Kecerdasan Buatan

M. Ali Fauzi

Artificial Intelligence

M. Ali Fauzi

TODAY

~ What is artificial intelligence?

~ **What is artificial intelligence?**
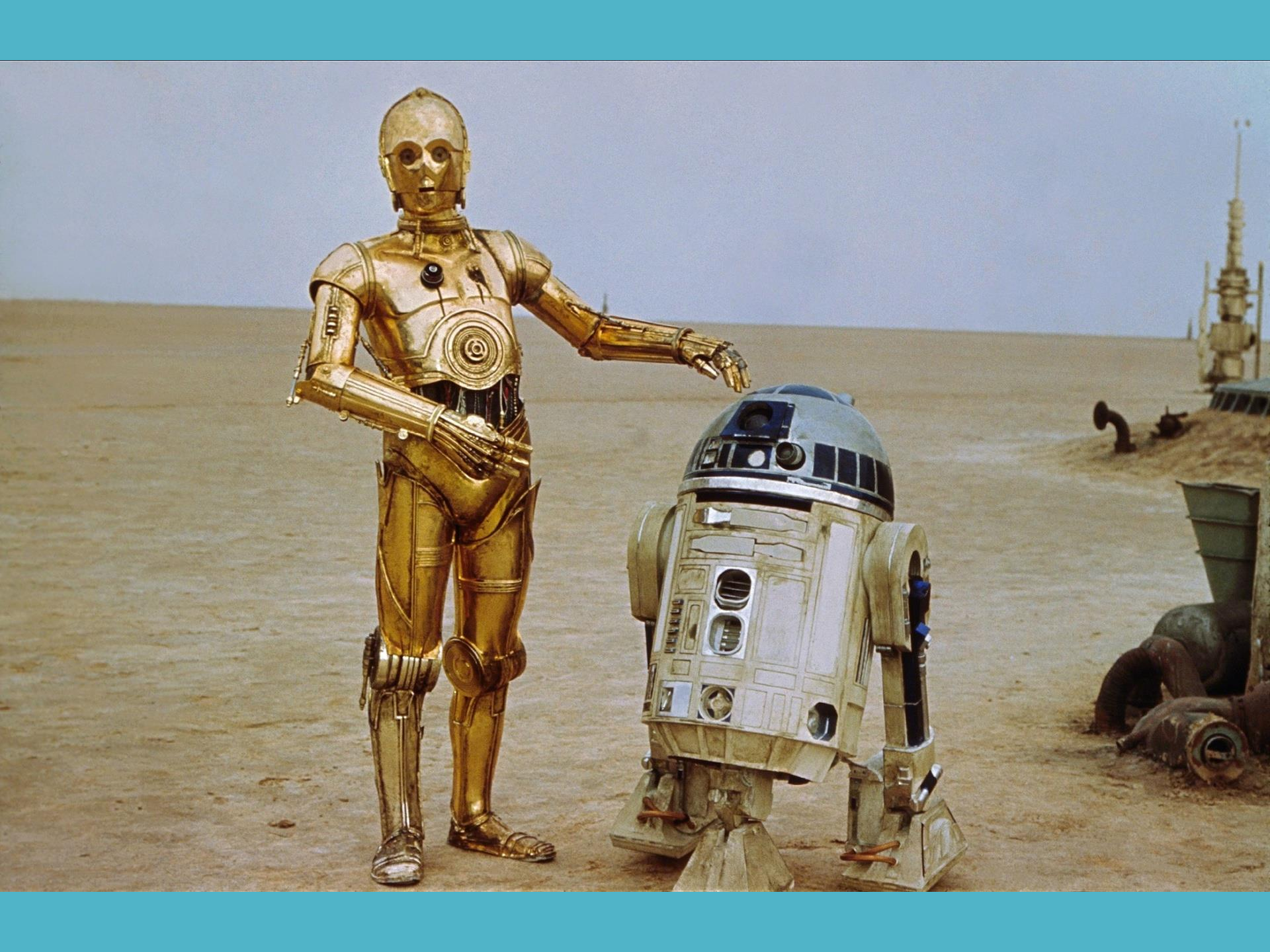~ **What can AI do?**
