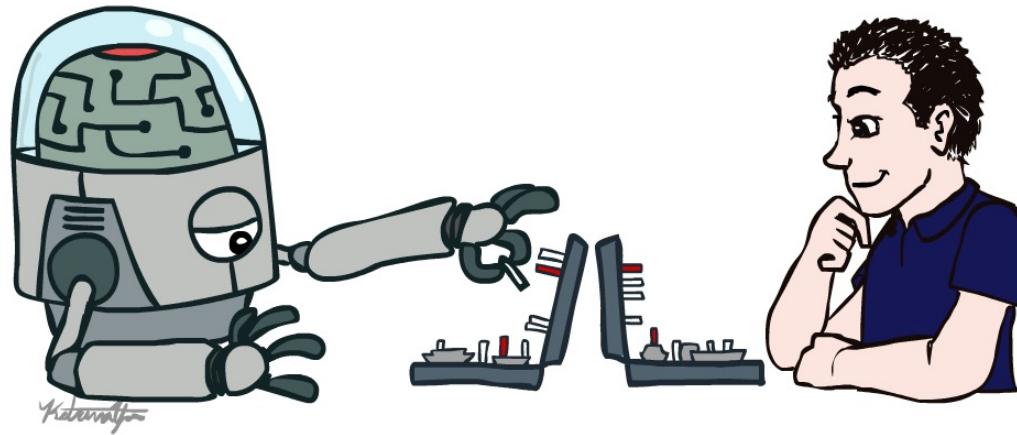


First part of course based on - CS 188: Artificial Intelligence



Spring 2023

University of California, Berkeley

[These slides were created by Dan Klein and Pieter Abbeel for CS188 Intro to AI at UC Berkeley (ai.berkeley.edu).]

Resources For Search Part of the Lectures

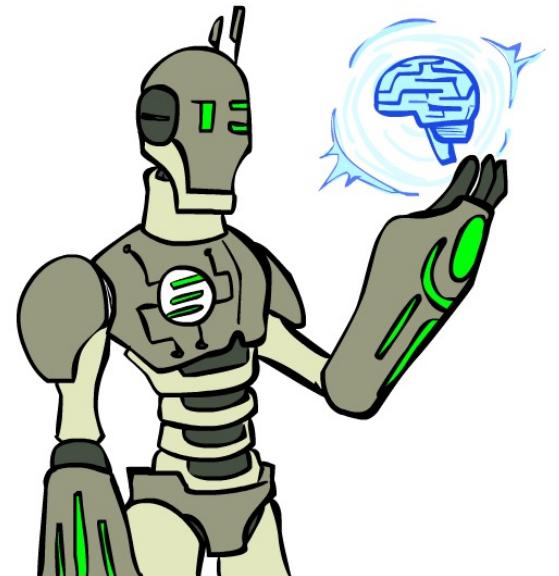
- Berkeley course website:

<https://inst.eecs.berkeley.edu/~cs188/sp24/>

- All resources (slides, notes, recordings, assignments, etc.) posted here

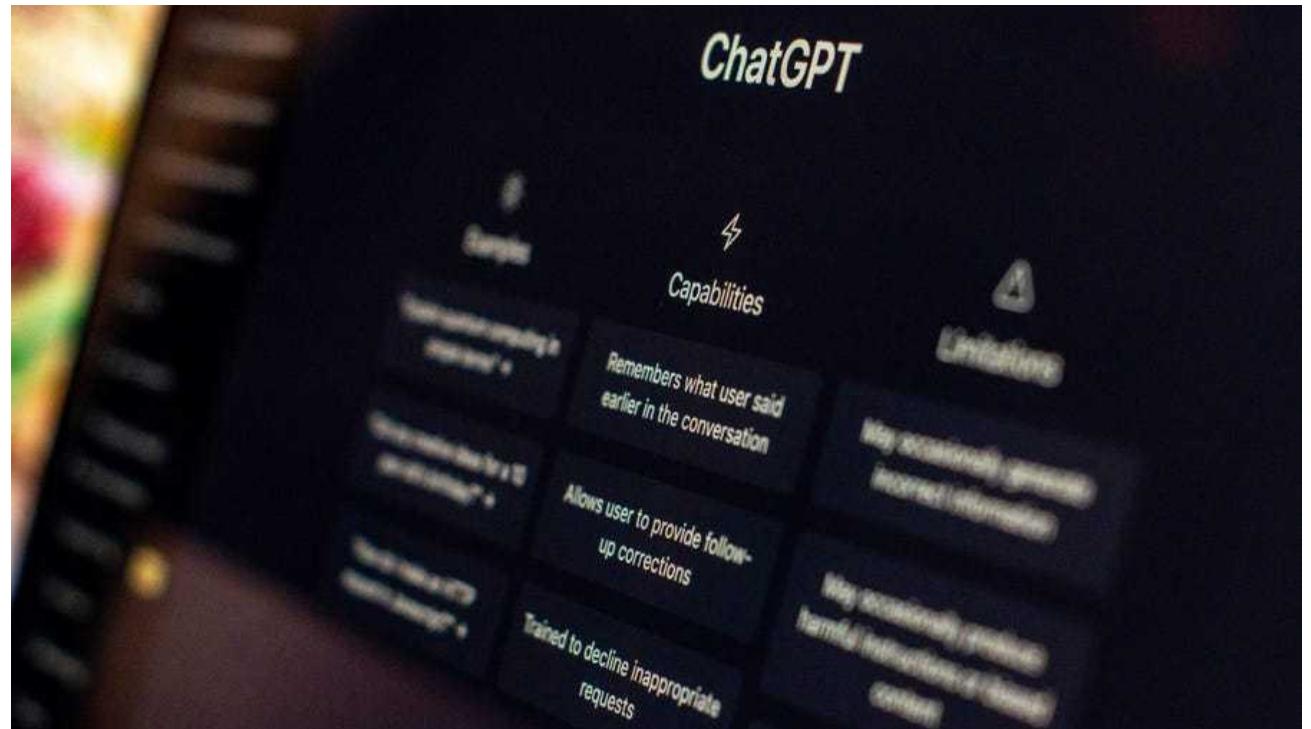
What is AI?

