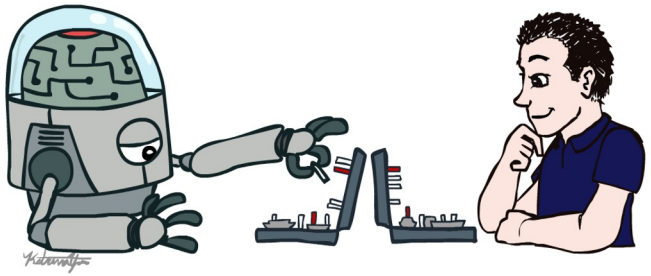
CSE 573 PMP: Artificial Intelligence

Hanna Hajishirzi



slides adapted from
Emma Pierson, Dan Klein, Pieter Abbeel ai.berkeley.edu
And Dan Weld, Luke Zettlemoyer

Resources

Website

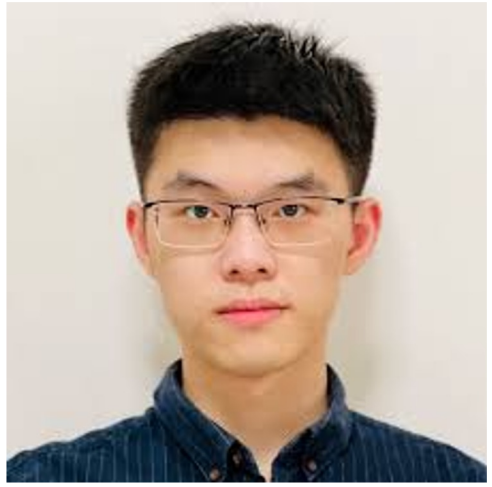
- tentative schedule
- lecture slides
- course policies, etc.
- https://courses.cs.washington.edu/courses/csep573/25au/

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

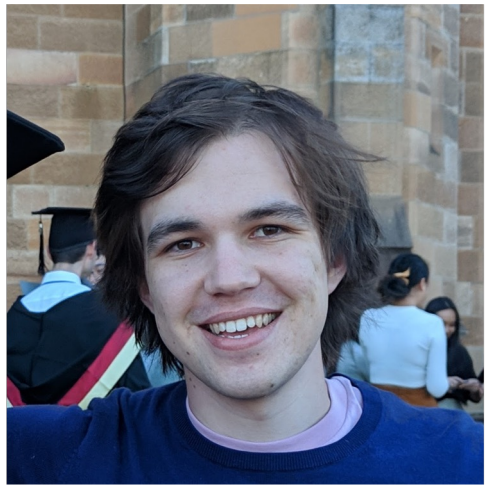
Ed: Discussion forum

Gradescope: Submit assignments here

Course Staff (TAs)



TA: Tianhua Tao
Office hours: W 7-8pm
Location: TBD



TA: Hamish Ivison
Office hours: TBD
Location: TBD

TA: Mengyi Shan
Office hours: M 6:30-7:30pm
Location: TBD

TA: Jingwei Ma
Office hours: Tu 7-8pm
Location: TBD

Course Staff

- Office hours
  - Schedule on the website
  - **TAs**: concepts, projects, homework
  - **Hanna**: concepts, high level guidance

Course Format

Programming Assignments (50%)

- 4 projects
- Python
- Autograded
- Give you hands-on experience with the algorithms
- I expect you to get 100% on projects

- Written homeworks (50%)
  - 2 written homeworks
  - Gives you a more conceptual understanding of the material

Prerequisites

Data Structure or Equivalent:
CSE 332

Math:

Basic exposure to probability and data structures

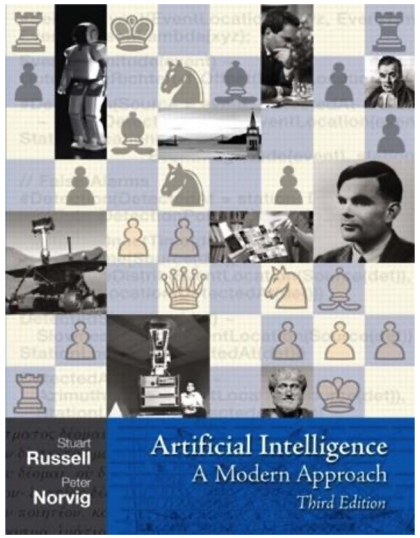
Programming – Familiar with Python

There is a 0th project (P0)

Textbook

Not required, but for students who want to read more we recommend

Russell & Norvig, AI: A Modern Approach, 3rd Ed.



Warning: Not a course textbook, so our presentation does not necessarily follow the presentation in the book.

Course Policies

Grade:

Your grade will be:

- 50% programming assignments,
- 50% written homeworks,

Assignments should be done individually unless otherwise specified.

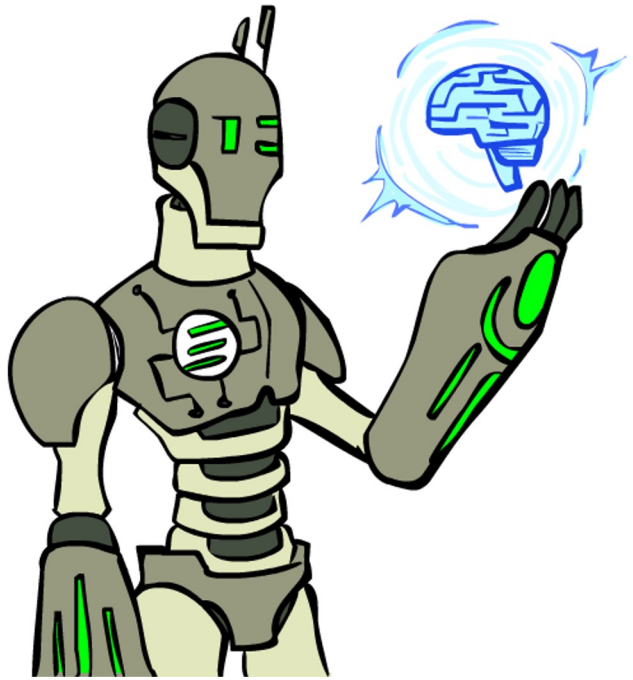
Late Policy: **6** penalty-free late days for the whole quarter.

What is AI?

What is AI?

What can it do?

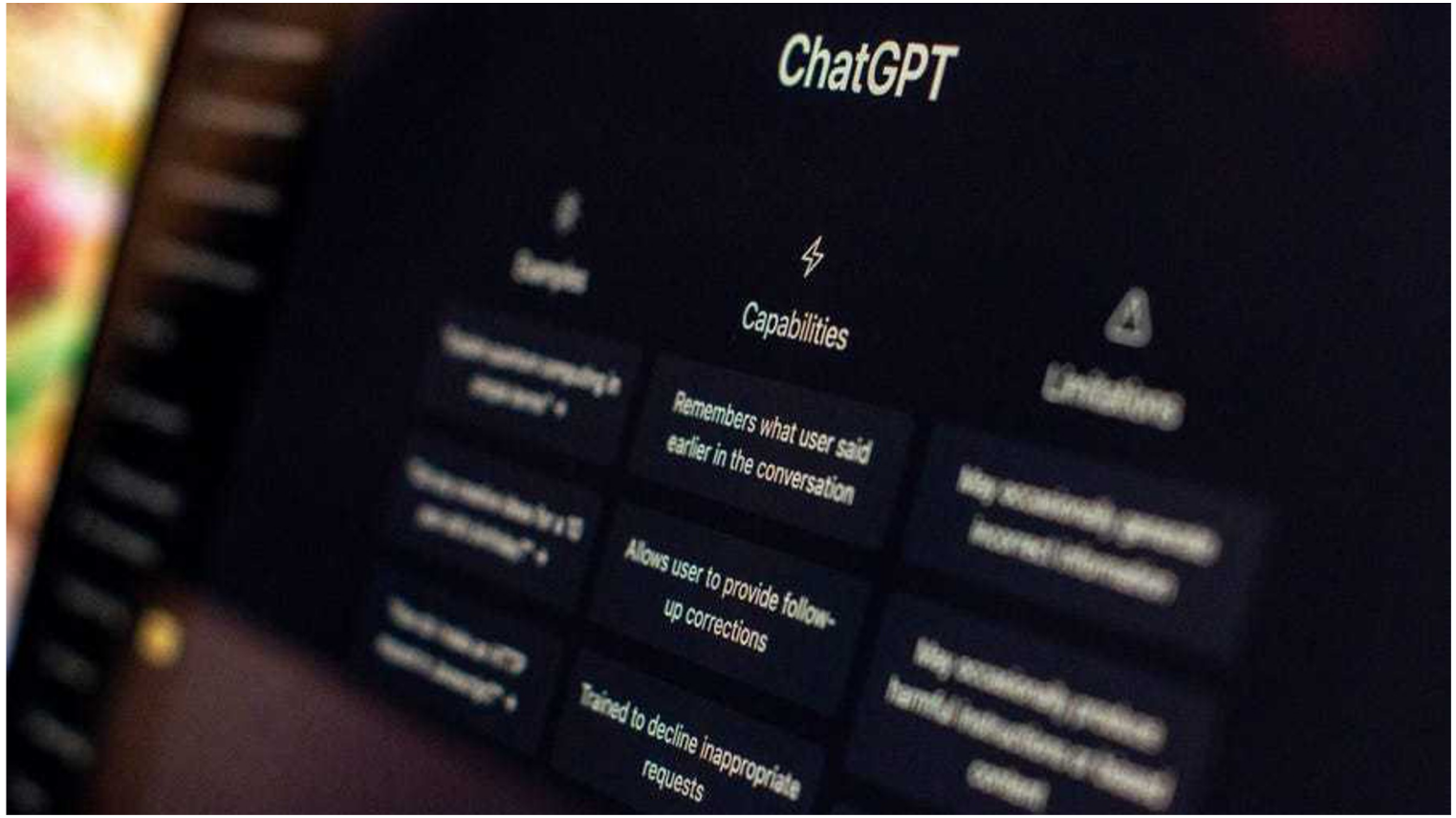
What is this course?