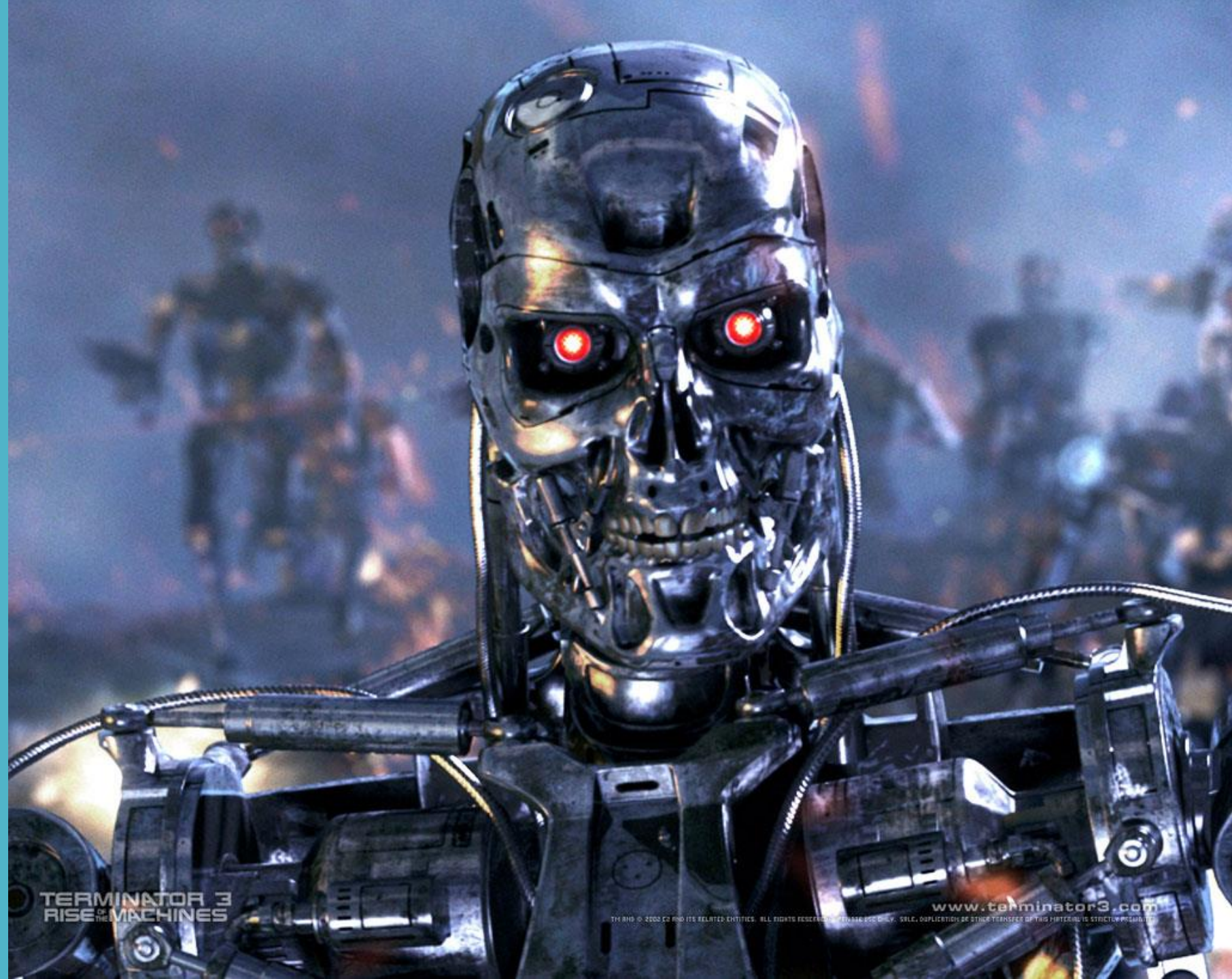
~ **What is artificial intelligence?**
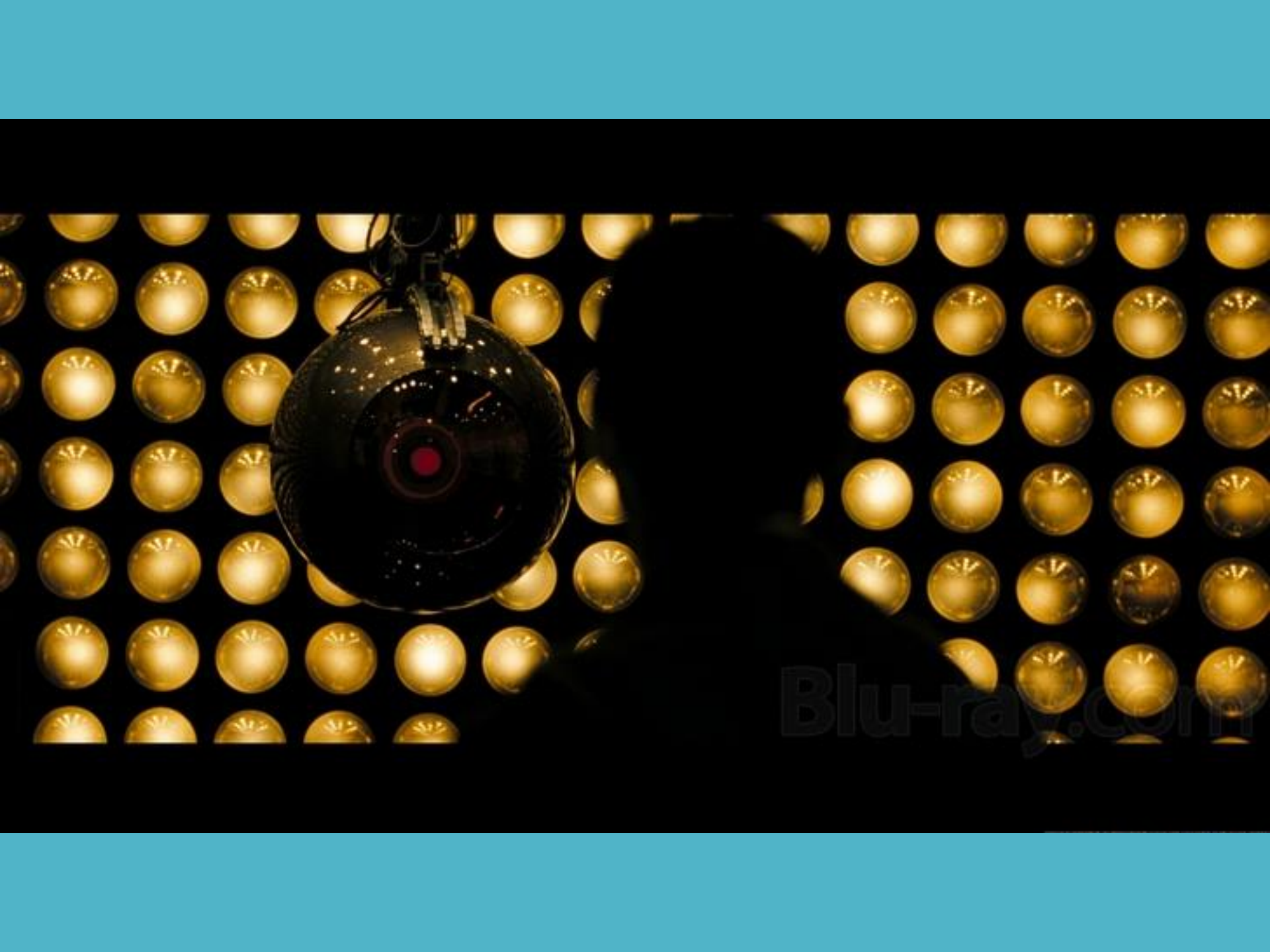~ **What can AI do?**
~ **What is this course?**
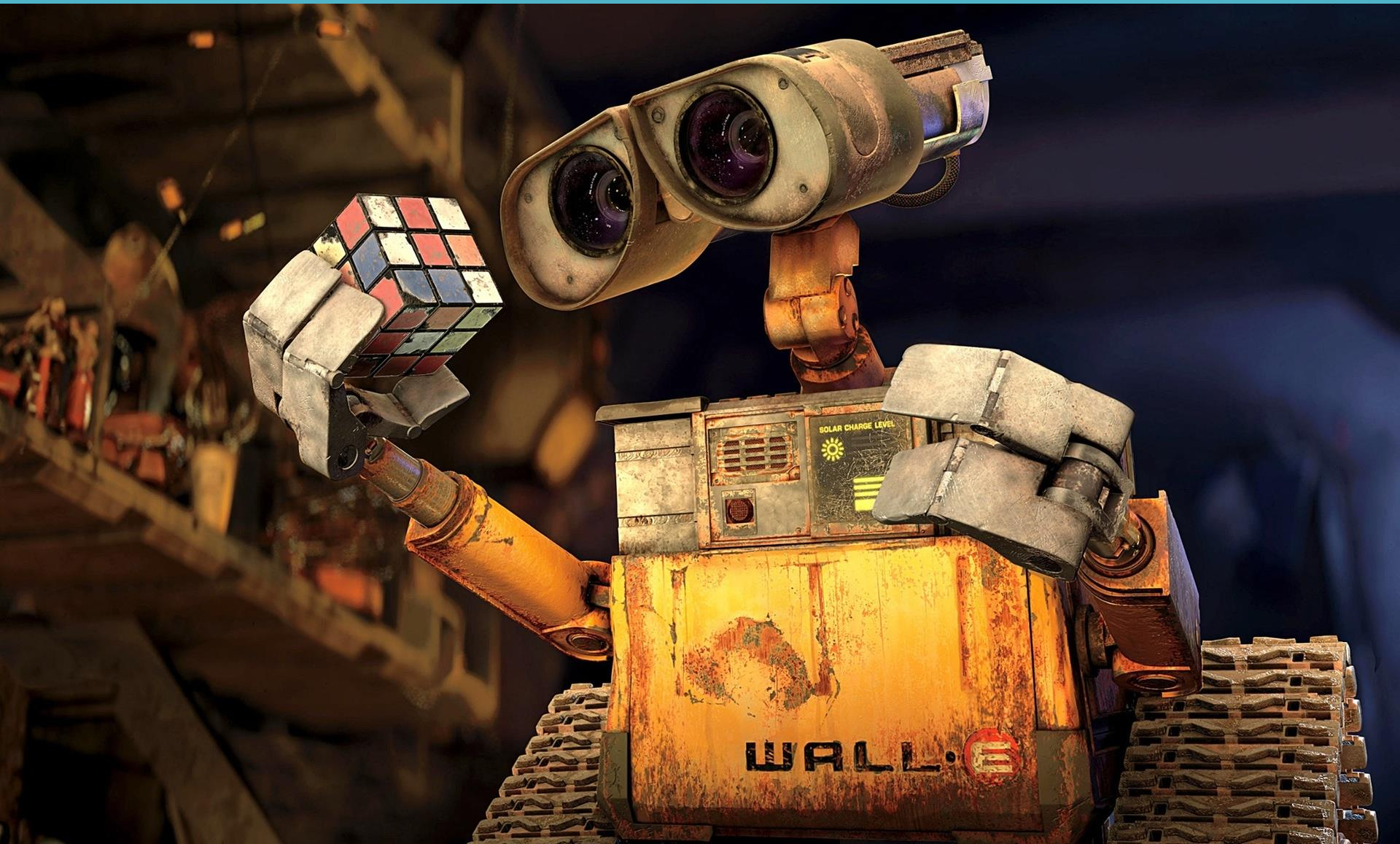
Sci-Fi AI