- What is artificial intelligence?
- What can AI do?
- What is this course?



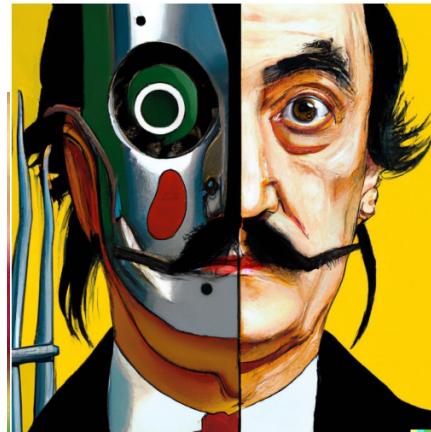
AI is having real-world impact

- Public imagination
 - Text assistants



AI is having real-world impact

- Public imagination
 - Text assistants
 - Image generation



vibrant portrait painting of Salvador Dalí with a robotic half face



a shiba inu wearing a beret and black turtleneck



a close up of a handpalm with leaves growing from it



an espresso machine that makes coffee from human souls, artstation



panda mad scientist mixing sparkling chemicals, artstation

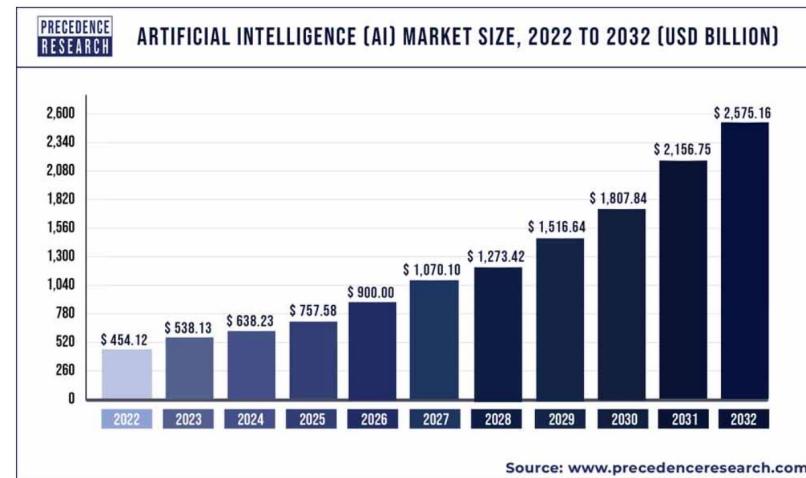


a corgi's head depicted as an explosion of a nebula

AI is having real-world impact

- Public imagination
- Economy
 - 454 billion USD globally

The global artificial intelligence (AI) market size was valued at USD 454.12 billion in 2022 and is expected to hit around USD 2,575.16 billion by 2032, progressing with a CAGR of 19% from 2023 to 2032. The North America artificial intelligence market was valued at USD 167.30 billion in 2022.



<https://www.precedenceresearch.com/artificial-intelligence-market>

AI is having real-world impact

- Public imagination
- Economy
- Politics



AI is having real-world impact

- Public imagination
- Economy
- Politics



AI is having real-world impact

- Public imagination
- Economy
- Politics



AI is having real-world impact

- Public imagination
- Economy
- Politics



AI is having real-world impact

- Public imagination
- Economy
- Politics
- Law

Aug. 18, 2023, 12:18 PM; Updated: Aug. 18, 2023, 12:48 PM

AI-Generated Art Lacks Copyright Protection, D.C. Court Says (1)



Riddhi Setty
Reporter



Isaiah Poritz
Legal Reporter



Bloomberg Law, 2023

AI is having real-world impact

- Public imagination
- Economy
- Politics
- Law
- Labor

Finance & economics | Free exchange

New research shows the robots are coming for jobs—but stealthily

Look beneath the aggregate economic numbers, and change is afoot

The Economist, 2021

The Optimist's Guide to Artificial Intelligence and Work

The focus of much discussion is on how it will replace jobs, but nothing is inevitable.

New York Times, 2023

The human labor behind AI chatbots and other smart tools

Data labeling is an important step in developing artificial intelligence but also exposes the people doing the work to harmful content.

MarketWatch, 2023

AI is having real-world impact

- Public imagination
- Economy
- Politics
- Law
- Labor
- Sciences

nature
BIOTECH

AlphaFold Developers Win \$3-Million Breakthrough Prize in Life Sciences

DeepMind's system for predicting the 3D structure of proteins is among five recipients of science's most lucrative awards

By Zeeya Merali, Nature magazine on September 22, 2022

Nature, 2022

AI is having real-world impact

- Public imagination
- Economy
- Politics
- Law
- Labor
- Sciences

AMIT KATWALA SCIENCE FEB 16, 2022 11:00 AM

DeepMind Has Trained an AI to Control Nuclear Fusion

The Google-backed firm taught a reinforcement learning algorithm to control the fiery plasma inside a tokamak nuclear fusion reactor.



PHOTOGRAPH: CURDIN WÜTHRICH, SPC/EPFL

Wired, 2022

AI is having real-world impact

- Public imagination
- Economy
- Politics
- Law
- Labor
- Sciences
- Education

BREAKING

ChatGPT In Schools: Here's Where It's Banned—And How It Could Potentially Help Students

Arianna Johnson Forbes Staff

I cover the latest trends in science, tech and healthcare.