AI is having real-world impact

Public imagination

Text assistants



AI is having real-world impact

Public imagination

Text assistants

Image generation

AI is having real-world impact

Public imagination

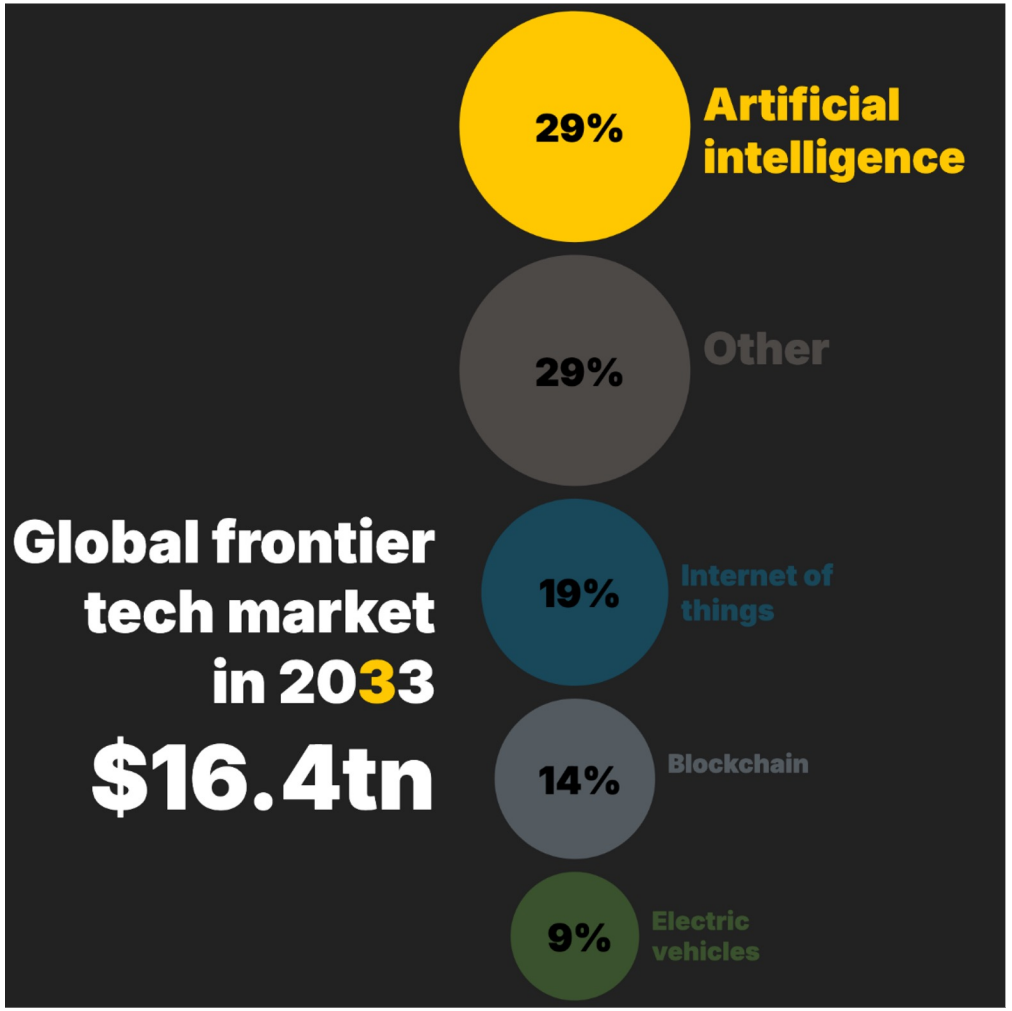
- Text assistants
- Image generation
- Film/Game Industry

AI is having real-world impact

Public imagination

Economy

$4.8 trillion by 2033
(25x increase in a decade)



https://unctad.org/publication/technology-and-innovation-report-2025

AI is having real-world impact

Public imagination

Economy

Politics

AI is having real-world impact

Public imagination

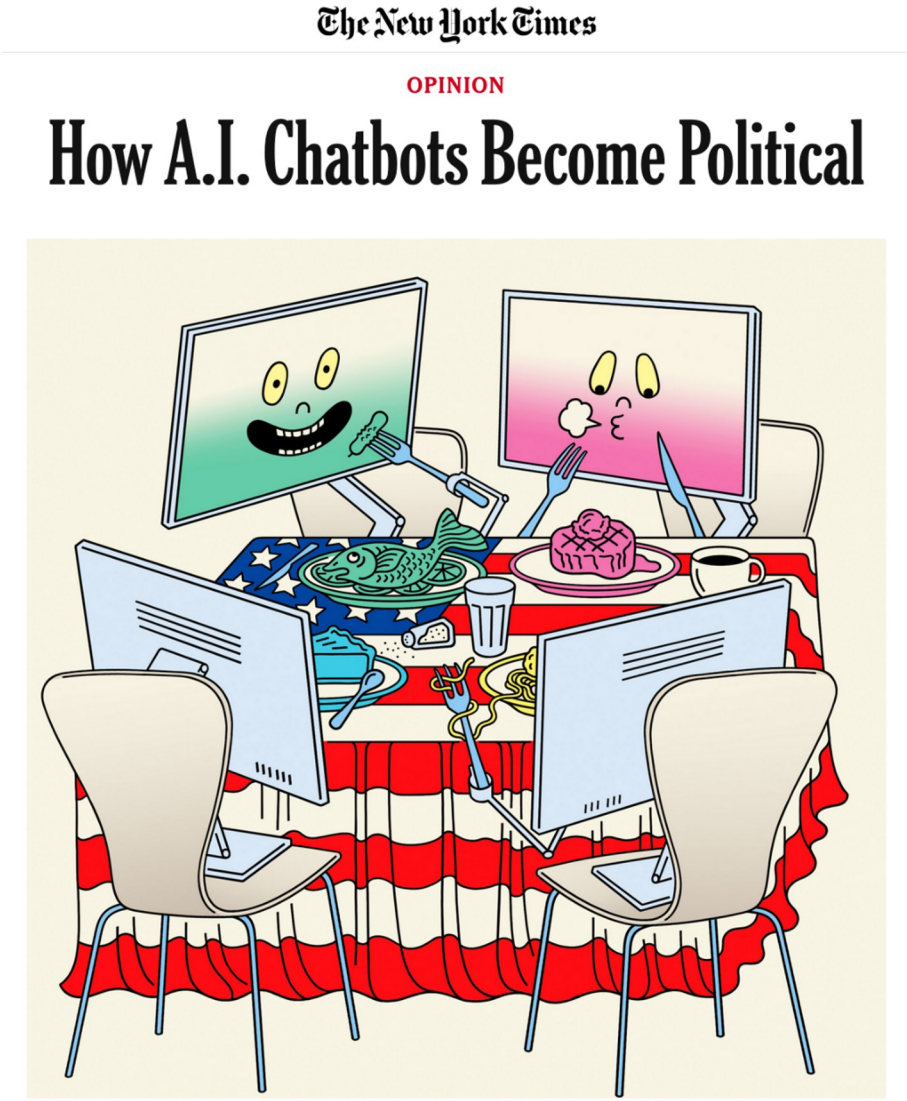
Economy

Politics

https://www.nytimes.com/2025/02/11/world/europe/vance-speech-paris-ai-summit.html

