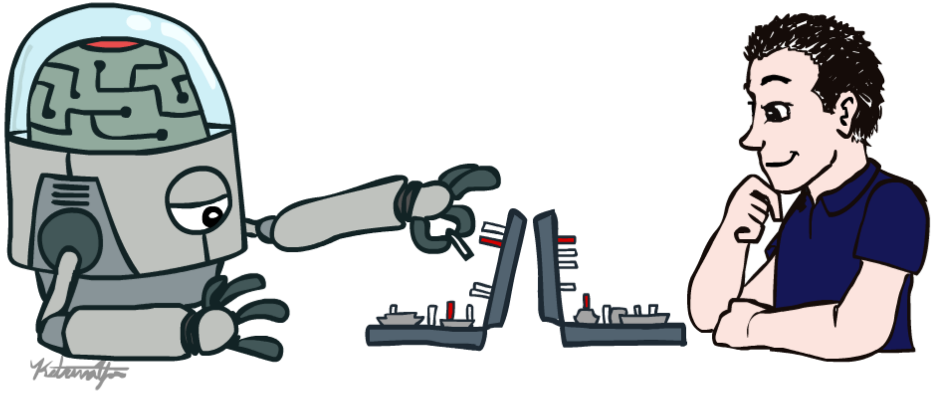
CS 5955/6955 Advanced Artificial Intelligence

Introduction



Instructor: Daniel Brown

University of Utah

[some slides and images adapted from those created by Dan Klein and Pieter Abbeel: http://ai.berkeley.edu.]

Course Staff

Professor

Daniel Brown

TAs

Zifan Wu

Varun Raveendra

Course Information

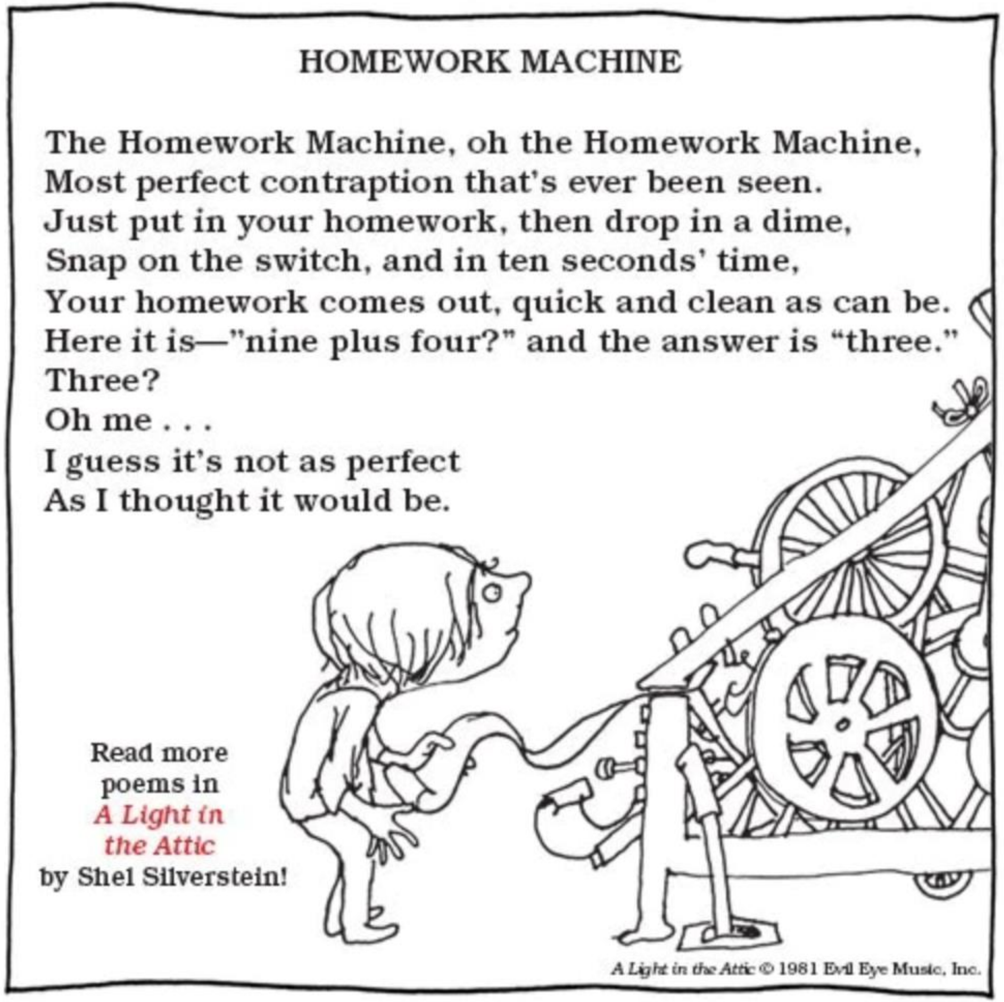
- Communication:
  - Announcements on Canvas (usually also posted on Piazza)
  - Questions and Discussion on Piazza
- Course format:
  - Reading assignments and programming assignments turned in via Canvas.
  - Big Final Project. No midterm or final
- Class Website:
  - https://dsbrown1331.github.io/advanced-ai-26/
  - Schedule
  - Assignment instructions
  - Readings
  - Etc.