Follow

2

Jan 18, 2023, 02:31pm EST

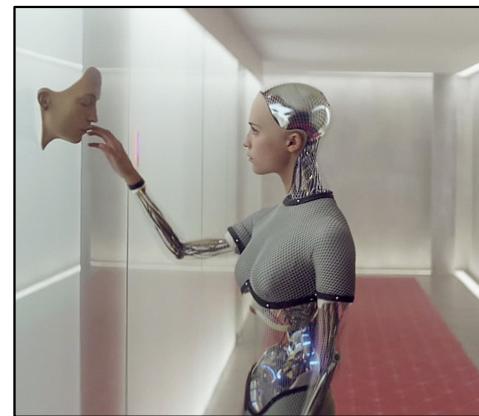
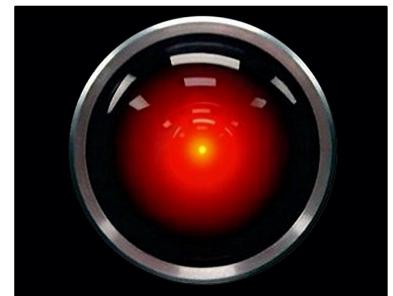
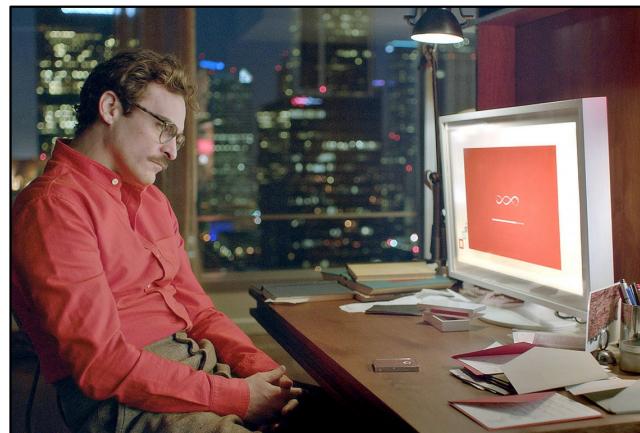
Forbes, 2023

AI is having real-world impact

- Public imagination
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- Education

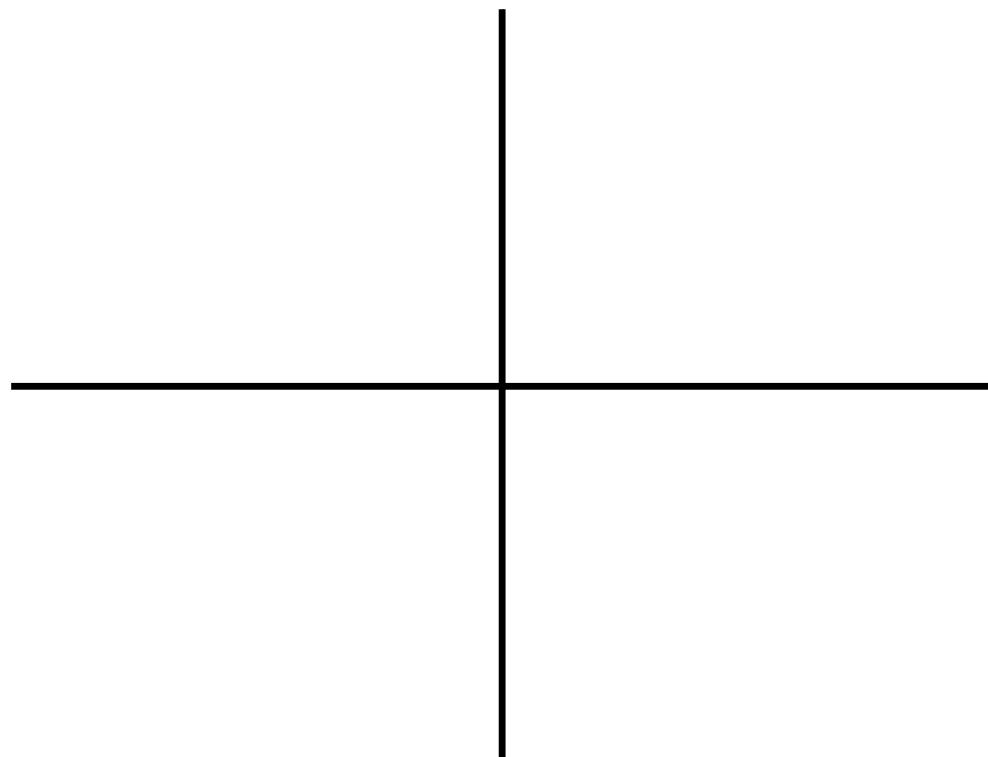
Ok, but what actually is AI???

Science fiction AI?



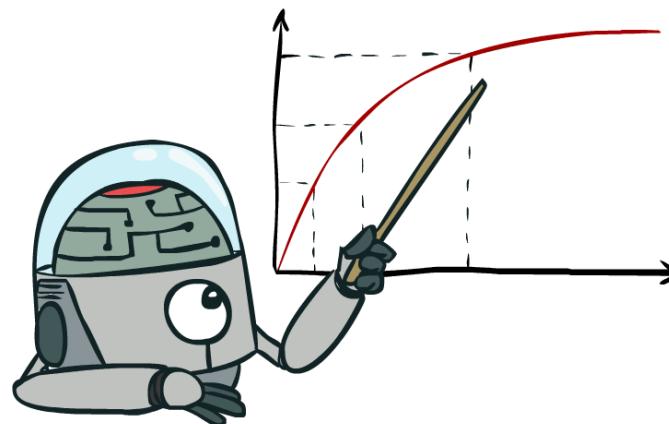
What should we build?

Should we make machines that...



Rational Decisions

- We'll use the term **rational** in a very specific, technical way:
 - Rational: *maximally achieving pre-defined goals*
 - Goals are expressed in terms of the **utility** of outcomes
 - World is uncertain, so we'll use **expected utility**
 - Being rational means acting to **maximize your expected utility**



Rational Decisions

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A better title for this course might be:

