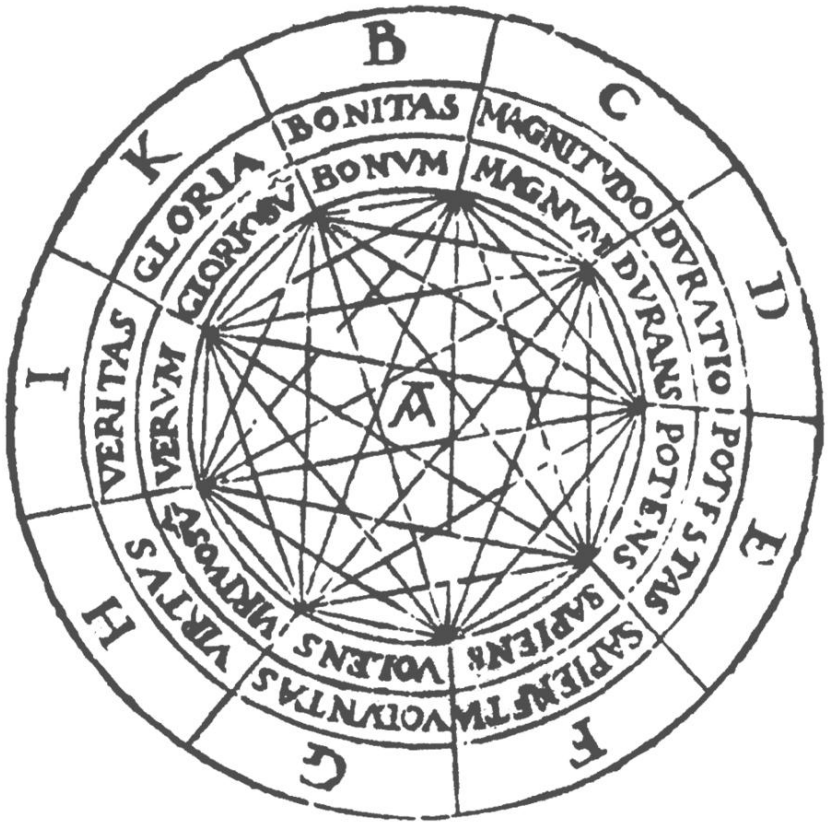
The abacus is an ancient **calculating tool** allowing humans to **perform fast calculations in commerce and engineering**. It consists of rows of movable objects representing digits and **can be considered the ancestor to the computer**.

Antikythera (around 125 BC)

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

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

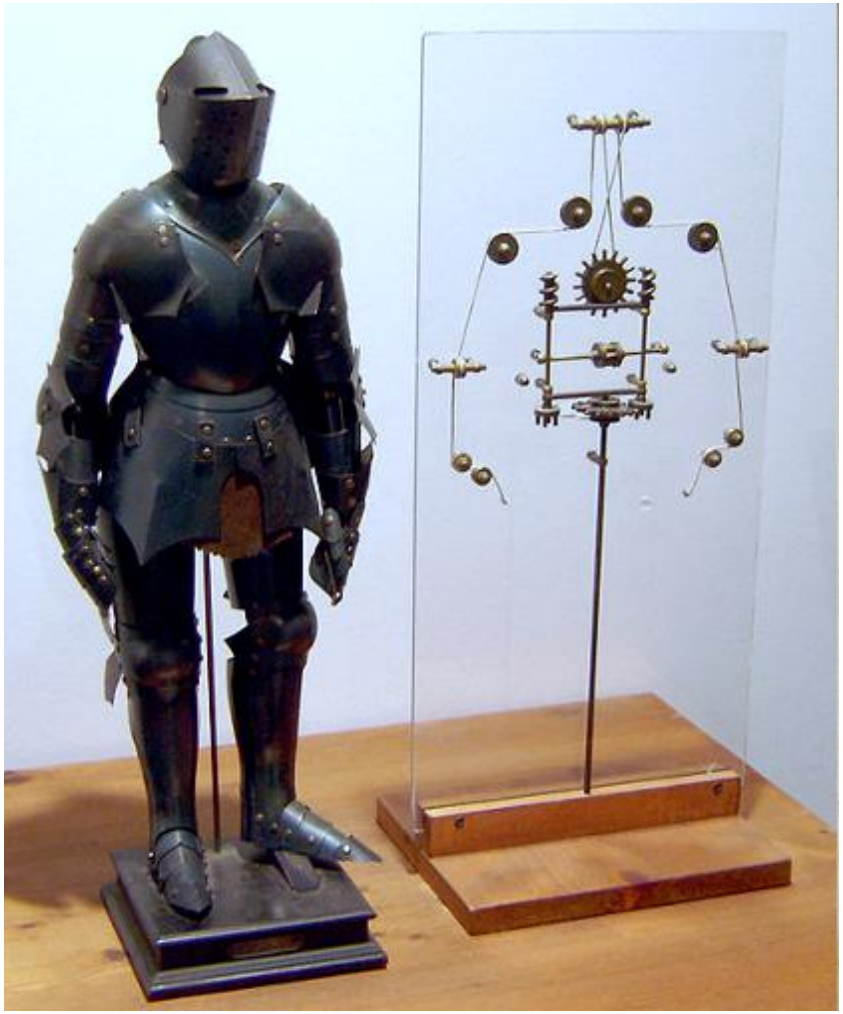
Llull's Ars Magna (around 1305)