AI is having real-world impact

- Public imagination
- Economy
- Politics



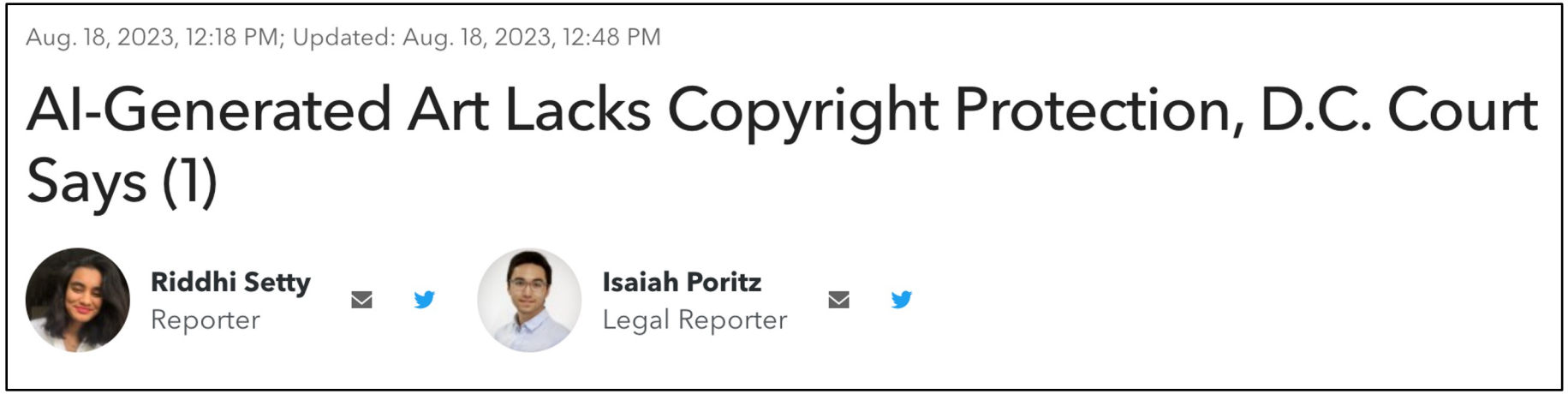
AI is having real-world impact

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

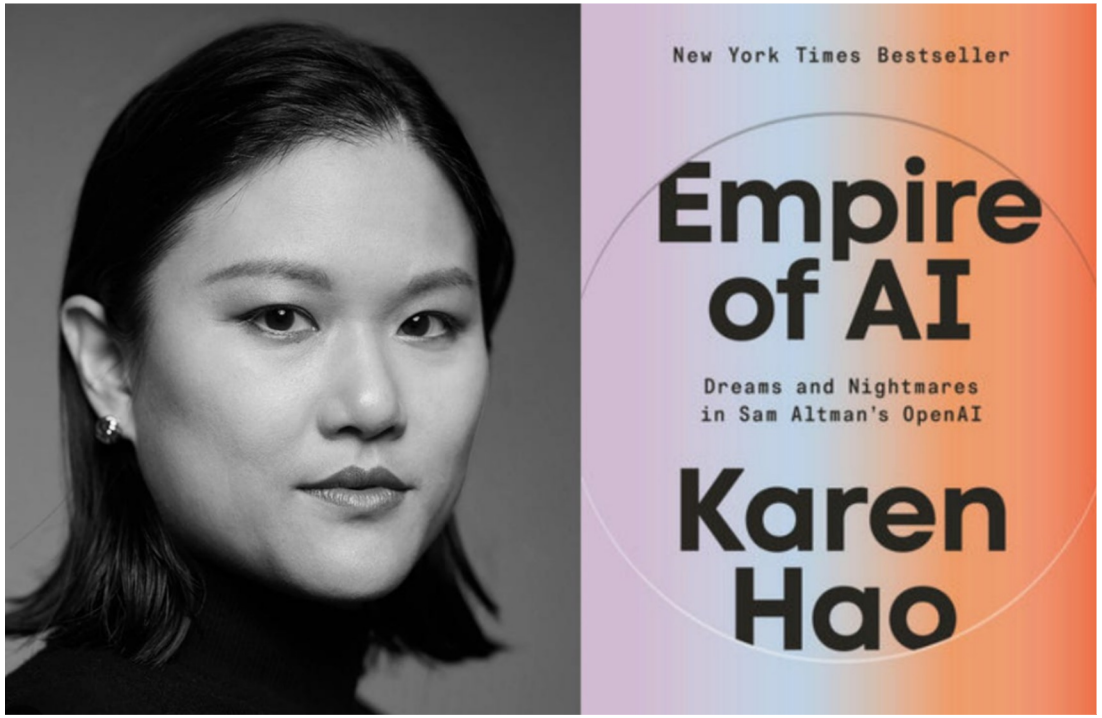
AI is having real-world impact

- Public imagination
- Economy
- Politics
- Law
- Labor

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
- Science
  - Chemistry and biology

Science & technology | The 2024 Nobel prizes

AI wins big at the Nobels

Awards went to the discoverers of micro-RNA, pioneers of artificial-intelligence models and those using them for protein-structure prediction

The Economist, 2024

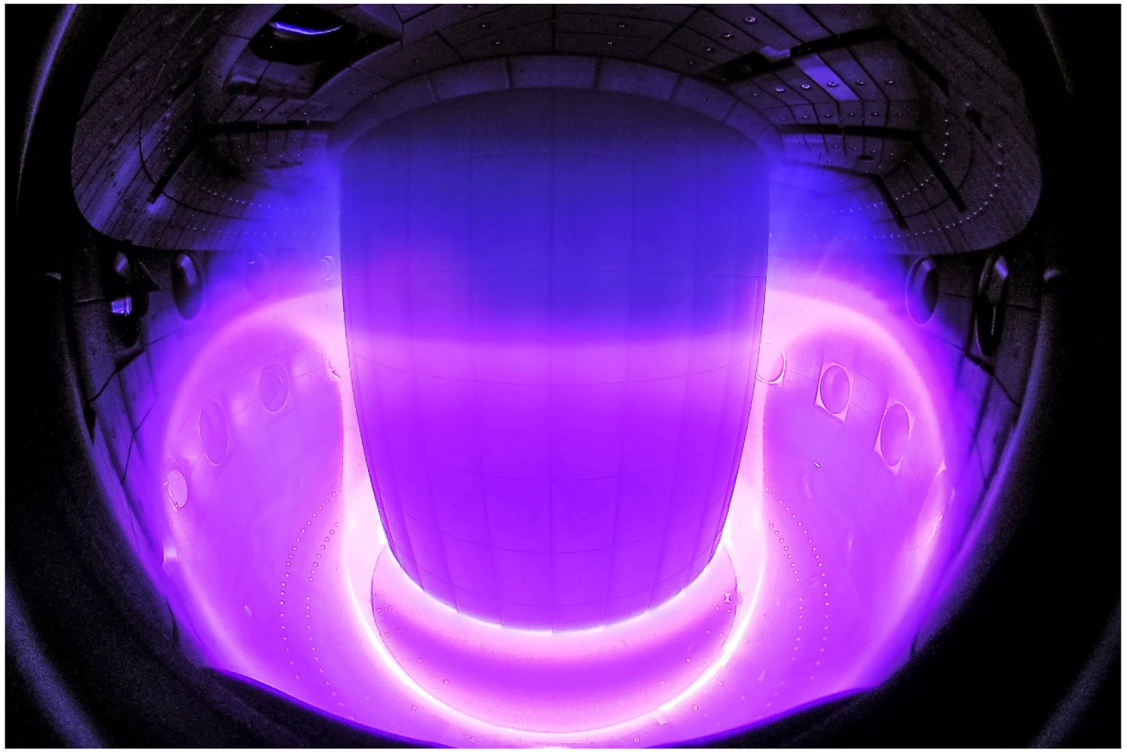
AI is having real-world impact

- Public imagination
- Economy
- Politics
- Law
- Labor
- Science
  - Physics

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

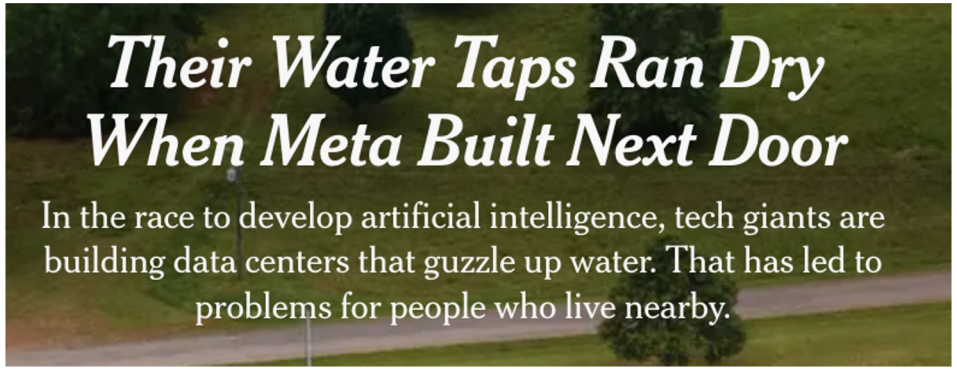
AI is having real-world impact

- Public imagination
- Economy
- Politics
- Law
- Labor
- Science
  - Conservation

Nature Communications, 2022

AI is having real-world impact

- Public imagination
- Economy
- Politics
- Law
- Labor
- Science
  - Resource use



The New York Times, 2025

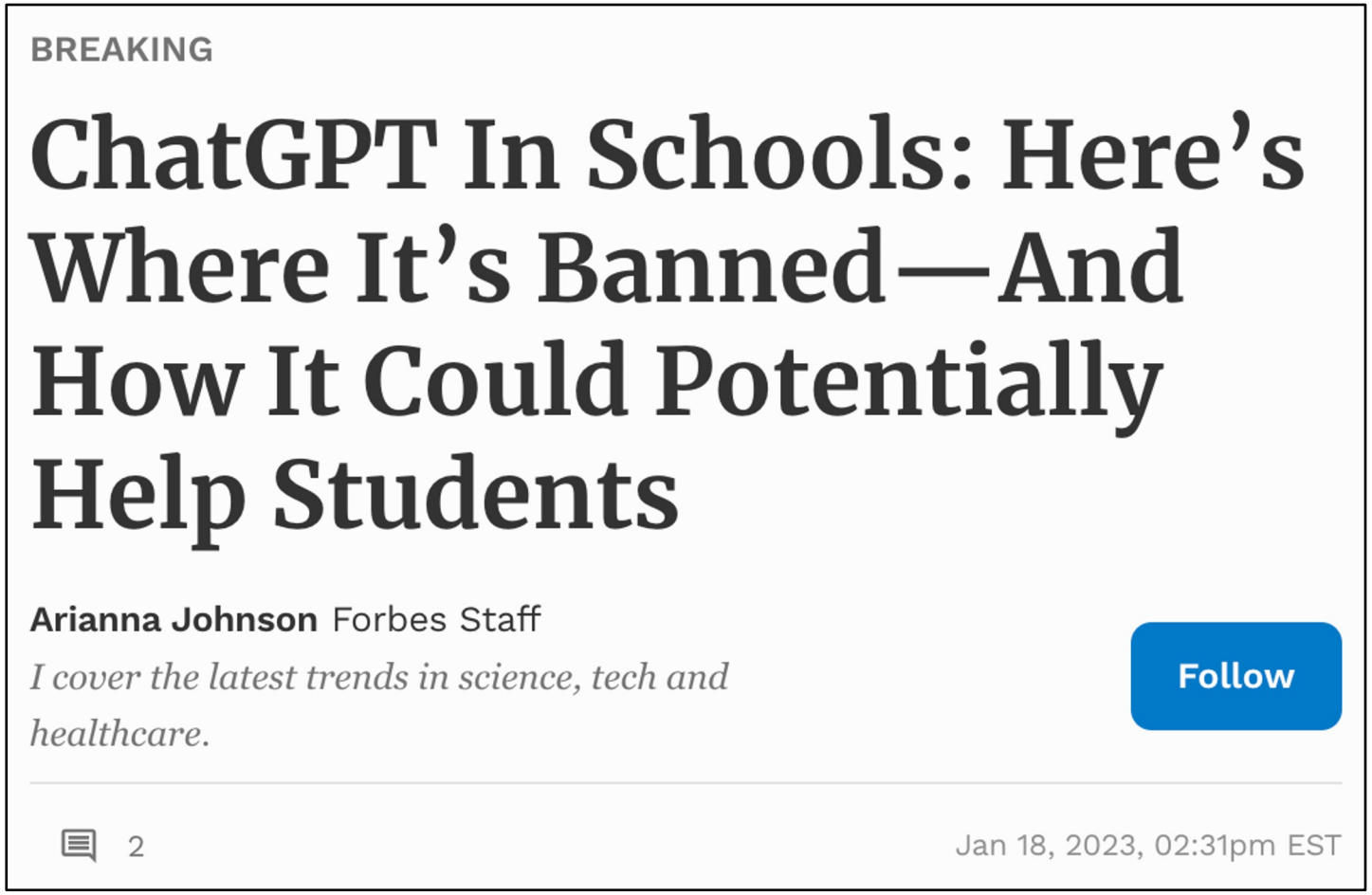
AI is having real-world impact

- Public imagination
- Economy
- Politics
- Law
- Labor
- Science
- Health

The Boston Globe, 2018

AI is having real-world impact

- Public imagination
- Economy
- Politics
- Law
- Labor
- Science
- Health
- 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