TERMINATOR 3
RISE OF THE MACHINES

www.terminator3.com
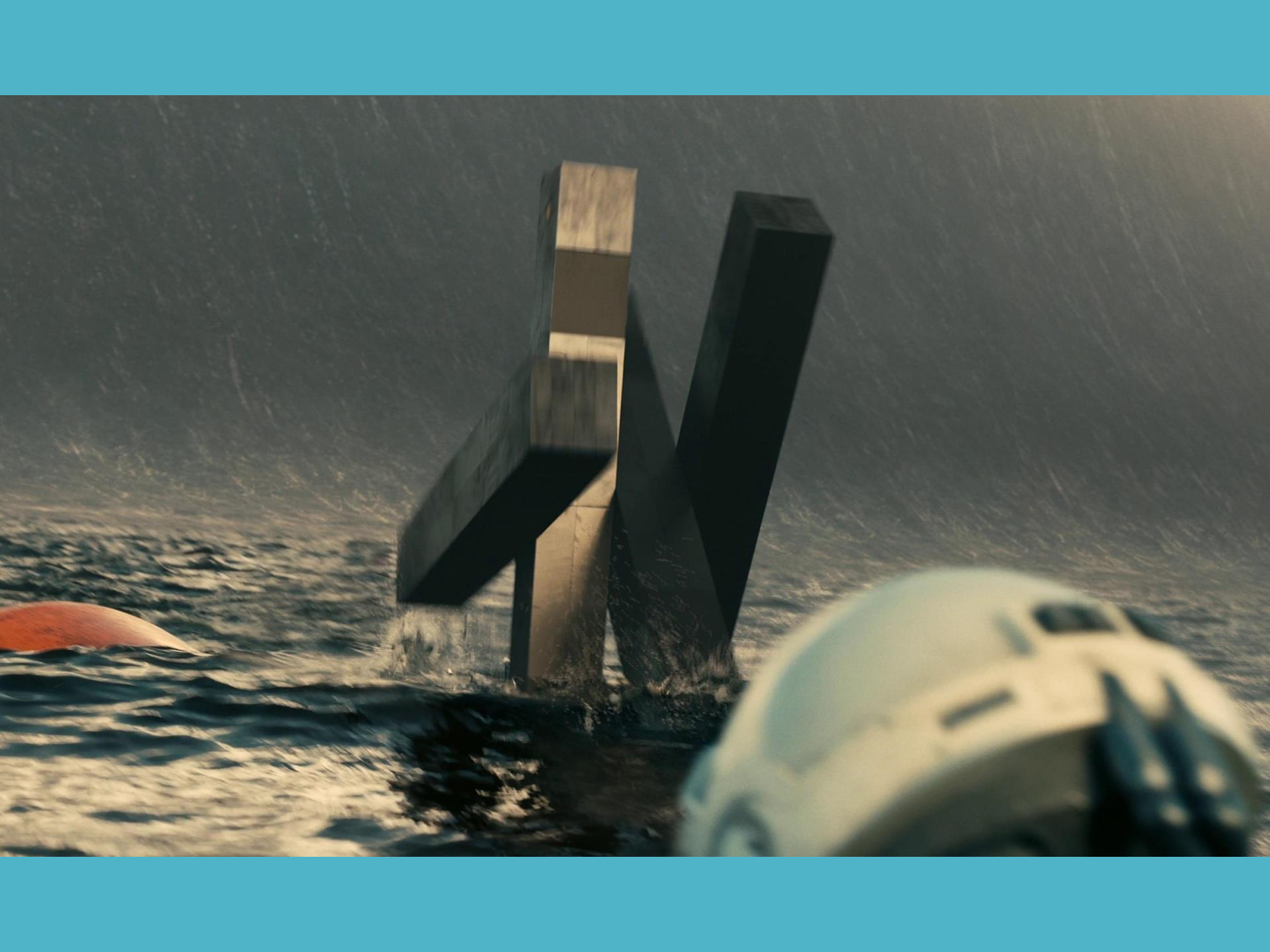
What is AI?