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

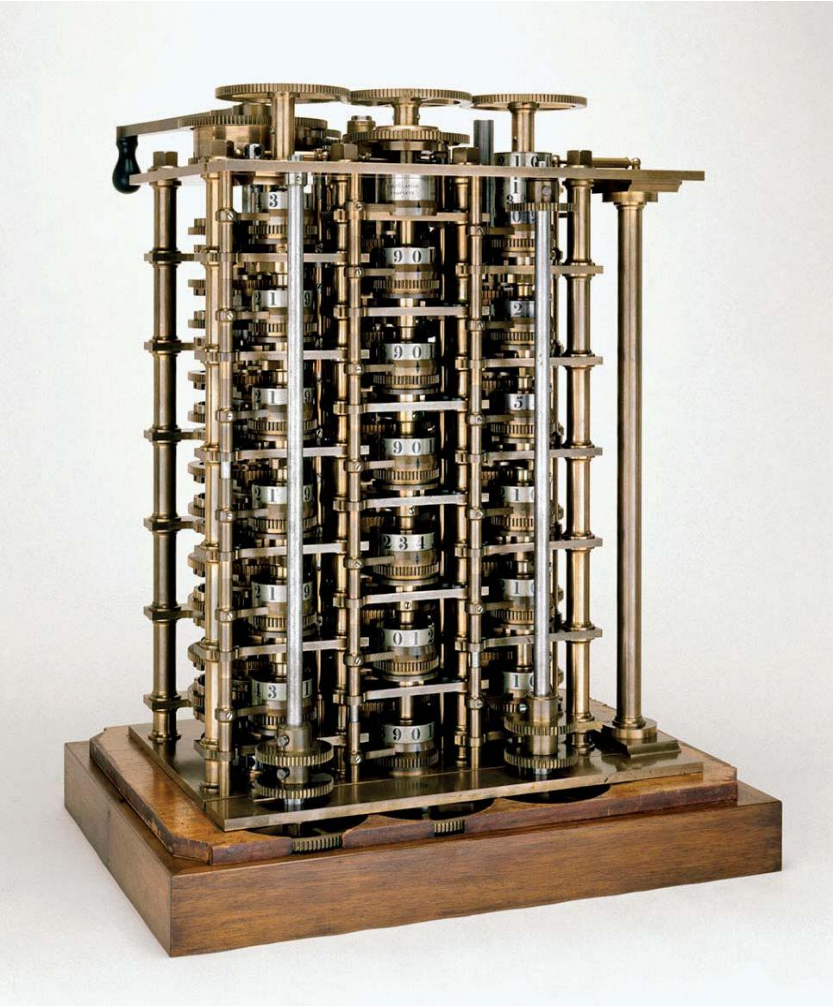
da Vinci's Knight (around 1495)



Source: 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.

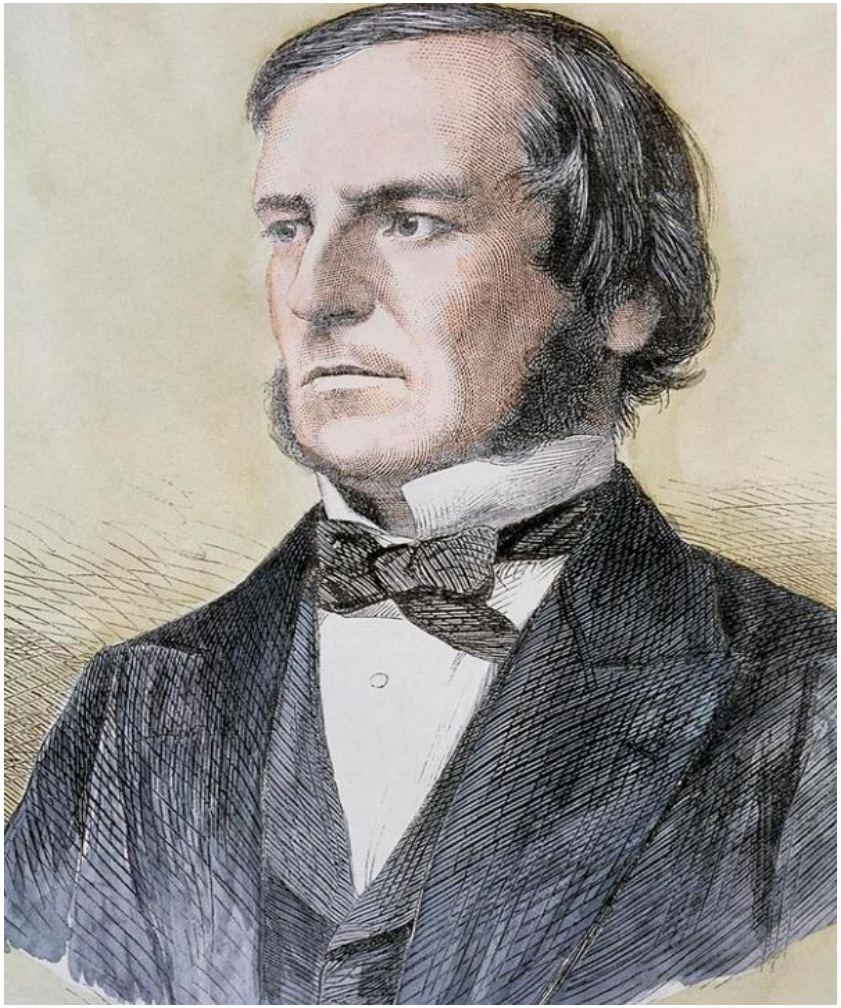
Babbage's Difference Engine (1822)



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

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.