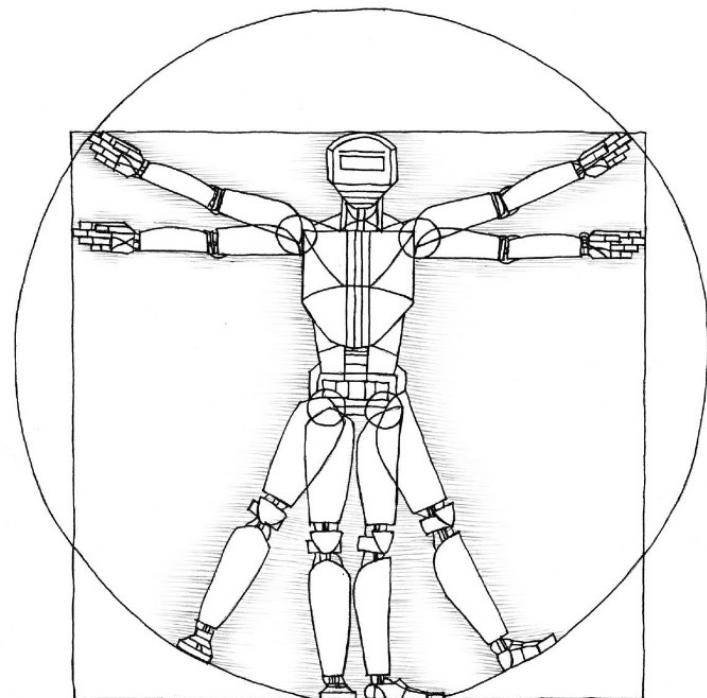
Computational Rationality

Perspectives on Intelligence

- Skills-based perspective
- “A system is only intelligent if it can do [X].”
 - Play chess?
 - Learn from experience?
 - Use words properly?
 - Make mistakes?
 - Not make mistakes?

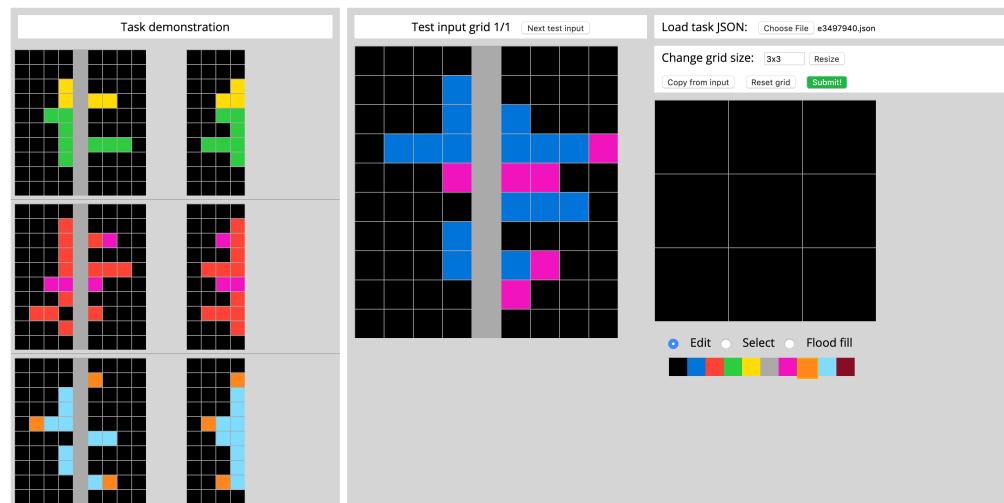
Perspectives on Intelligence

- Embodiment perspective (Rodney Brooks)



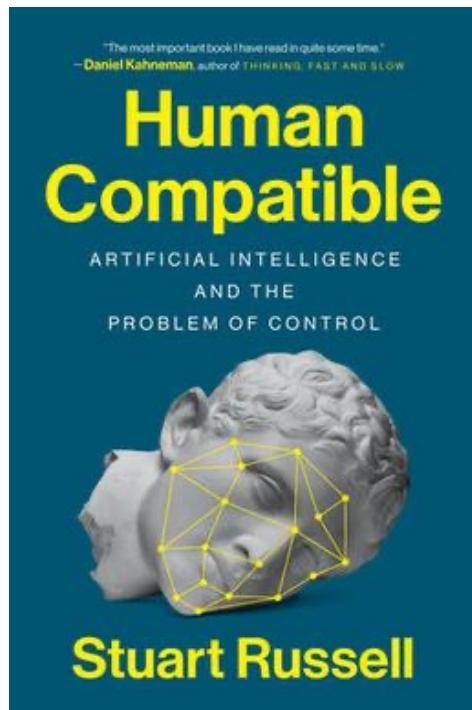
Perspectives on Intelligence

- Psychometrics perspective (François Chollet)
- “Measuring abilities, not skills [...] across a broad range of tasks, including tasks that were previously unknown to the ability-enabled system and its developers.”



Perspectives on Intelligence

- Human-compatible perspective (Stuart Russell)



1. Machine's objective is to maximize human utility.
2. Initially uncertain about human preferences.
3. Must learn about preferences from human behavior.

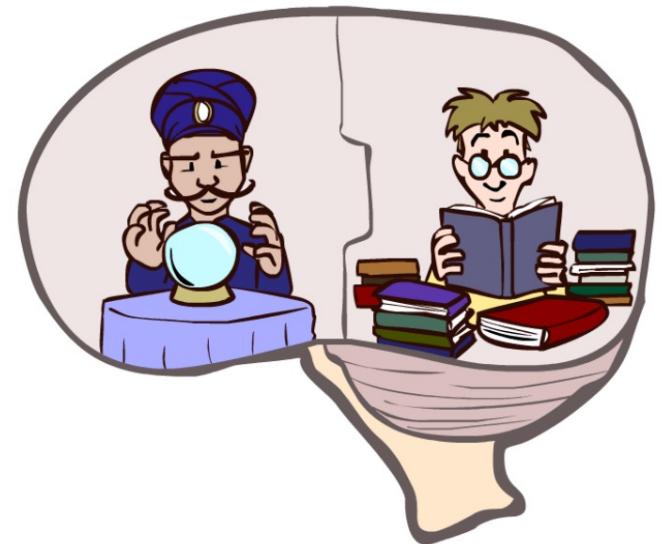
Perspectives on Intelligence

A human being should be able to change a diaper, plan an invasion, butcher a hog, conn a ship, design a building, write a sonnet, balance accounts, build a wall, set a bone, comfort the dying, take orders, give orders, cooperate, act alone, solve equations, analyze a new problem, pitch manure, program a computer, cook a tasty meal, fight efficiently, die gallantly. Specialization is for insects.

—Robert A. Heinlein

What About the Brain?