The science of making machines that:
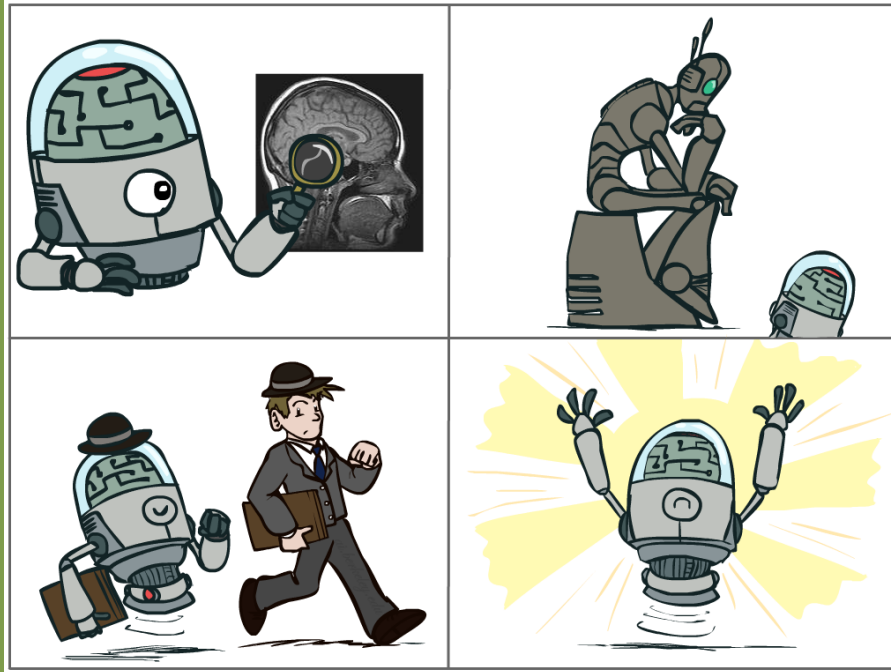
Think humanly
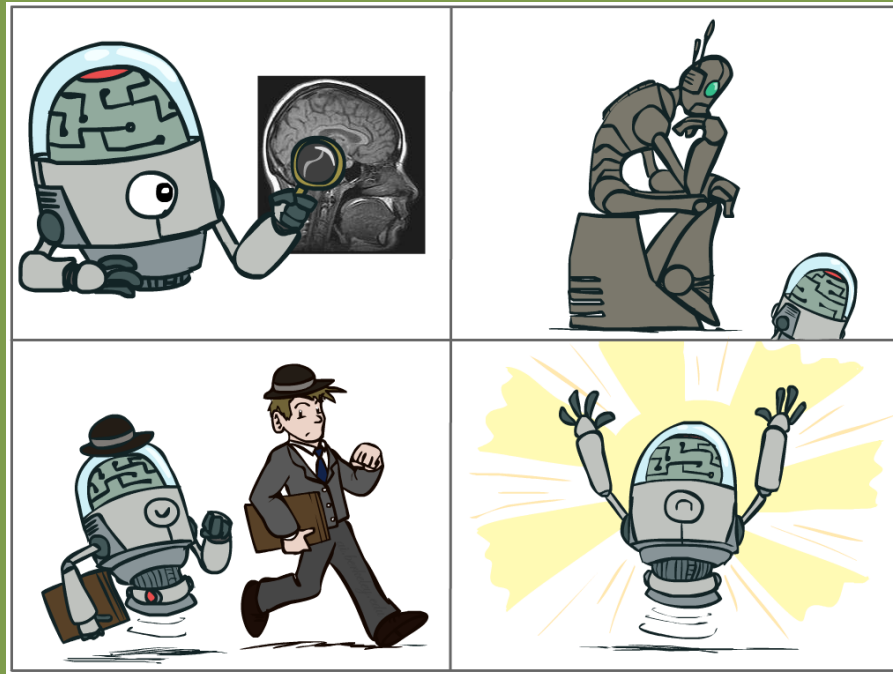
Act humanly

Think Rationally

Act Rationally

Systems that think like humans	Systems that think rationally
"The exciting new effort to make computers think ... *machines with minds,* in the full and literal sense." (Haugeland, 1985) "[The automation of] activities that we associate with human thinking, activities such as decision-making, problem solving, learning ...'" (Bellman, 1978)	"The study of mental faculties through the use of computational models." (Chamiak and McDermott, 1985) "The study of the computations that make it possible to perceive, reason, and act." (Winston, 1992)
Systems that act like humans	**Systems that act rationally**
"The art of creating machines that perform functions that require intelligence when performed by people." (Kurzweil, 1990) "The study of how to make computers do things at which, at the moment, people are better." (Rich and Knight, 1991)	"Computational Intelligence is the study of the design of intelligent agents." (Poole *et al.*, 1998) "AI ...is concerned with intelligent behavior in artifacts." (Nilsson, 1998)

Figure 1.1   Some definitions of artificial intelligence, organized into four categories.

The science of making machines that:

Think humanly

Act humanly

Think Rationally

Act Rationally

Human vs Rational?

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**

So, humans are necessarily "irrational" in the sense of "emotionally unstable" or "insane" ?

One merely need note that **we are not perfect** : we are not all chess grandmasters, even those of us who know all the rules of chess; and, unfortunately, not everyone gets an A on the exam
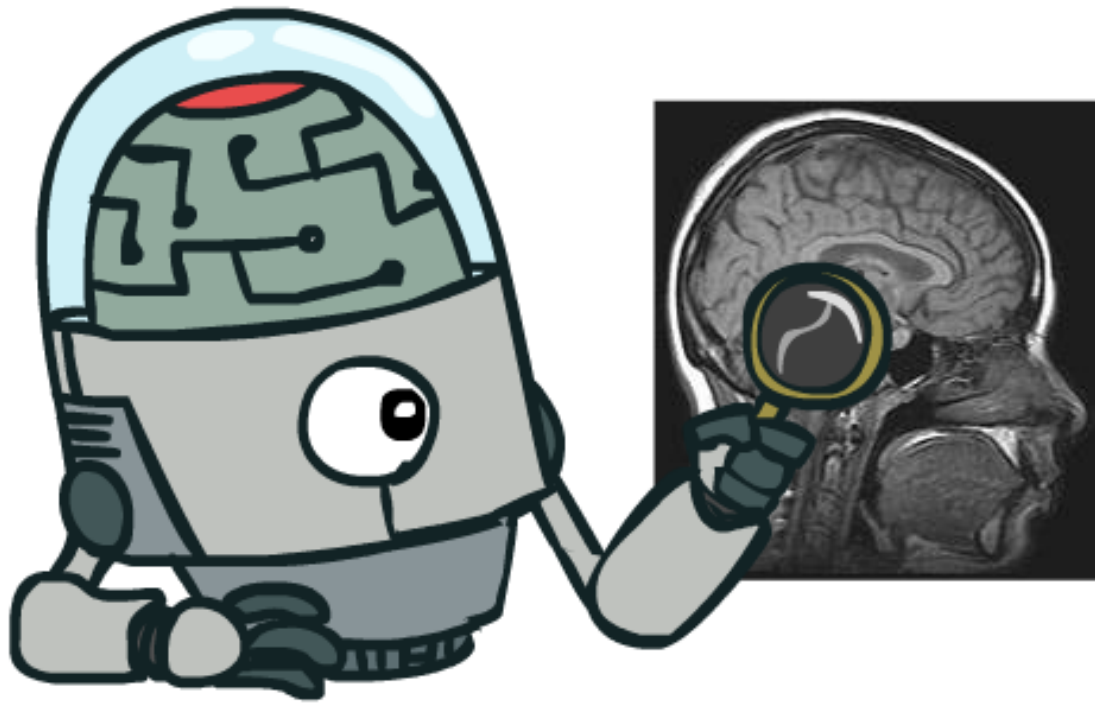
Think Humanly