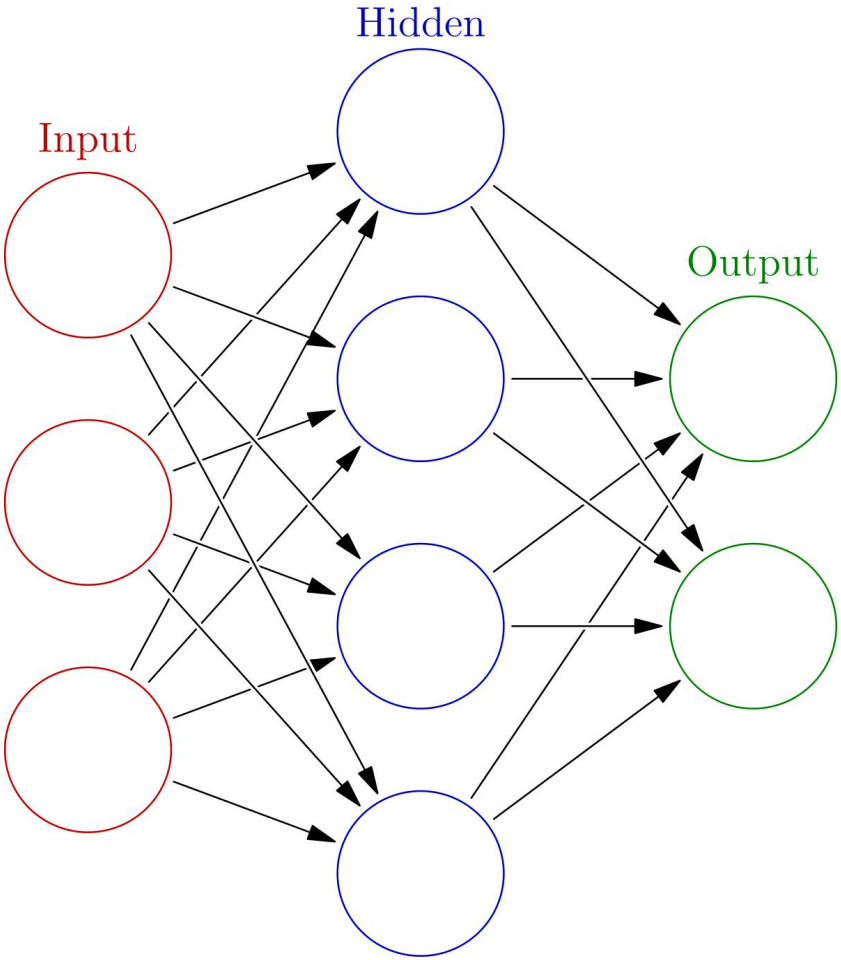
Boolean Algebra (1854)



Source: 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,

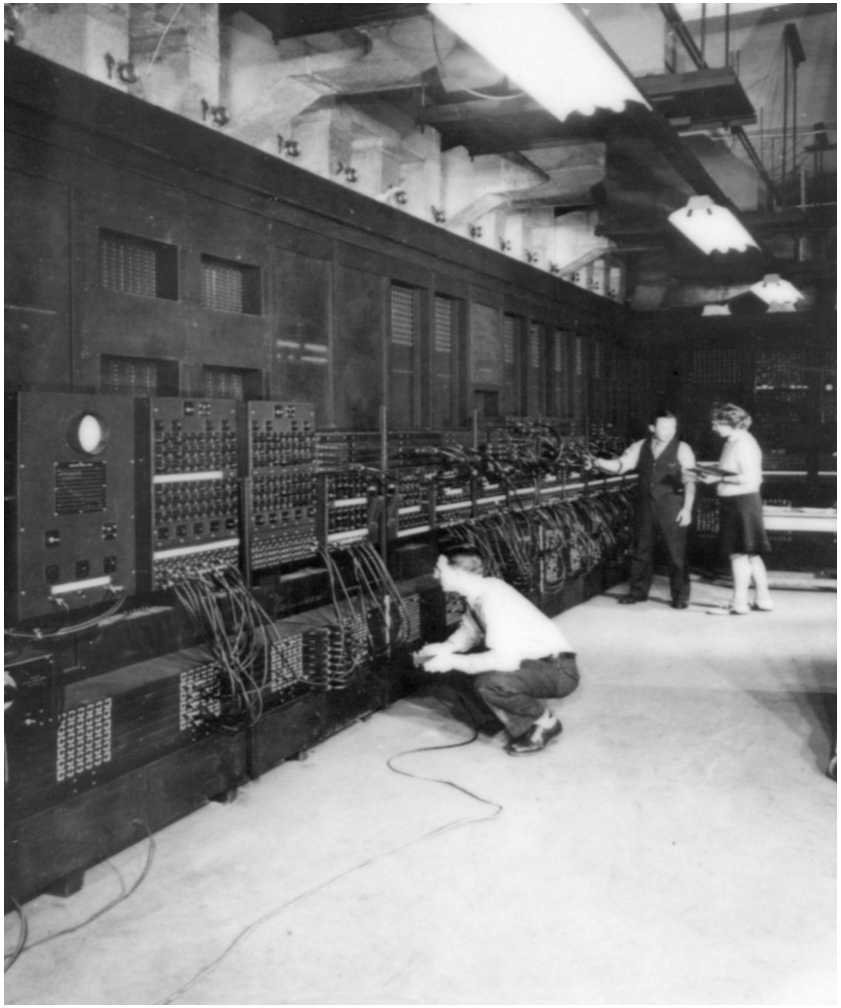
Artificial Neural Network (1943)



Source:
https://en.wikipedia.org/wiki/Artificial_neural_network

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**.