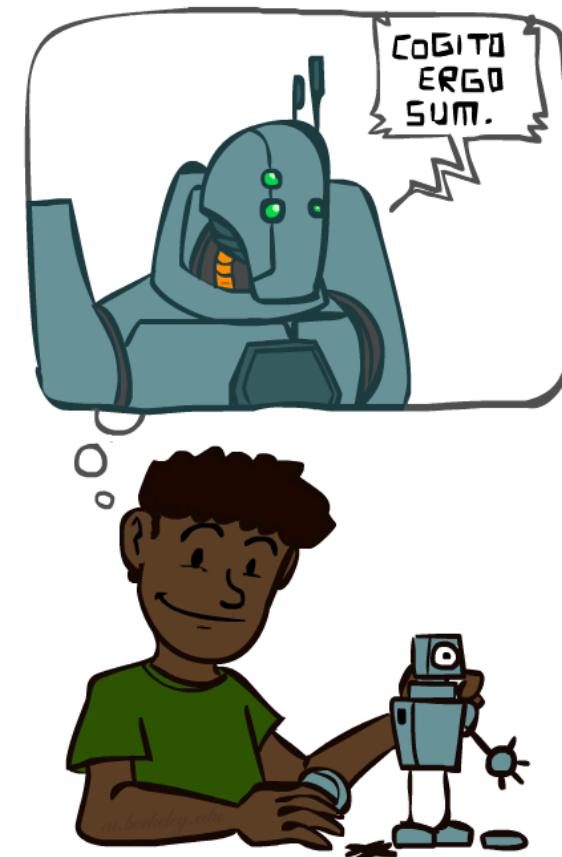
- Brains (human minds) are very good at making rational decisions, but not perfect
- Brains aren't as modular as software, so hard to reverse engineer!
- AI may be better than brains at some tasks
- *"Brains are to intelligence as wings are to flight"*
- We can't yet build AI on the scale of the brain
 - ~100T synapses in the human brain vs ~1.8T weights in GPT4
- Still, the brain can be a great inspiration for AI!



A (Short) History of AI

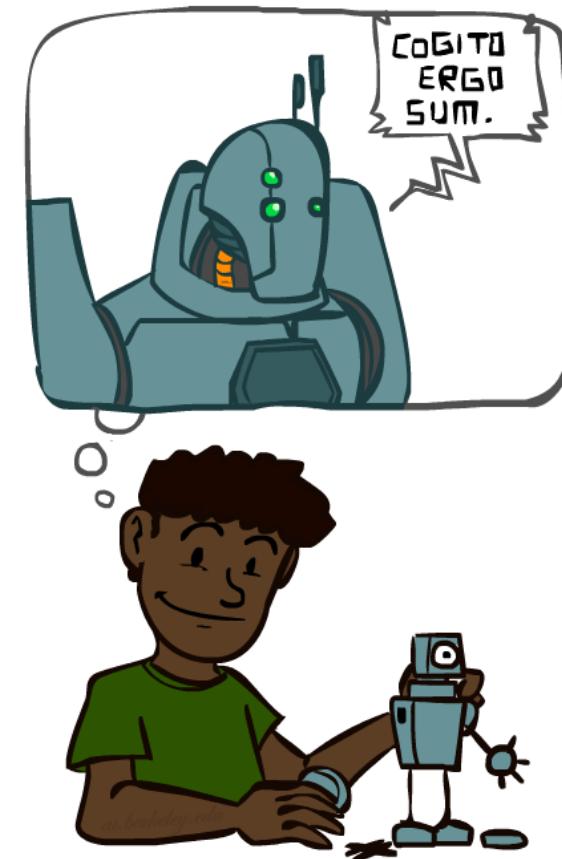
- 1940-1950: Early days: neural and computer science meet
 - 1943: McCulloch & Pitts: Perceptron–boolean circuit model of brain
 - 1950: Turing's "Computing Machinery and Intelligence"
- 1950—70: Excitement! Logic-driven
 - 1950s: Early AI programs, including Samuel's checkers program, Newell & Simon's Logic Theorist, Gelernter's Geometry Engine
 - 1956: Dartmouth meeting: "Artificial Intelligence" adopted

"We propose that a 2-month, 10-man study of artificial intelligence be carried out during the summer of 1956 at Dartmouth College in Hanover, New Hampshire. The study is to proceed on the basis of the conjecture that every aspect of learning or any other feature of intelligence can in principle be so precisely described that a machine can be made to simulate it. 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 in one or more of these problems if a carefully selected group of scientists work on it together for a summer."



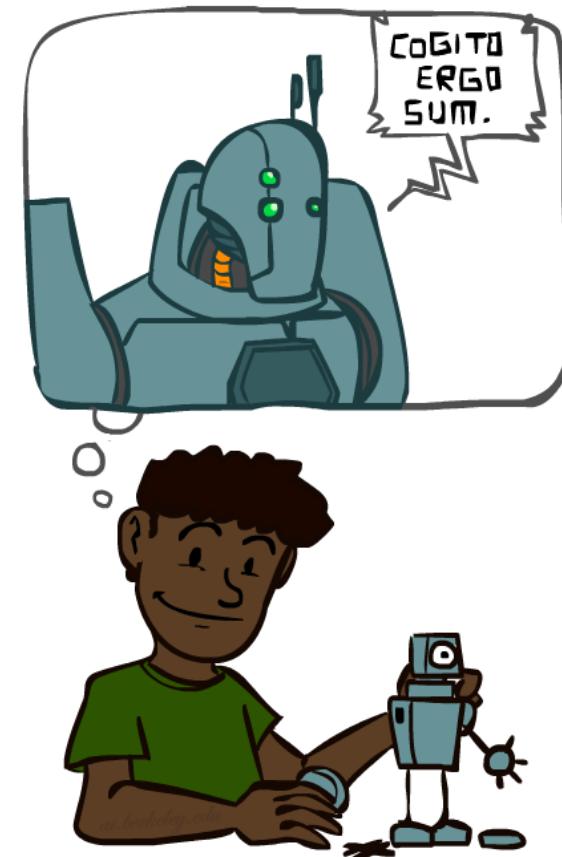
A (Short) History of AI

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 - 1950s: Early AI programs, including Samuel's checkers program, Newell & Simon's Logic Theorist, Gelernter's Geometry Engine
 - 1956: Dartmouth meeting: "Artificial Intelligence" adopted
 - 1969: Minsky & Papert: perceptrons can't learn XOR/parity!
- 1970–90: Knowledge-based approaches
 - 1969–79: Early development of knowledge-based systems
 - 1980–88: Expert systems industry booms; backpropagation makes it feasible to train multi-layer neural networks
 - 1988–93: Expert systems industry busts: "AI Winter"
- 1990–2010: Statistical approaches, agents
 - Resurgence of probability, focus on uncertainty
 - Agents and learning systems... "AI Spring"?
 - 1992: TD-Gammon achieves human-level play at backgammon
 - 1997: Deep Blue defeats Gary Kasparov at chess
 - 2002: Embodied AI; Roomba vacuum invented