We need to get inside the actual workings of human minds.

There are two ways to do this:
- **Through introspectior** : trying to catch our own thoughts as they go by
- **Through psychological experiments.**

Example : Allen Newel and Herbert Simon who developed GPS (General Problem Solver) in 1961, were not content to have their program solve problems correctly.

They were more concerned with comparing the trace of its **reasoning steps** to traces of human subjects solving the same problems.

There is actually a science that studies this and it's not really AI anymore : **cognitive science** and **computational neuroscience**
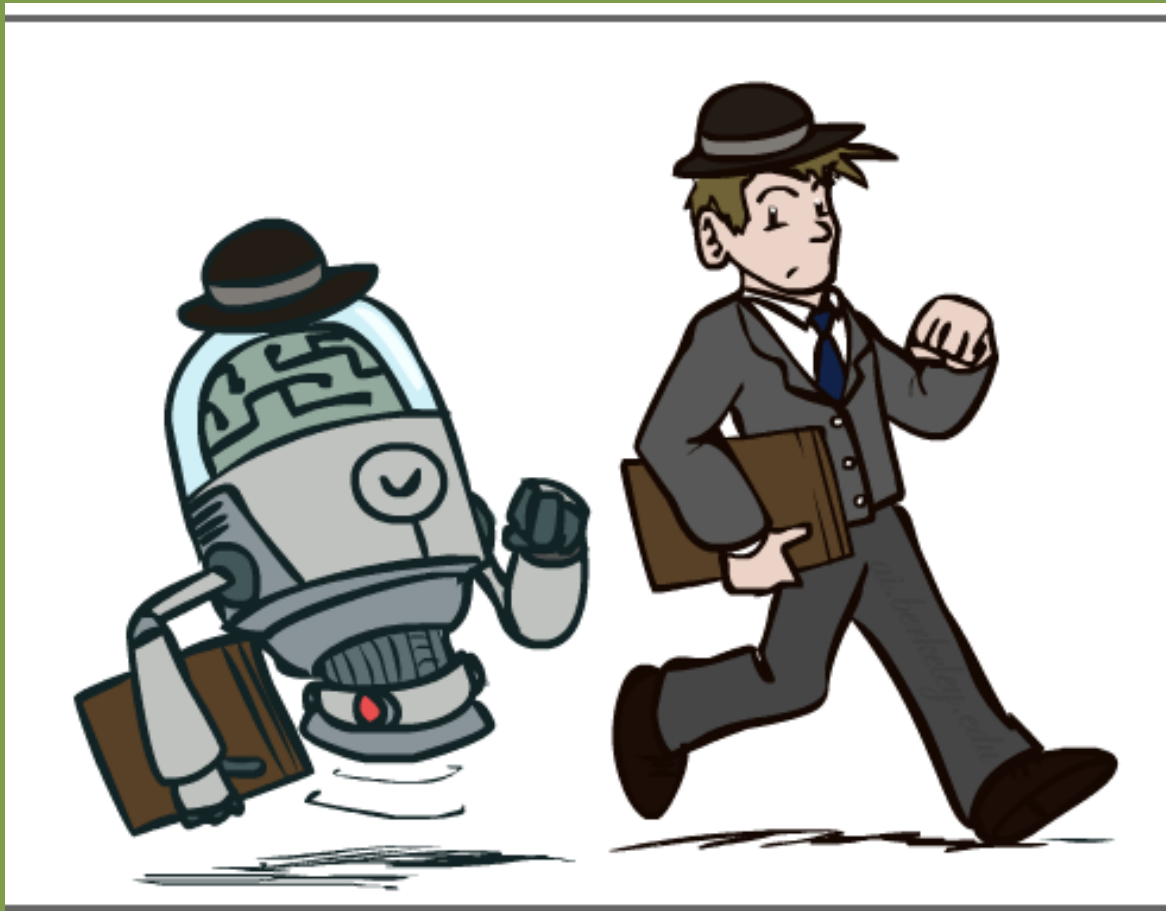
Act Humanly

The Turing Test : a test based on indistinguishability from undeniably intelligent entities - human beings.