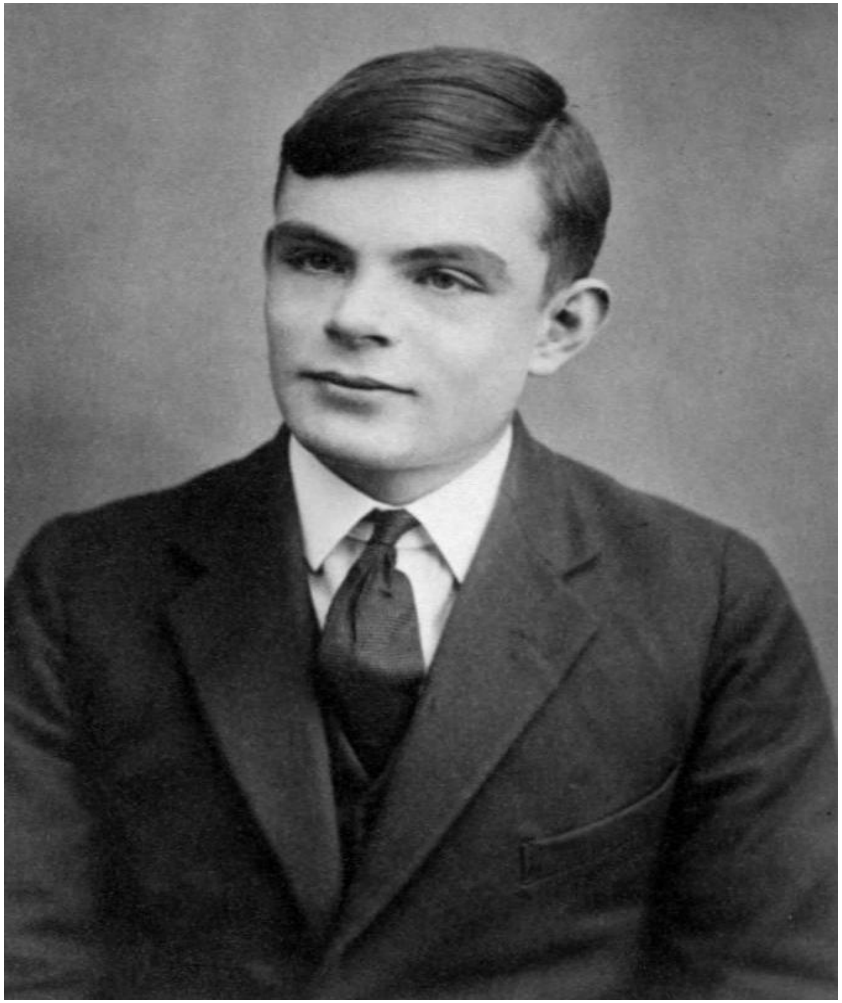
ENIAC (1946)



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

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.

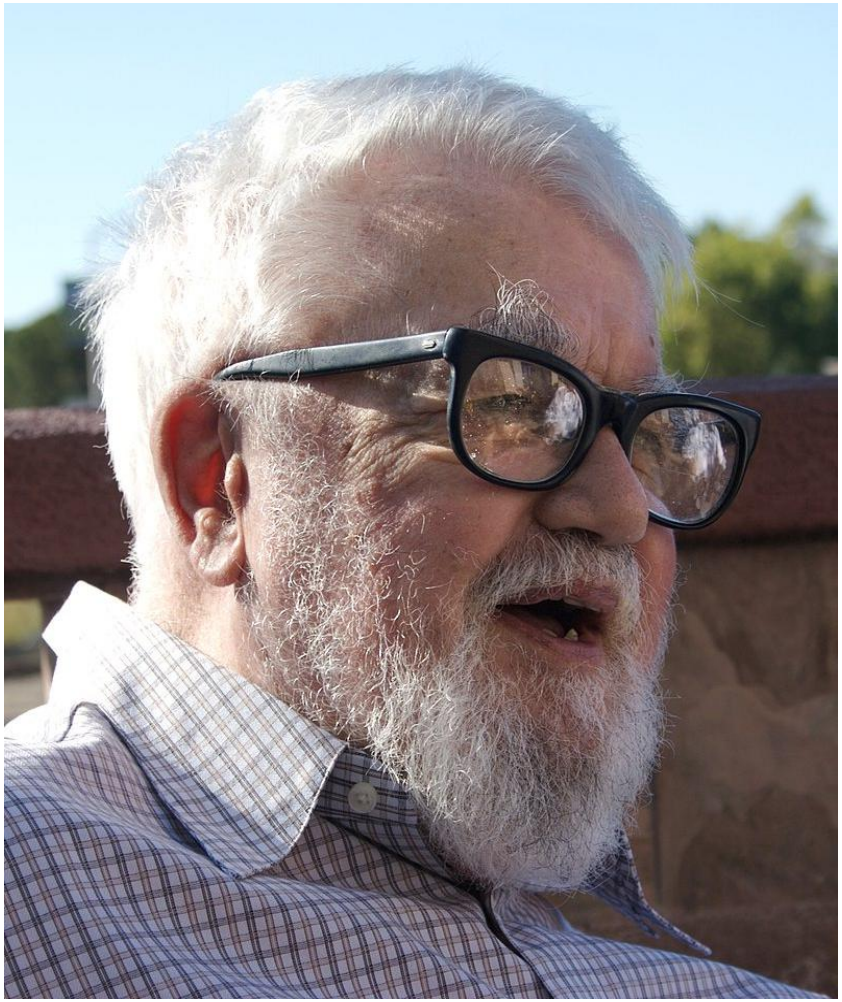
Turing Test (1950)



Source: 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)