Grading

- Programming Assignments: 45%
- Quizzes/Attendance/Reading Reports: 20%
- Final project proposal: 5%
- Final project presentation: 10%
- Final project written report: 20%
- All submissions due electronically **by midnight** on due date.
- There is a moratorium on complaints about grading, etc., of **one week after grades are released.**

Use of AI in class (highly encouraged)

- Have fun and use whatever tools you find beneficial for helping with coding, debugging, experimenting, brainstorming, etc.
  - Beware blindly copying and pasting. You won’t learn anything that way.
  - Try copilot
  - Try OpenAI Codex (free as student at U), Claude Code, etc.
- You need to actually write the results and discussion and summary yourself.
  - Writing builds critical thinking skills!
  - Forces you to realize what you do and don’t understand. If you can’t explain it simply in your own words, then you don’t really understand something.



HOMEWORK MACHINE

The Homework Machine, oh the Homework Machine,
Most perfect contraption that's ever been seen.
Just put in your homework, then drop in a dime,
Snap on the switch, and in ten seconds' time,
Your homework comes out, quick and clean as can be.
Here it is—"nine plus four?" and the answer is “three.”
Three?
Oh me . . .
I guess it's not as perfect
As I thought it would be.

Read more
poems in
*A Light in
the Attic*
by Shel Silverstein!

Use of AI in class (highly encouraged)

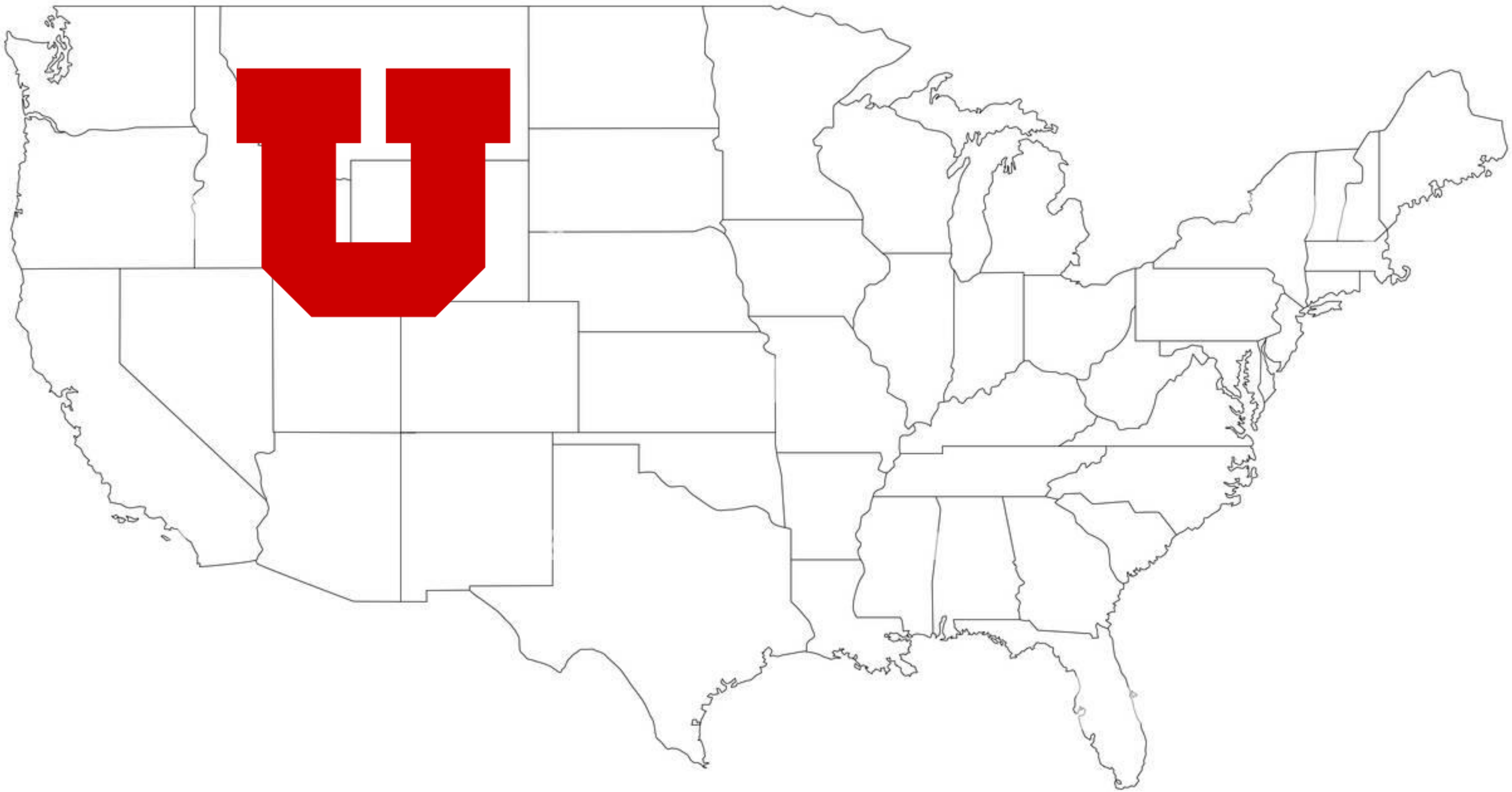
- Use AI to understand papers.
  - Ask for a brief, easy to understand summary before you start.
  - Upload pdf and ask about equations, why results matter, what are flaws.
  - Don’t just blindly trust, think about it and decide if you agree
  - If you see a term you don’t recognize, ask for a quick definition
  - Etc.