The computer would need to possess the following capabilities : *Natural Language Processing, Knowledge Representation, Automated Reasoning, Machine Learning* **Plus** *Computer Vision and Robotics.*
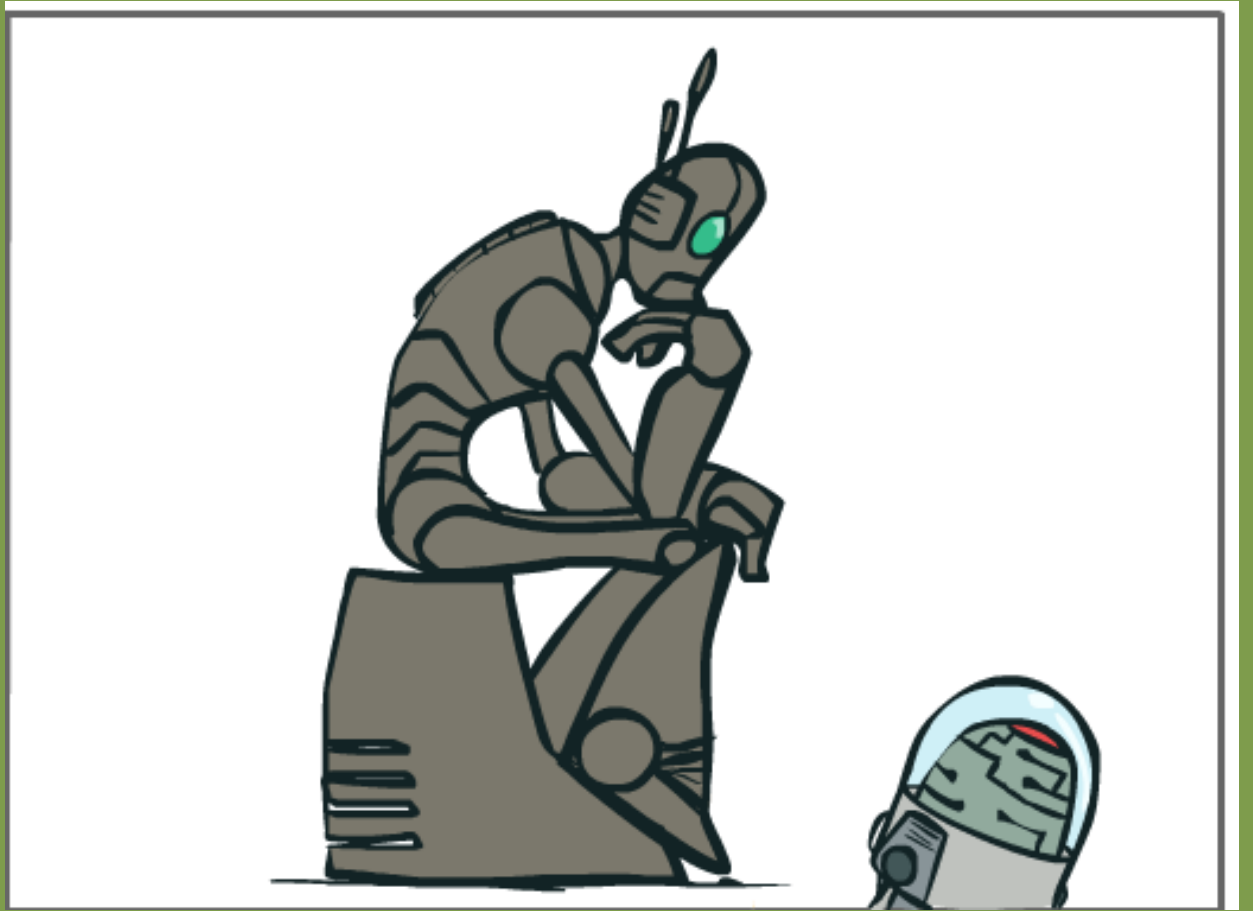
Think Rationally

The "laws of thought" approach

Aristotle was one of the first to attempt to codify "right thinking," that is, irrefutable **reasoning processes**

His **syllogisms** provided patterns for argument structures that always yielded correct conclusions when given correct premises.

Logicians in the 19th century developed a precise **notation** for statements about all kinds of things in the world and about the relations among them.

By 1965, programs existed that could, in principle, solve any solvable problem described in logical notation

There are **two main obstacles** to this approach.
First, it is not easy to take informal knowledge and state it in the formal terms required by logical notation, particularly when the knowledge is less than 100% certain.

There are **two main obstacles** to this approach.
Second, there is a big difference between being able to solve a problem "in principle" and doing *so* in practice.
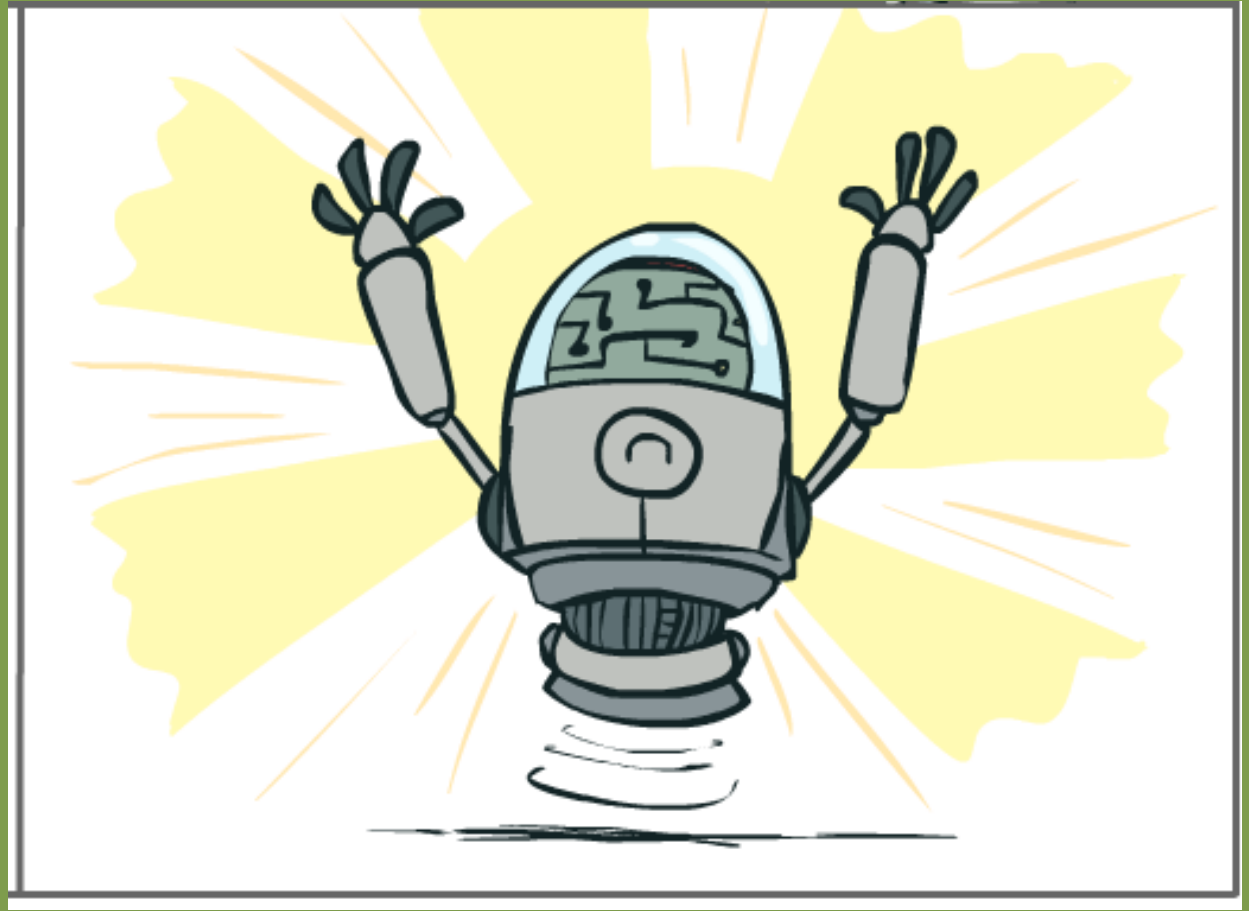
Act Rationally

We only care about **what they do**

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

In the "laws of thought" approach to AI, the emphasis was on **correct inferences**.