Economy

Politics

Law

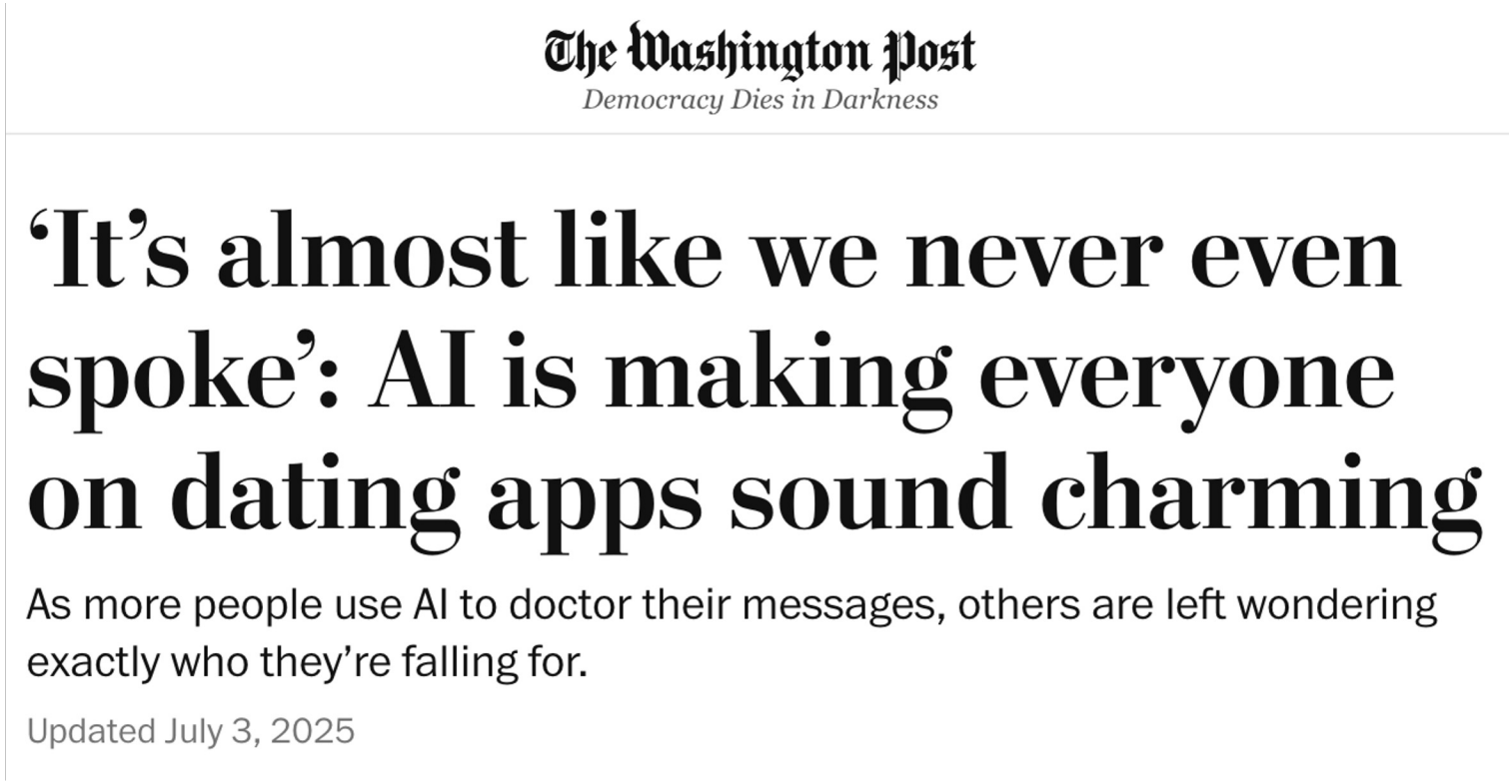
Labor

Science

Health

Education

Social interaction



The Washington Post
Democracy Dies in Darkness

‘It’s almost like we never even spoke’: AI is making everyone on dating apps sound charming

As more people use AI to doctor their messages, others are left wondering exactly who they’re falling for.

Updated July 3, 2025

AI is having real-world impact

Public imagination

Economy

Politics

Law

Labor

Science

Health

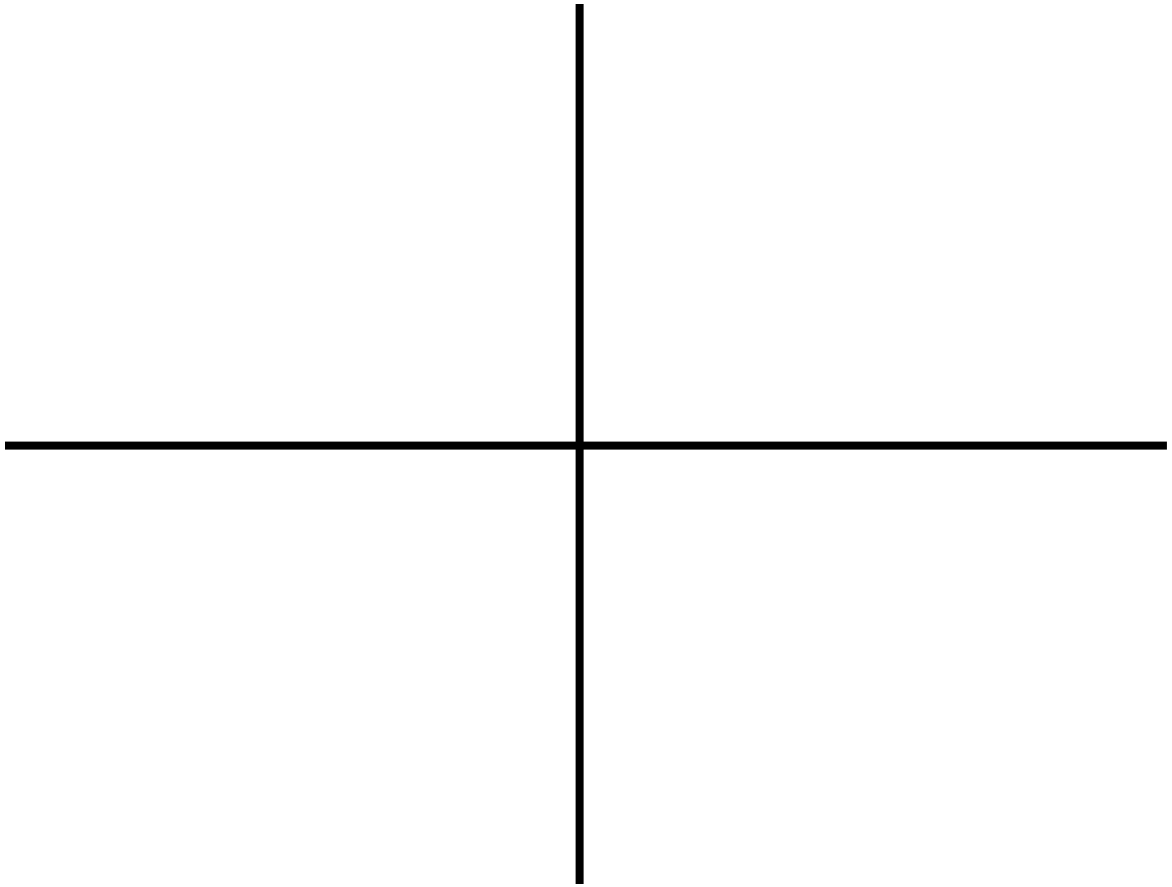
Education

Social interaction

Ok, but what actually is AI???

What should we build?

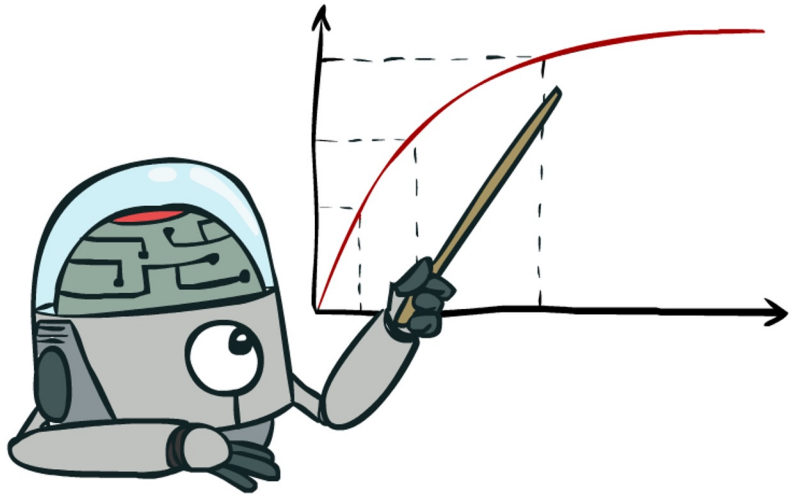
Should we make machines that…



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**



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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?

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!