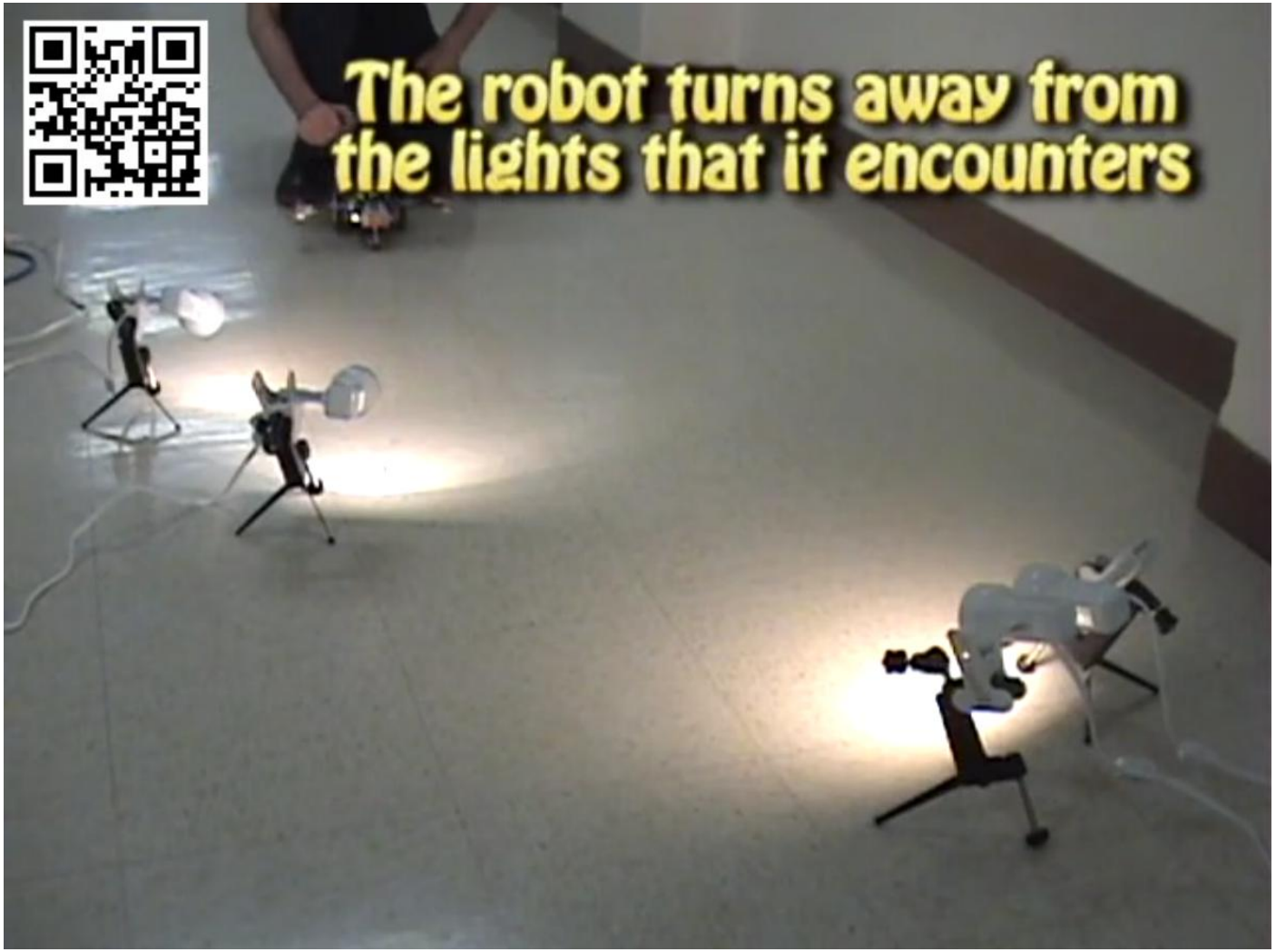


John McCarthy, who coined the term AI. Source: https://en.wikipedia.org/wiki/John_McCarthy_(computer_scientist)

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

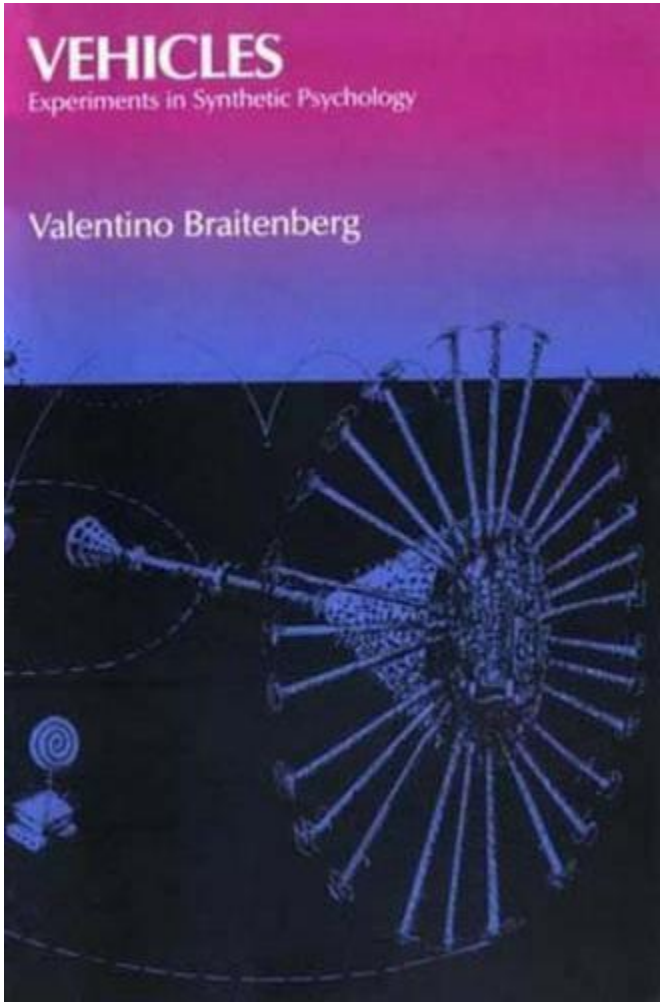
Have you noticed any key themes?

Is this intelligence?

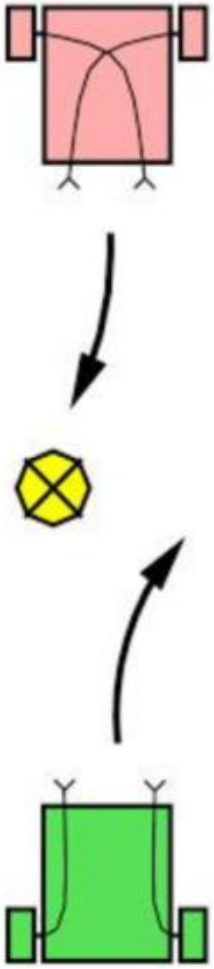


Source: https://www.youtube.com/watch?v=yUVcI5Pw2o4

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

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:

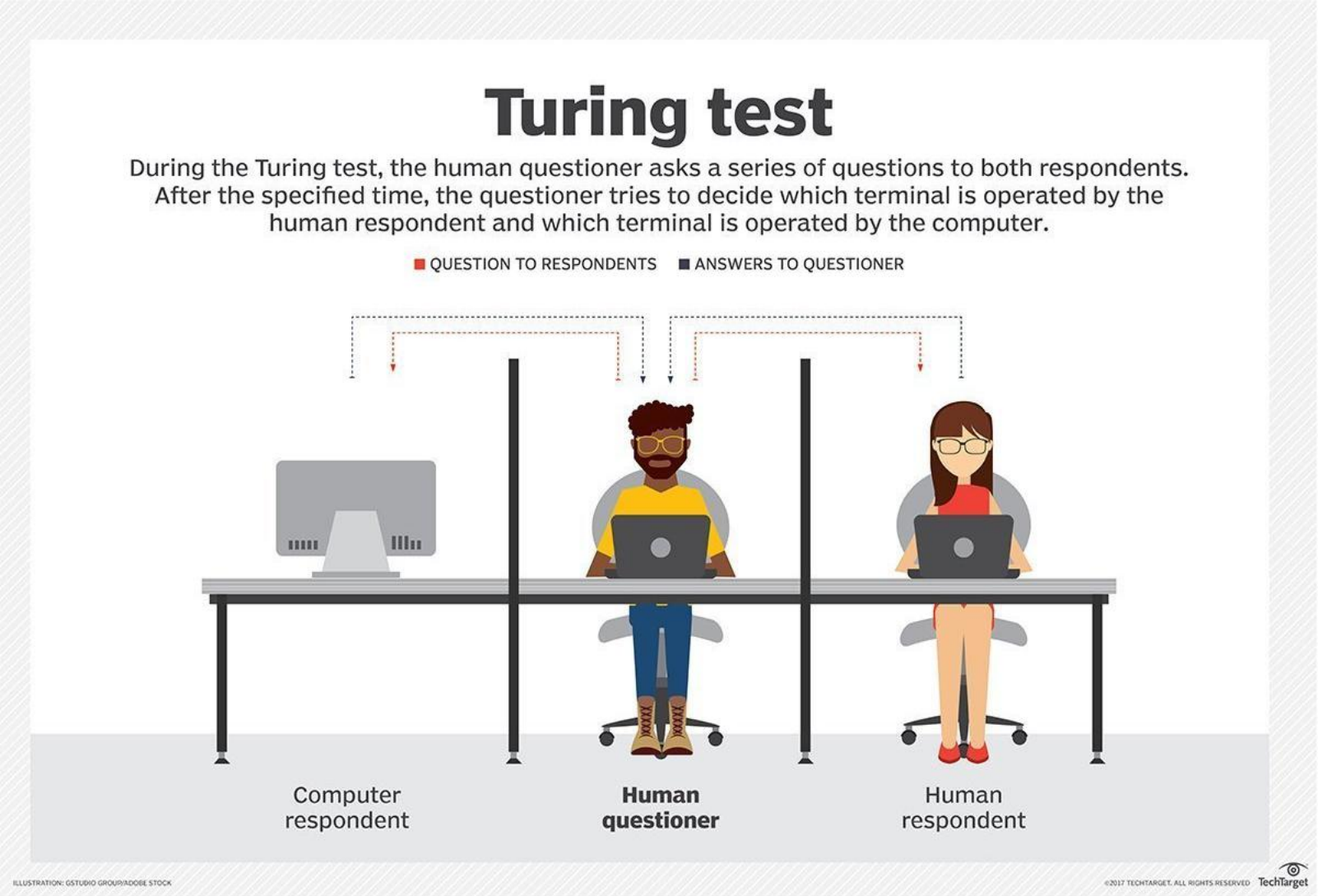
How do you decide if someone or something is intelligent?

Are animals intelligent?

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

Are we the most intelligent beings?

Turing Test



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

What questions would you suggest for a Turing test?

(we'll make it a Blackboard discussion)