Making correct inferences is **sometimes part of** being a rational agent, because one way to **act rationally** is to **reason logically** to the conclusion that a given action will achieve one's goals and then to act on that conclusion.

The study of AI as rational-agent approach has at least **two advantages**.
First, it is more general than the "laws of thought" approach.

Second, it is **more amenable** to scientific development than are approaches based on human behavior or human thought because the **standard of rationality is clearly defined and completely general**.

There are also ways of acting rationally that **cannot be said to involve inference**. For example, recoiling from a hot stove is a reflex action that is usually more successful than a slower action taken after careful deliberation.

This course really we should call the **Computational Rationality**

Maximizing your expected utility
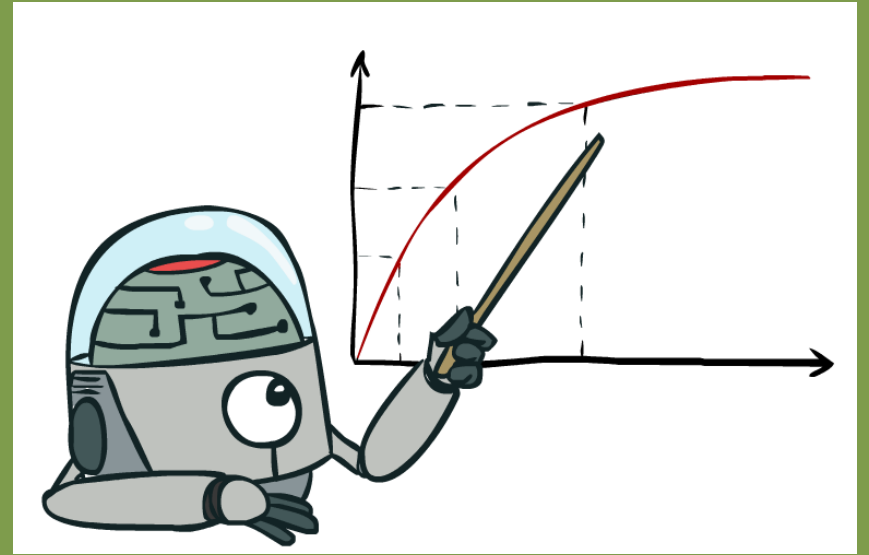
What about the BRAIN?
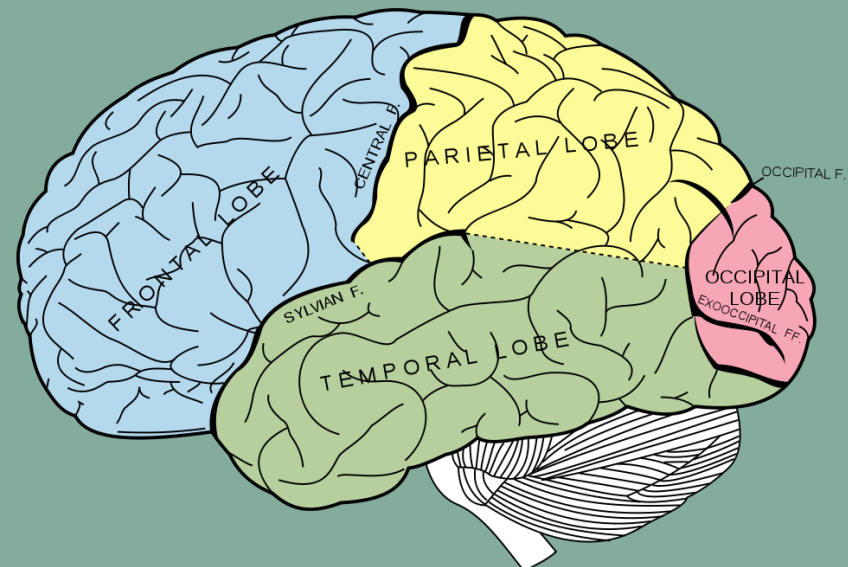
Brains (human minds) are very good at making rational decisions, but not perfect

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 and simulation are key to decision making

The Foundation of Artificial Intelligence

Philosophy (428 B. c.- present)

~ Can formal rules be used to draw valid conclusions?
~ How does the mental mind arise from a physical brain?
~ Where does knowledge come from?
~ How does knowledge lead to action?

Mathematics (c. 800-present)

~ What are the formal rules to draw valid conclusions?
~ What can be computed?
~ How do we reason with uncertain information?

Economics (1776-present)

~ How should we make decisions so as to maximize payoff?

~ How should we do this when others may not go along?

~ How should we do this when the payoff may be fix in the future?

Neuroscience (1861-present)

~ How do brains process information?

Psychology (1879-present)
~ How do humans and animals think and act?

Computer engineering (1940-present)
~ How can we build an efficient computer?