A (Short) History of AI

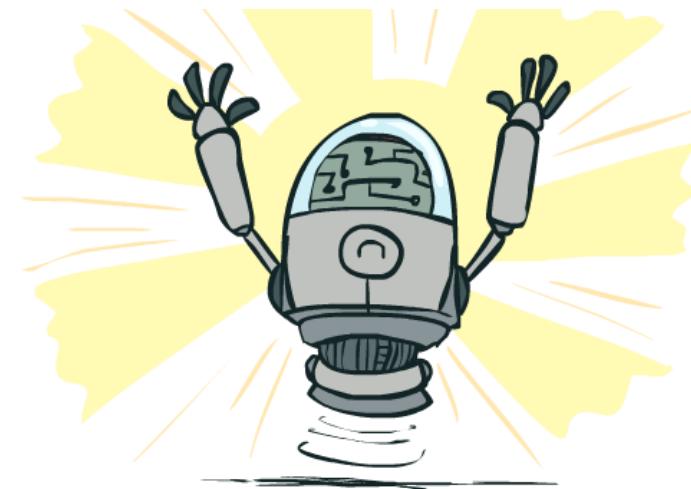
- 2010—2017: Big Data, GPUs, Deep Learning
 - 2011: Apple releases Siri
 - 2012: AlexNet wins ImageNet competition
 - 2015: DeepMind achieves “human-level” control in Atari games
 - 2016: DeepMind’s AlphaGo defeats Lee Sedol at Go
 - 2016: Google Translate migrates to neural networks
- 2017—: Scaling Up, Large Language Models
 - 2017: Google invents Transformer architecture
 - 2017: DeepStack/Libratus defeat humans at poker
 - 2018-2020: AlphaFold predicts protein structure from amino acids
 - 2021-2022: Modern text-to-image generation
 - 2022: OpenAI releases ChatGPT
 - 2023: Every other company also releases a chatbot



What Can AI Do?

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

- ✓ Win against any human at chess?
- ✓ Win against the best humans at Go?
- Play a decent game of table tennis?
- Unload any dishwasher in any home?
- Drive safely along the highway?
- Drive safely along streets of San Francisco?
- Buy a week's worth of groceries on the web?
- Buy a week's worth of groceries at Berkeley Bowl?
- Discover and prove a new mathematical theorem?
- Perform a surgical operation?
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Google's AlphaGo beats Lee Sedol at Go in 2016



But ... a plot twist in 2023!

DEEP BLUE WAS JUST THE START —

Man beats machine at Go in human victory over AI

Amateur exploited weakness in systems that have otherwise dominated grandmasters.

RICHARD WATERS, FINANCIAL TIMES - 2/19/2023, 4:51 AM

What Can AI Do?

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A photograph showing a man in a black puffer jacket and a blue surgical mask playing ping pong. He is holding a paddle and looking towards a white ping pong table. A white robotic arm with a blue paddle is positioned across the table from him, having just hit a yellow ping pong ball. The background shows a laboratory or workshop setting with various equipment and a glass partition.
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California just opened the floodgates for self-driving cars

After a state regulatory board ruling, San Francisco will have 24/7 robotaxis on its streets. A Washington Post analysis shows how it's a pivotal moment for the industry.

By [Trisha Thadani](#) and [Jeremy B. Merrill](#)

Updated August 10, 2023 at 10:06 p.m. EDT | Published August 10, 2023 at 9:15 p.m. EDT

The Register®

California DMV hits brakes on Cruise's SF driverless fleet after series of fender benders

50% chop effective 'immediately' as department investigates traffic and safety issues

Jude Karabus

Mon 21 Aug 2023 // 14:28 UTC

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- Construct a building?



You

Please write me a very funny, and extremely short story.

< 6 / 6 >



ChatGPT

Once there was a chicken who was terribly afraid of crossing roads. One day, it mustered up all its courage, stepped onto the road, and halfway across, it suddenly stopped and said, "Wait, why am I doing this again?"

< 12 / 12 >

What Can AI Do?