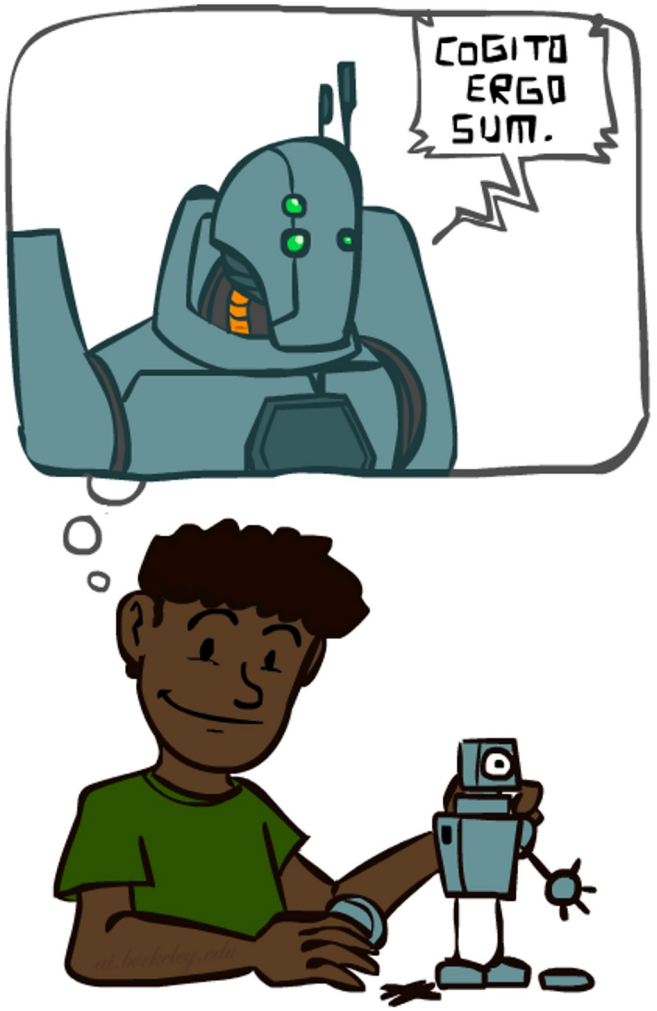
A (Short) History of AI

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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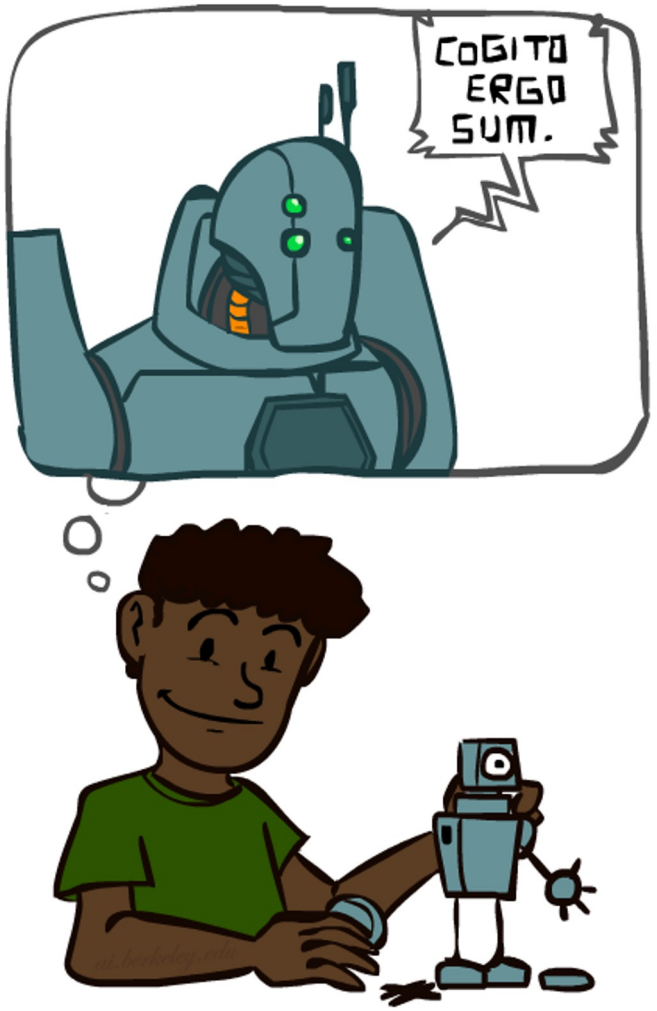
- 1956: Dartmouth meeting: “Artificial Intelligence” adopted
- 1969: Minsky & Papert: perceptrons can’t learn XOR/parity!

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



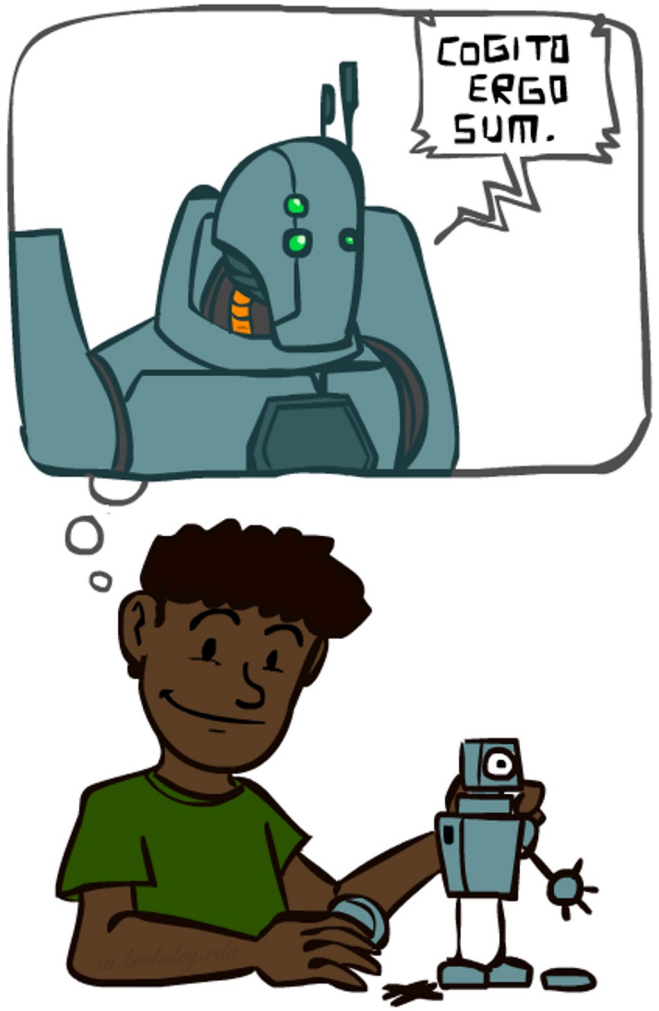
A (Short) History of AI

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
- 2024: Nobel prizes in physics and chemistry go to AI advances



A (Short) History of AI

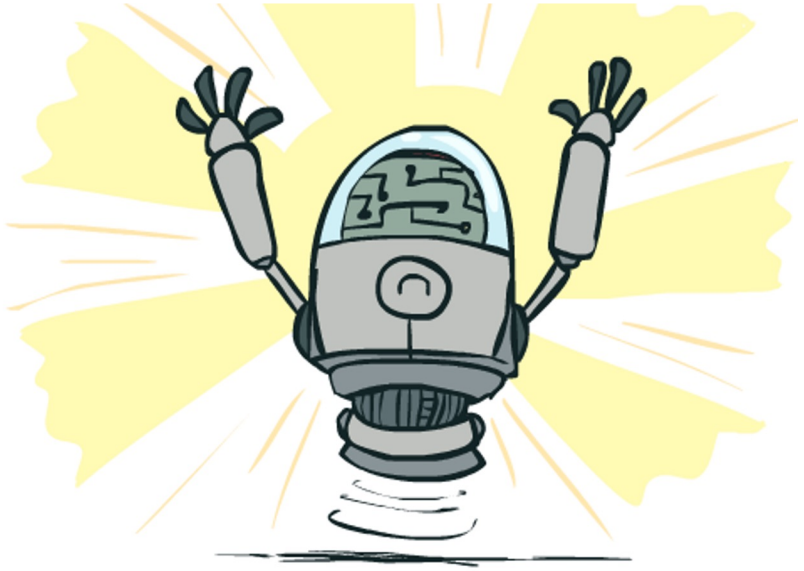
Zooming out, some general patterns:

- Overclaiming followed by disillusionment (AI winters)
- Simultaneous discovery, or rediscovery, of ideas
- Interdisciplinary
  - Math, statistics, control theory, neuroscience, psychology, economics, philosophy, computer engineering, linguistics
  - And increasingly: law, medicine, education…

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 UDistrict Farmer's Market?
- Discover and prove a new mathematical theorem?
- Perform a surgical operation?
- Translate spoken Chinese into spoken English in real time?
- Win an art competition?
- Write an intentionally funny story?
- Construct a building?