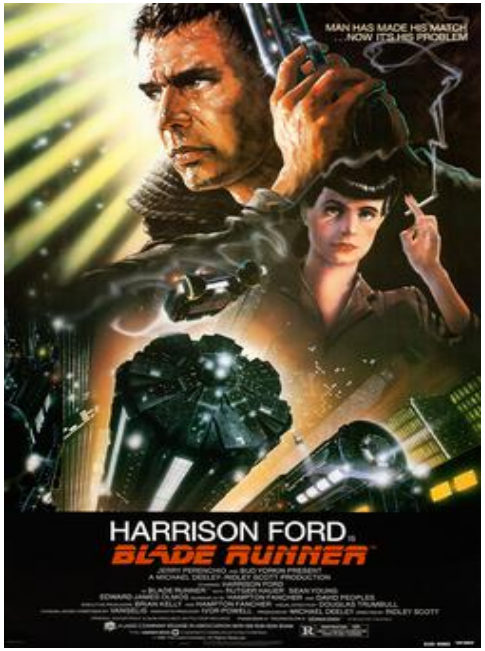
Narrow / Strong / Super AI

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

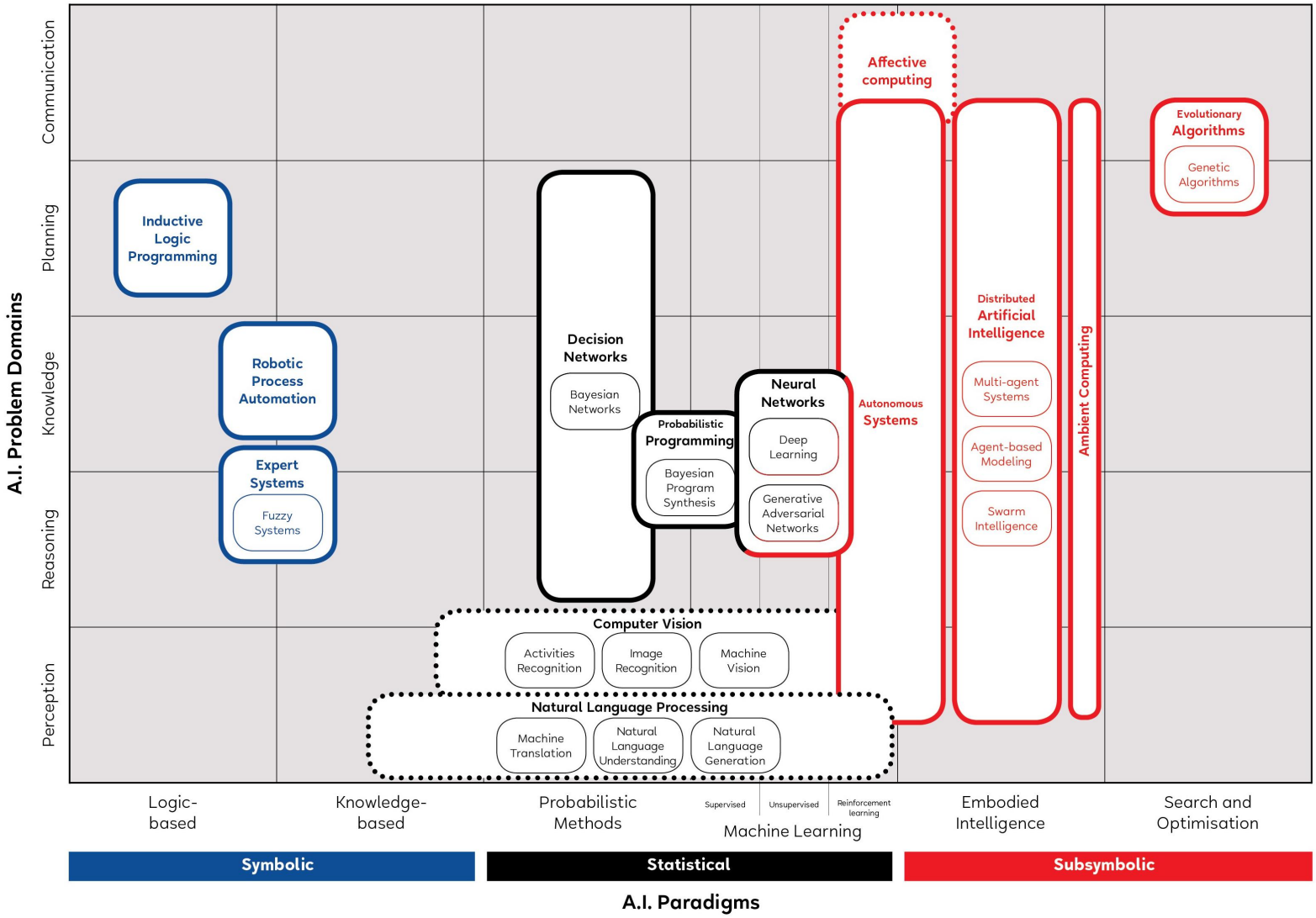
AI Progress - Games Perspective

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



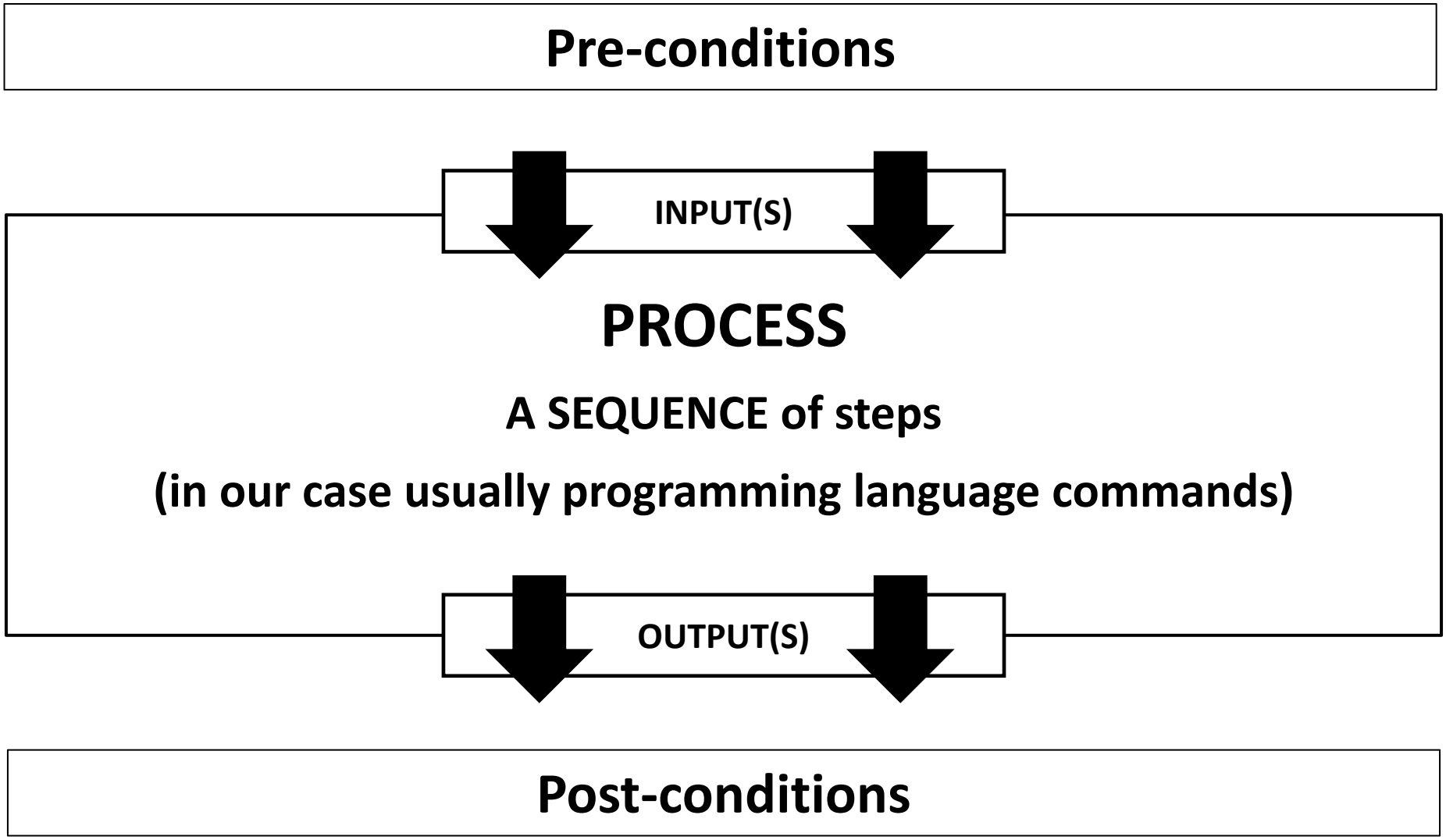
Source:https://francesco-ai.medium.com/ai-knowledge-map-how-to-classify-ai-technologies-6c073b969020