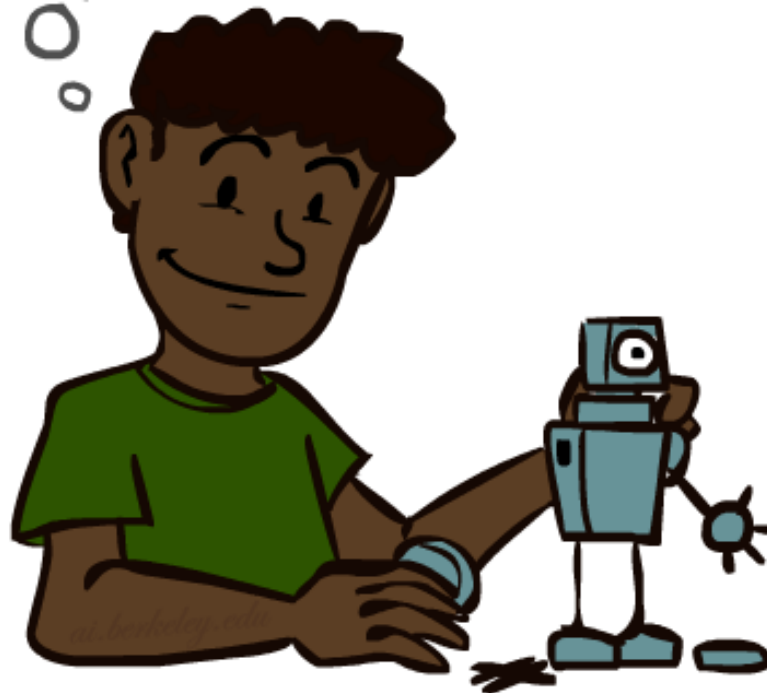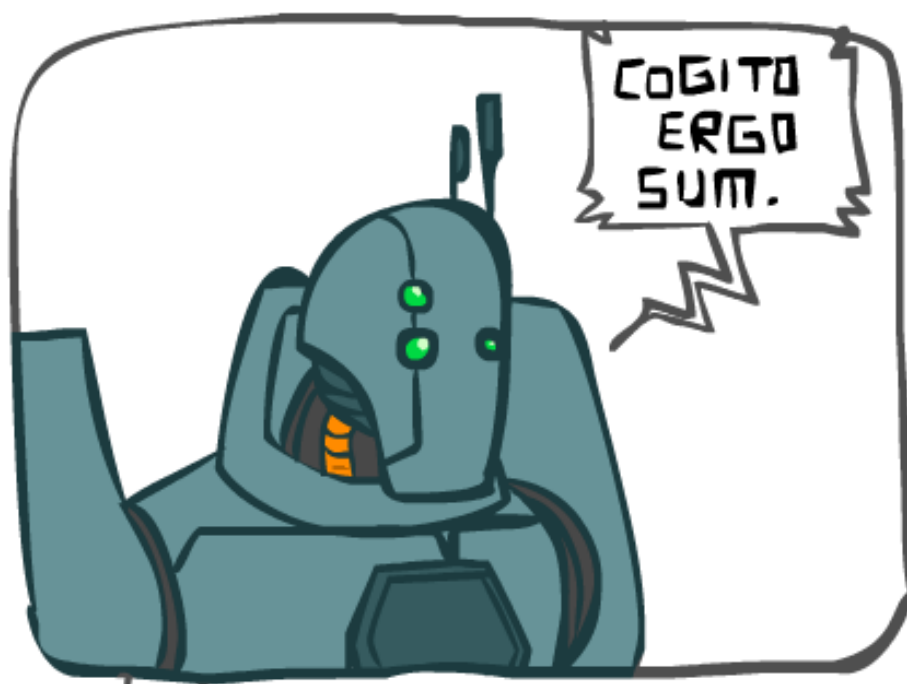# Control theory and Cybernetics (1948-present)

~ How can artifacts operate under their own control?

Linguistics (1957-present)

~ How does language relate to thought?

A (Short) History of AI

1940-1950: Early days

 1941: Electronic Computer era

 1943: McCulloch & Pitts: Boolean circuit model of brain

 1950: Turing's "Computing Machinery and Intelligence"

1950-70: Excitement: Look, Ma, no hands!

1950s: Early AI programs, including Samuel's checkers program, Newell & Simon's Logic Theorist, Gelernter's Geometry Engine

1956: Dartmouth meeting: "Artificial Intelligence" adopted. Alan McCarthy coined it

1965: Robinson's complete algorithm for logical reasoning

1970-90: Knowledge-based approaches

1969-79: Early development of knowledge-based systems

1980-88: Expert systems industry booms

1988-93: Expert systems industry busts: "AI Winter"

1990-: Statistical approaches

Resurgence of probability, focus on uncertainty

General increase in technical depth

Agents and learning systems... "AI Spring"?

2000-: Where are we now?

Example:

~ **GPS**

~ **CHESS**

~ **MedicWare**

~ **Speech Processing**

~ **Computer Vision**

~ **Robotic**

What Can AI Do?

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

Play a decent game of football?
Drive safely along a curving mountain road?
Drive safely along gang Kerto?
Buy a week's worth of groceries on the web?
Buy a week's worth of groceries at Sardo?

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

Discover and prove a new mathematical theorem?

Converse successfully with another person for an hour?

Perform a surgical operation?

Put away the dishes and fold the laundry?

Translate spoken Chinese into spoken English in real time?

Write an intentionally funny story?

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.
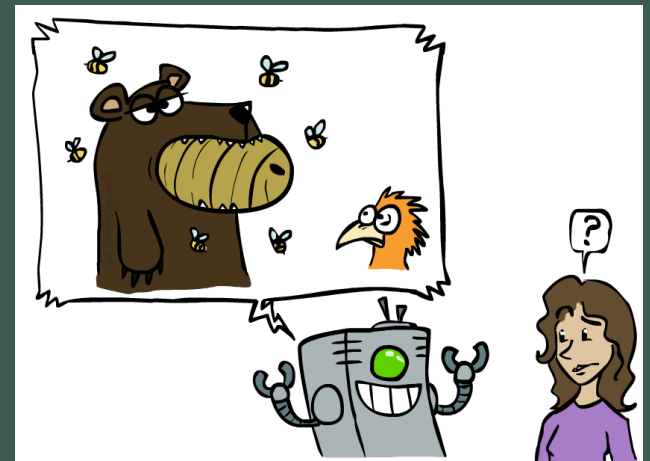
Natural Language >

Speech technologies (e.g. Siri)
~ Automatic speech recognition (ASR)
~ Text-to-speech synthesis (TTS)
~ Dialog systems

Language processing technologies
~ Question answering
~ Machine translation
~ Web search
~ Text classification, spam filtering, etc...

Vision (Perception) >

Object and face recognition
Scene segmentation
Image classification

Robotics

Robotics
    Part mech. eng.
    Part AI
    Reality much harder than simulations!
Technologies
    Vehicles
    Rescue
    Soccer!
    Lots of automation…

Logic

Logical systems
    Theorem provers
    NASA fault diagnosis
    Question answering

Methods:
    Deduction systems
    Constraint satisfaction
    Satisfiability solvers (huge advances!)

Game Playing

Open question:

How does human cognition deal with the search space explosion of chess? Or: how can humans compete with computers at all??

Game Playing

1996: Kasparov Beats Deep Blue

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

1997: Deep Blue Beats Kasparov

"Deep Blue hasn't proven anything."

Huge game-playing advances recently, e.g. in Go!

Game Playing

Classic Moment: May, '97: Deep Blue vs. Kasparov
- First match won against world champion
- "Intelligent creative" play
- 200 million board positions per second
- Humans understood 99.9 of Deep Blue's moves
- Can do about the same now with a PC cluster

Decision Making

Applied AI involves many kinds of automation

- **Scheduling, e.g. airline routing, military**
- **Route planning, e.g. Google maps**
- **Medical diagnosis**
- **Web search engines**
- **Spam classifiers**
- **Automated help desks**
- **Fraud detection**
- **Product recommendations**

The Future of AI?