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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

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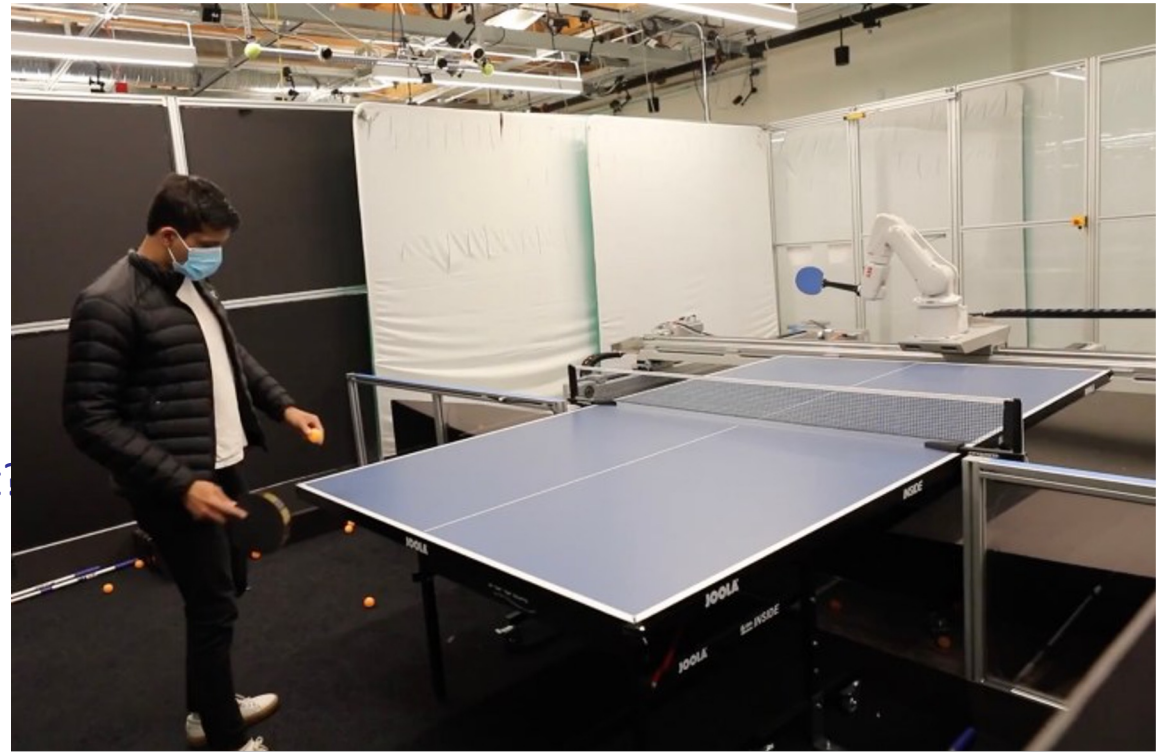

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- Construct a building?

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

MONEYWATCH

Waymo recalls roughly 1,200 self-driving vehicles prone to hitting road barriers

MONEY WATCH

By **Anne Marie D. Lee**
Edited By **Alain Sherter**
May 14, 2025 / 4:36 PM EDT / CBS News

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please write me a very funny, and extremely short story

A penguin walks into a bar, looks around, and says,
"Has anyone seen my brother?"

The bartender squints and asks,
"What does he look like?"

ChatGPT, 2025

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This Course: Designing Rational Agents

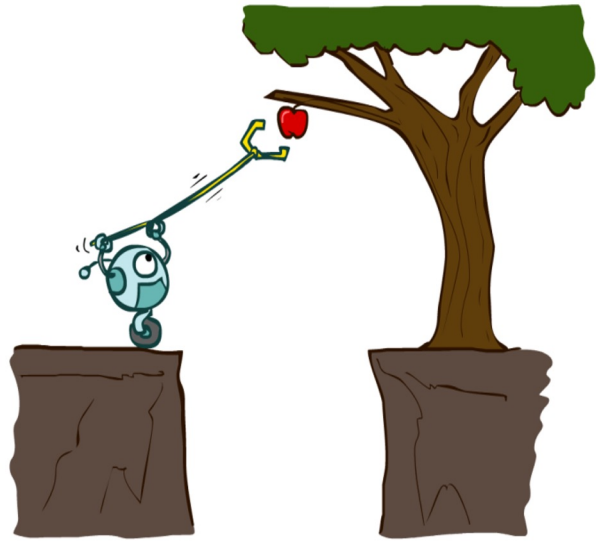
An **agent** is an entity that perceives and acts.

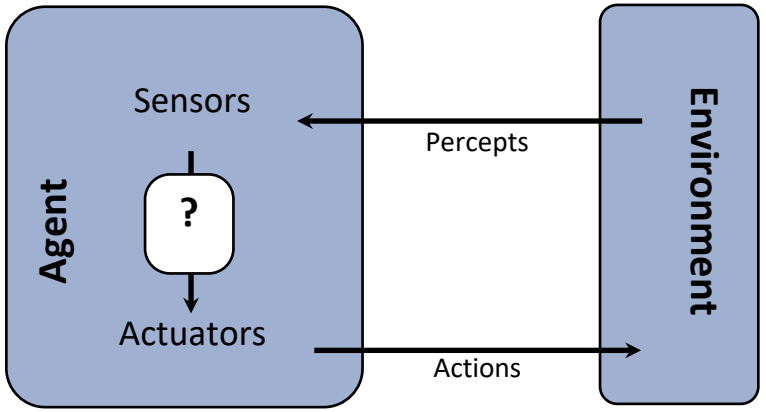
A **rational agent** selects actions that maximize its (expected) **utility**.

Characteristics of the **percepts**, **environment**, and **action space** dictate techniques for selecting rational actions

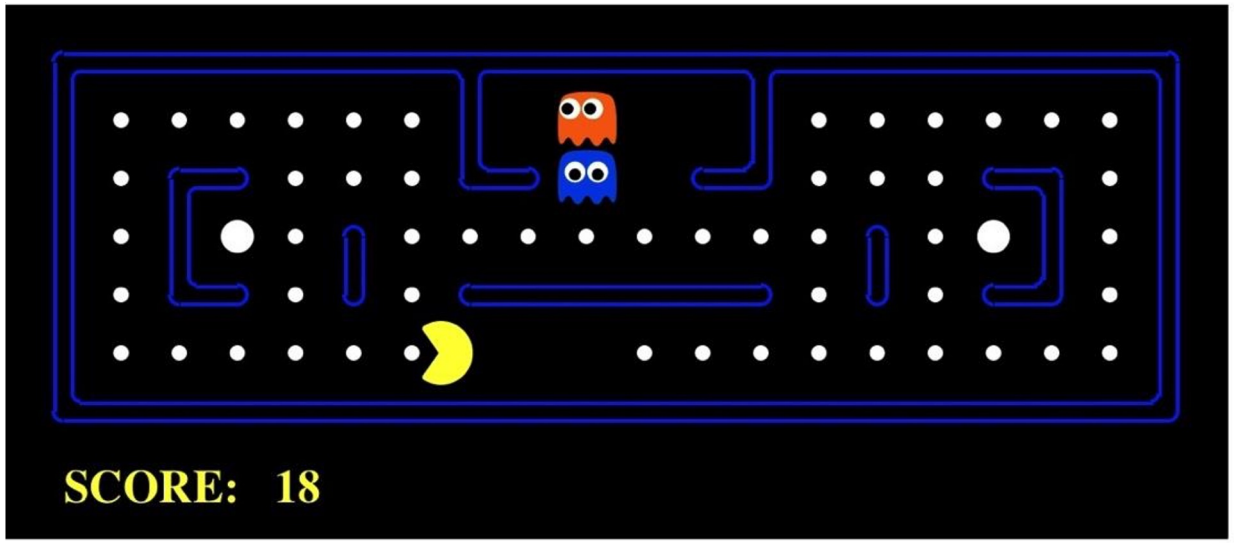
This course is about:

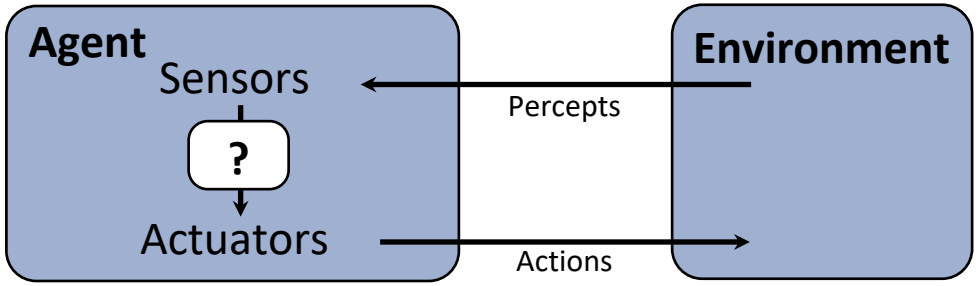
- General AI techniques for a variety of problem types
- Learning to recognize when and how a new problem can be solved with an existing technique