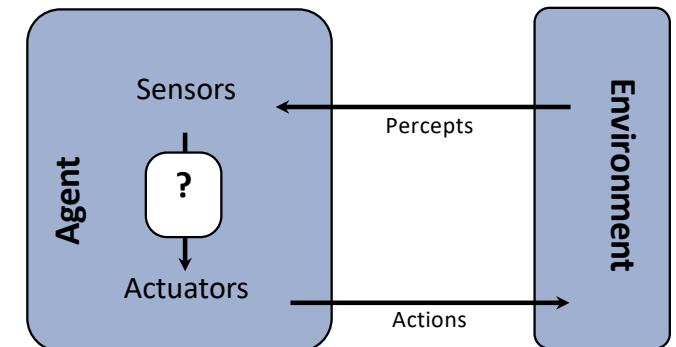
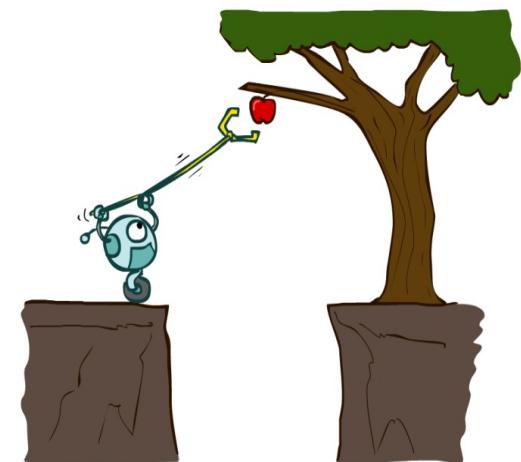
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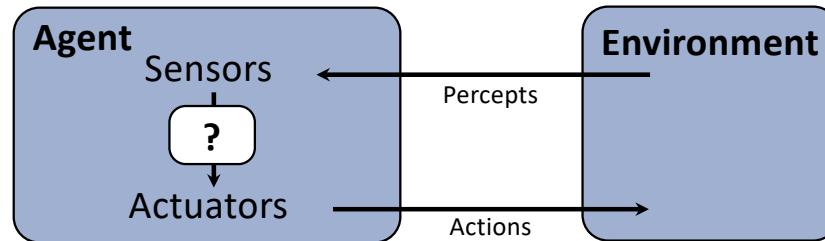
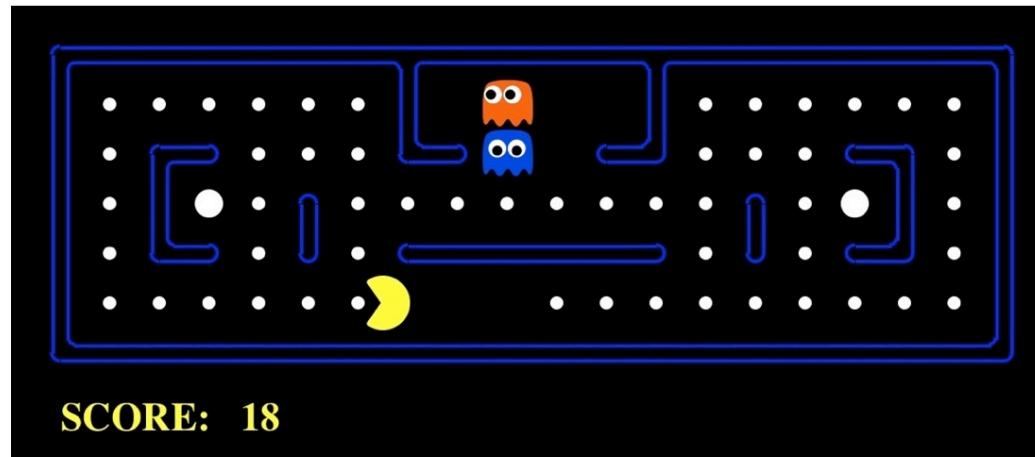


This Course: Designing Rational Agents

- An **agent** is an entity that perceives and acts.
- A **rational agent** selects actions that maximize its (expected) **utility**.
- Characteristics of the **percepts**, **environment**, and **action space** dictate techniques for selecting rational actions
- This course is about:
 - General AI techniques for a variety of problem types
 - Learning to recognize when and how a new problem can be solved with an existing technique



Pac-Man as an Agent



Pac-Man is a registered trademark of Namco-Bandai Games, used here for educational purposes



Core Components of Rational Agents:

Search &
Planning

Probability &
Inference

Supervised
Learning

Reinforcement
Learning

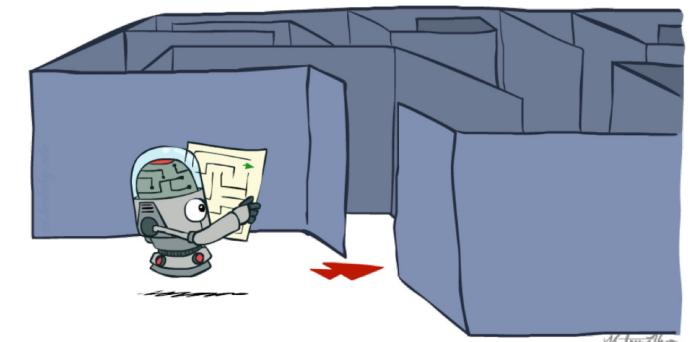
Course Topics

Search &
Planning

Probability &
Inference

Supervised
Learning

Reinforcement
Learning



How can I use my *model* of the world to find a
sequence of actions to achieve my *goal*?

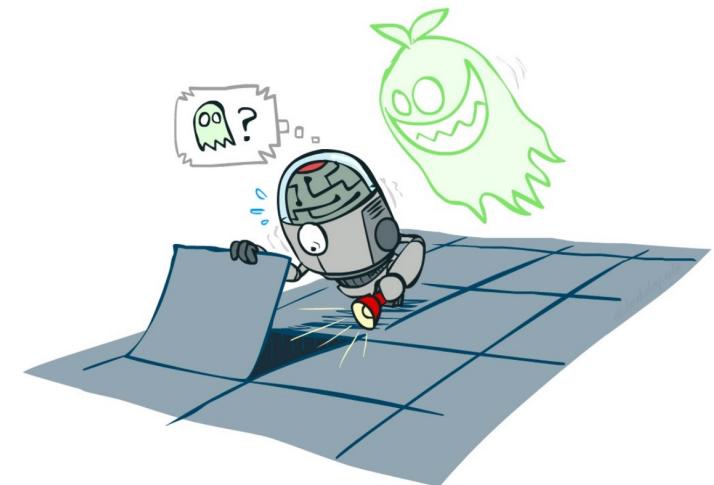
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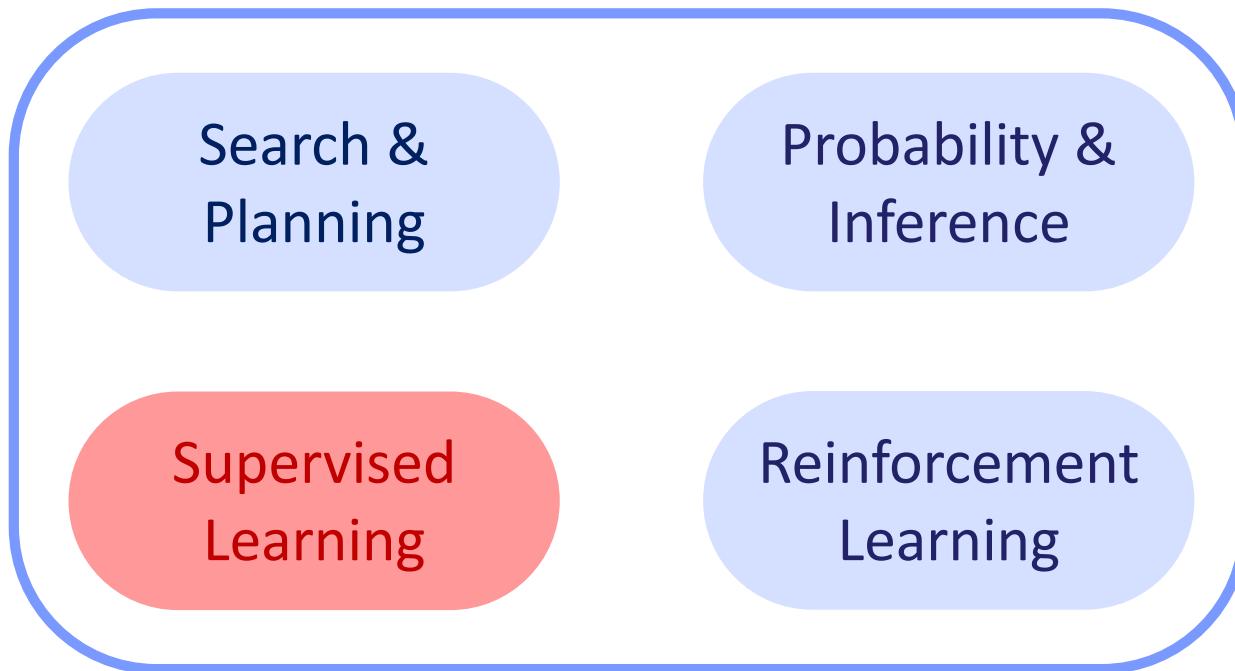
Supervised
Learning