Identyfing Problems Suitable for AI

Most AI problems will exhibit the following three characteristics:

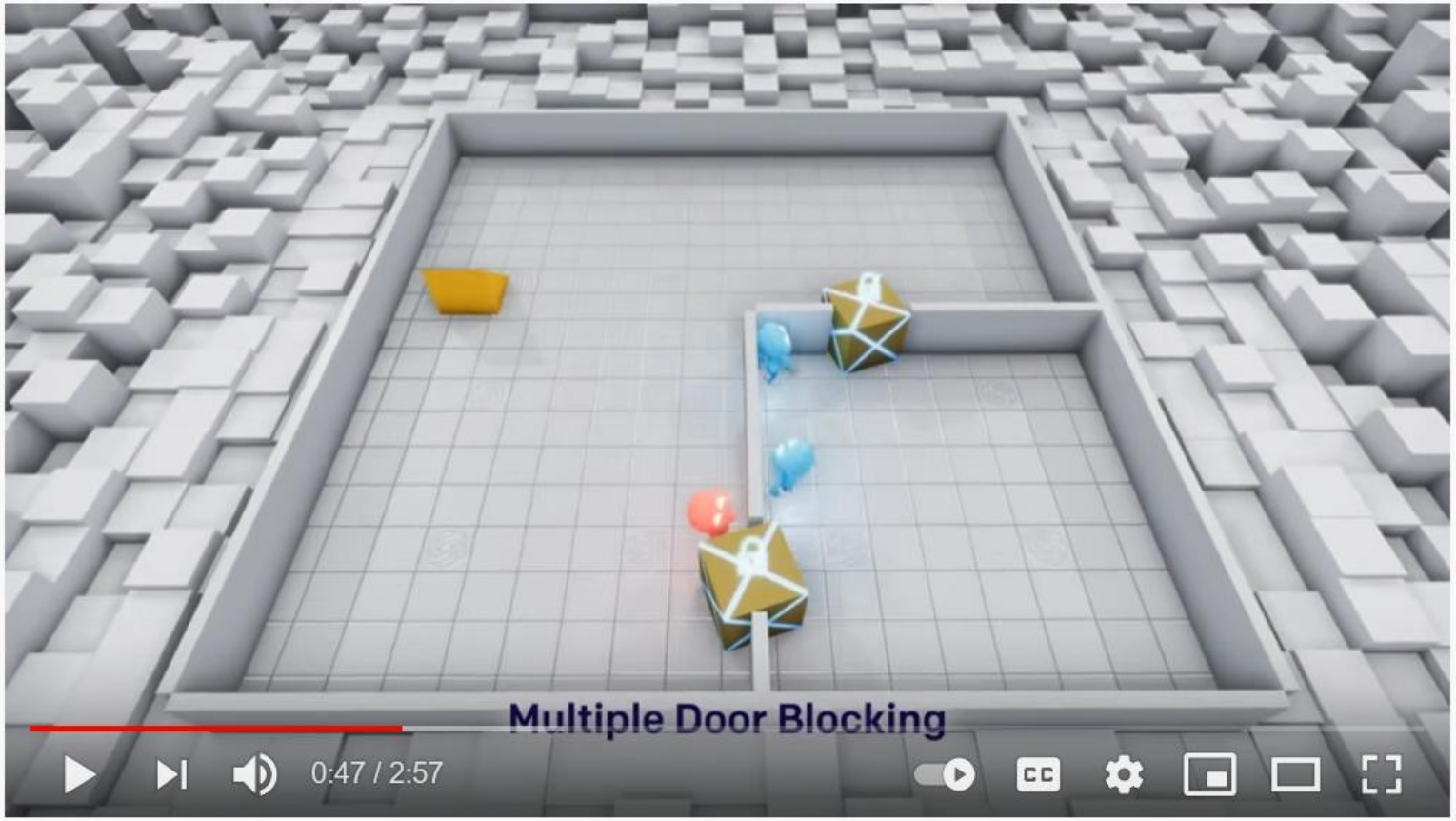
- tend to be large,
- computationally complex and cannot be solved by a straightforward algorithm,
- tend to require a significant amount of human expertise to be solved

Solving Problems: A Structure



Intelligent (Autonomous) Agents

Intelligent Agents in Action



Multi-Agent Hide and Seek

4,588,797 views • Sep 17, 2019 120K 1.7K SHARE SAVE

Source: https://www.youtube.com/watch?v=kopoLzvh5jY

Agent

Agent:

An **agent** is just **something that acts** (from the Latin agere, to do).

Of course, we would prefer "acting" to be:

- autonomous
- situated in some environment (that could be really complex)
- adaptive
- creative and goal-oriented

Rational Agent

Rational Agent:

A **rational agent** is one that acts so as **to achieve the best outcome**, or when there is uncertainty, **the best expected outcome**.*

* no worries, we will make it a little less vague soon

AI: Constructing Agents

You can say that:

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

Agent