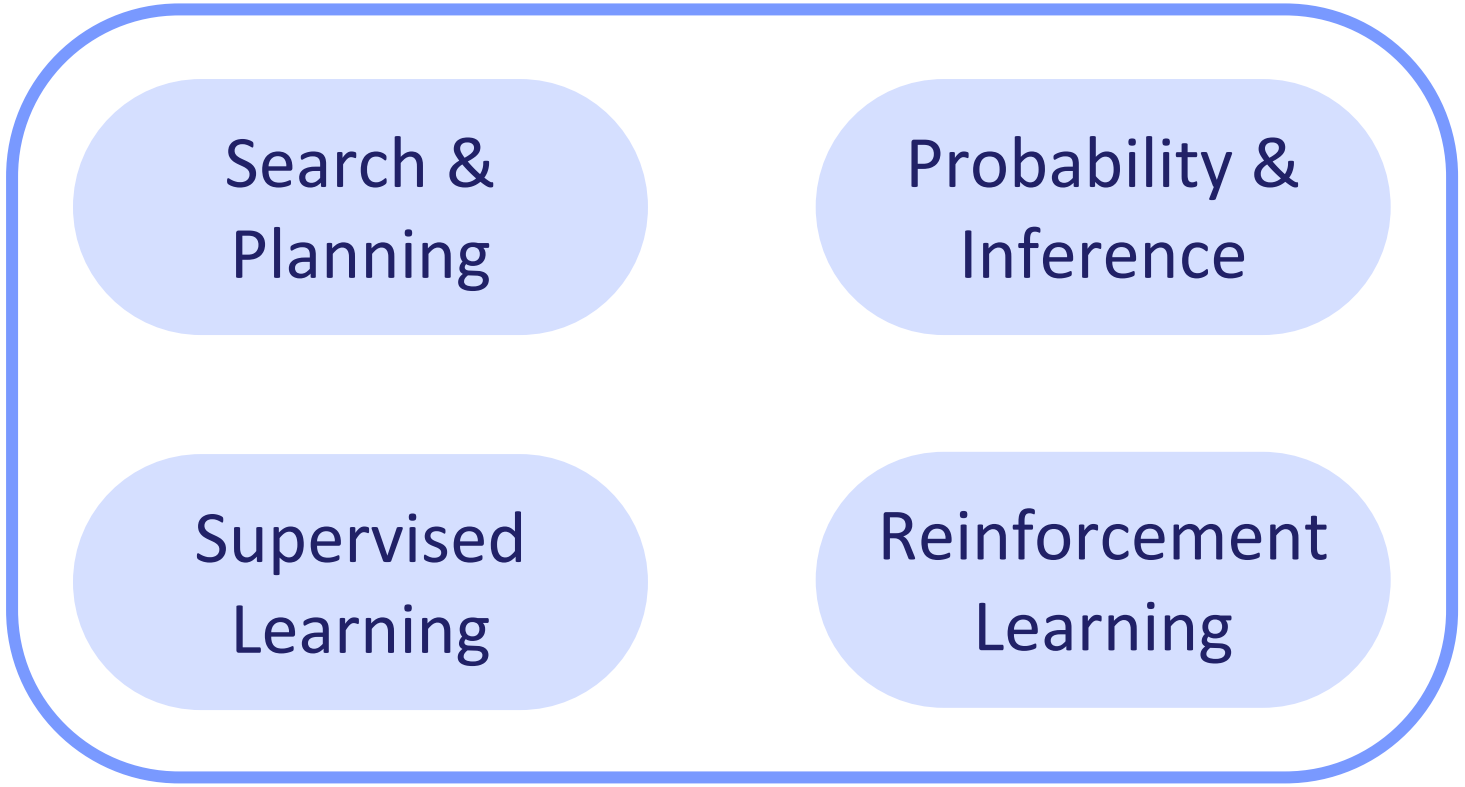
Pac-Man as an Agent





Course Topics

Core Components of Rational Agents:



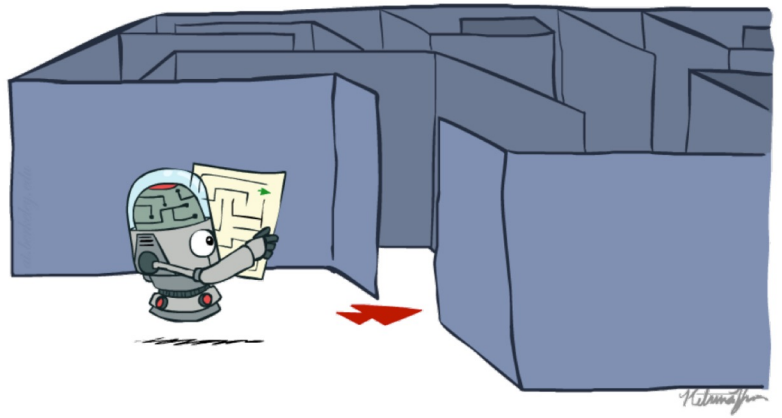
Course Topics

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***?

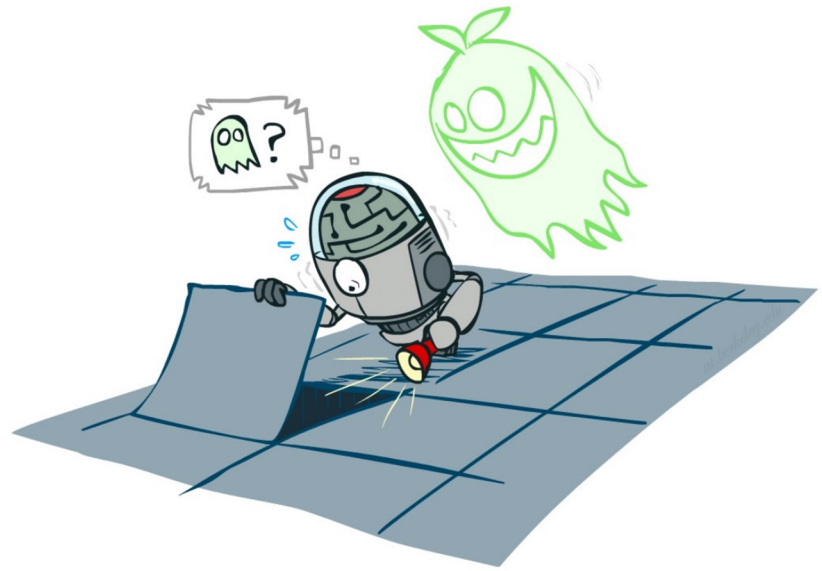
Course Topics

Search & Planning

Probability & Inference

Supervised Learning

Reinforcement Learning



How can I make sense of ***uncertainty***?