Reinforcement
Learning



How can I make sense of *uncertainty*?

Course Topics



How can I learn a *model* of the world from *data*?

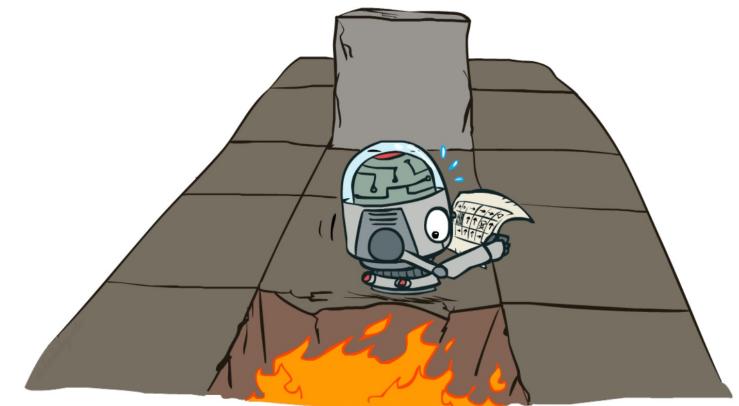
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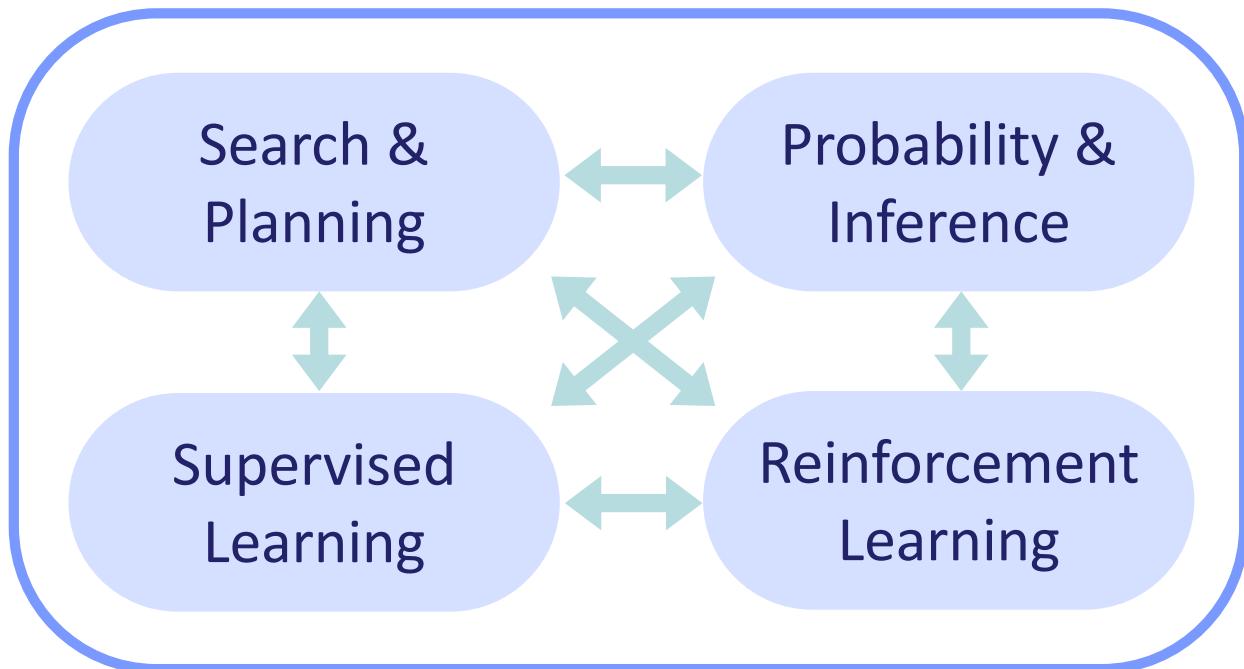
Supervised
Learning

Reinforcement
Learning



How can I learn a *policy* for any situation
so that I can *maximize utility*?

Course Topics



Course Topics

Search &
Planning

Probability &
Inference

Supervised
Learning

Reinforcement
Learning

Applications

Impact on Sciences, Technology, Society

Next Lecture: Search