Course Topics

Search & Planning

Probability & Inference

Supervised Learning

Reinforcement Learning

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

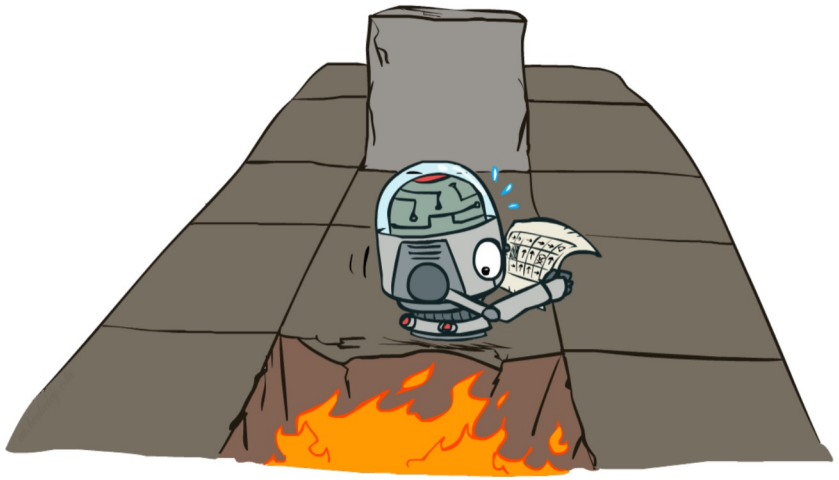
Course Topics

Search & Planning

Probability & Inference

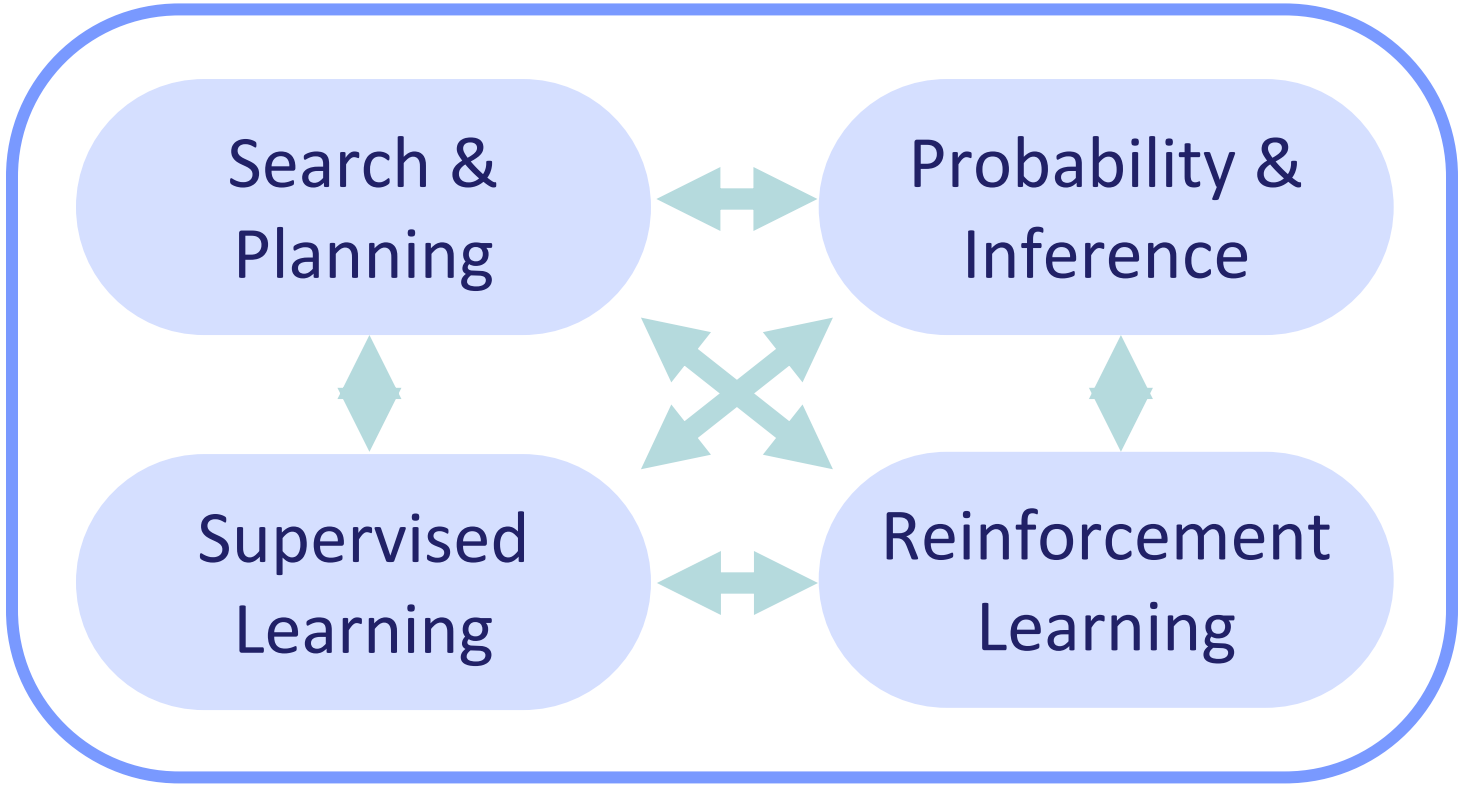
Supervised Learning

Reinforcement Learning

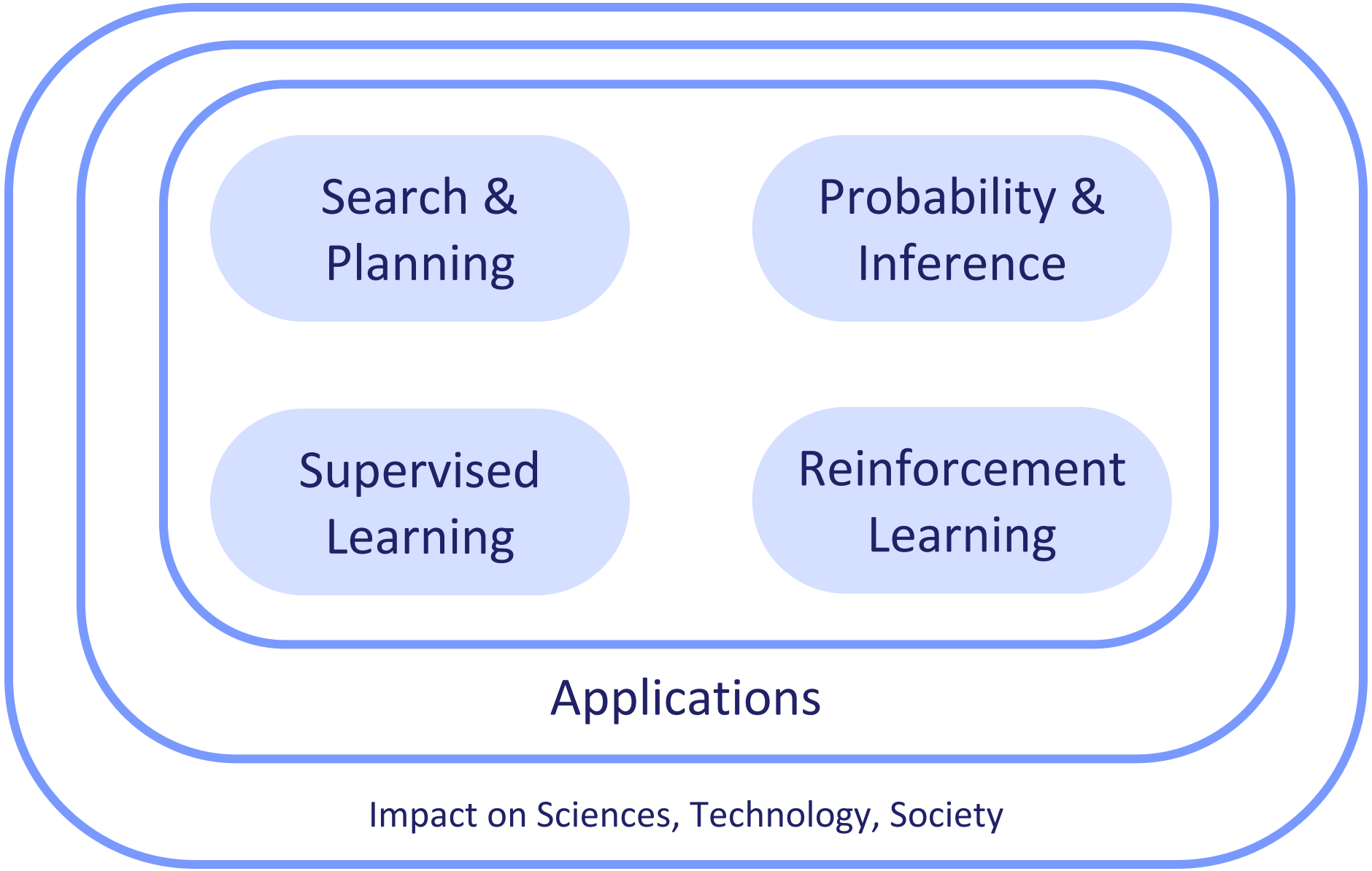


How can I learn a ***policy*** for any situation so that I can ***maximize utility***?

Course Topics



Course Topics



Topics in This Course

Part I: Intelligence from Computation

- Fast search
- Adversarial and uncertain search

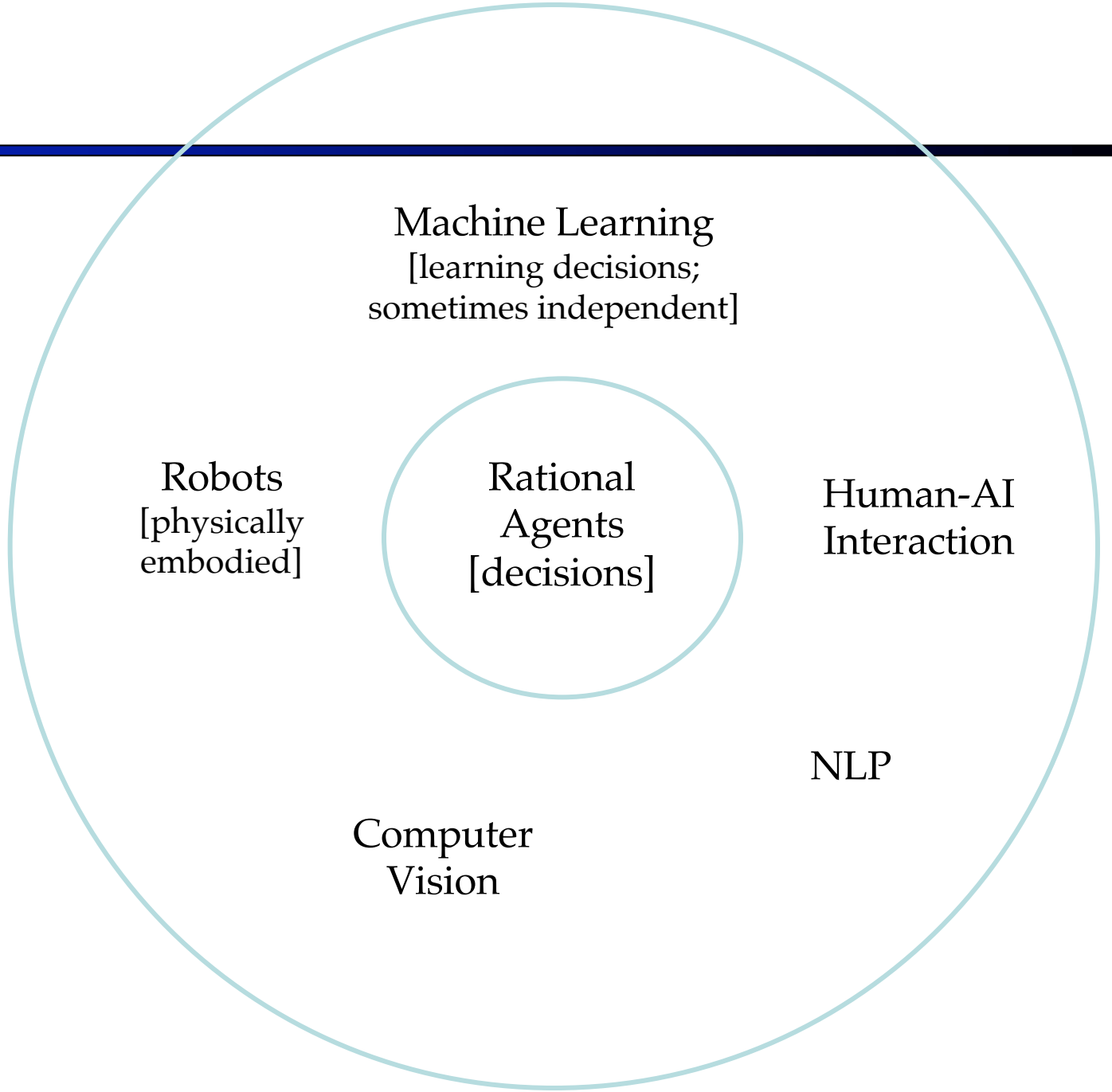
Part II: Reasoning under Uncertainty

- Decision theory: Reinforcement Learning, Markov Decision Processes
- Machine learning
- Graphical Models - Bayes Nets; HMMs

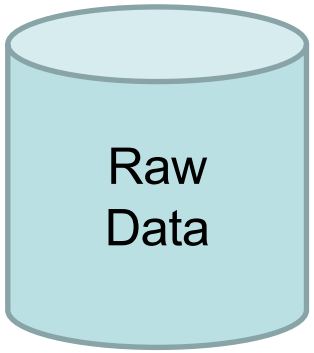
Throughout: Applications

- Natural language, vision, robotics, games, …

This course w.r.t. Current AI Research



This course w.r.t. Current AI Research



Modeling

Neural models

.....

State space

Probabilistic (Graphical Models)

Feature space & Linear functions

Inference

Decision Making & Planning

Machine Learning

Should I take CSEP 573?

Yes, if you want to know how to design rational agents!

- CSEP 573 gives you extra mathematical and conceptual maturity
- CSEP 573 gives you a survey of other non-CS fields that interact with AI (e.g. robotics, cognitive science, economics)

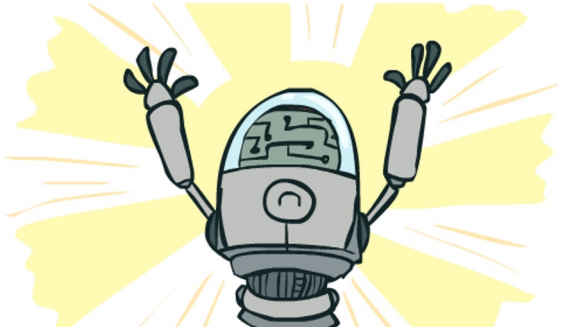
By the end of this course you'll:

Build and understand math of rational, learning agents

Select and apply the right AI methods for wide range of problems

Recognize how these methods are used in modern AI systems

Be prepared to make decisions on how AI is used in society



Important This Week

- Important this week:
  - **Check out** canvas--- our main resource for assignments and grades
  - **Check out** website – for schedule and slides
  - **Check out** Ed – for discussions; we have added everyone to Ed
  - **Check out** Gradescope -- for written assignments
  - **P0: Python tutorial** is out

Next Lecture: Search