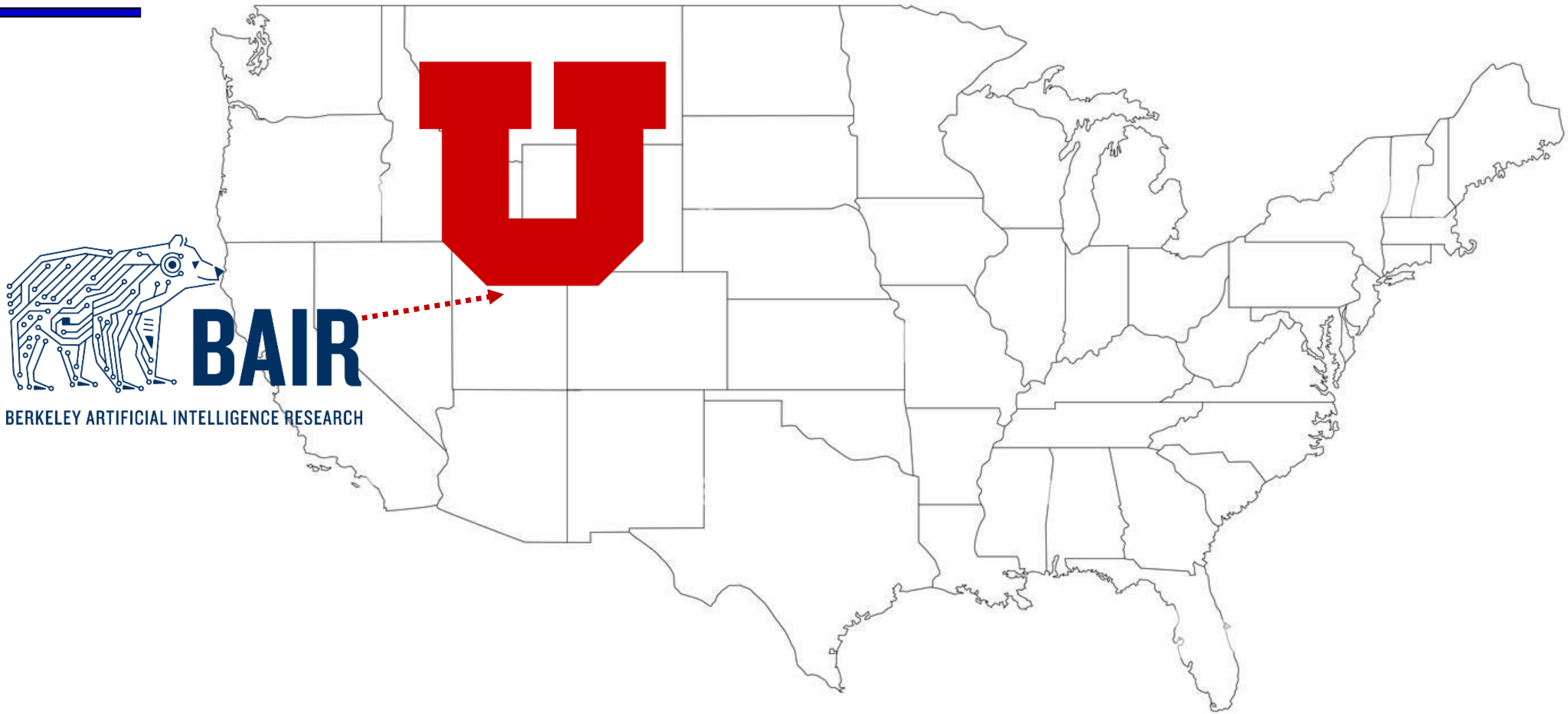
How to read papers?

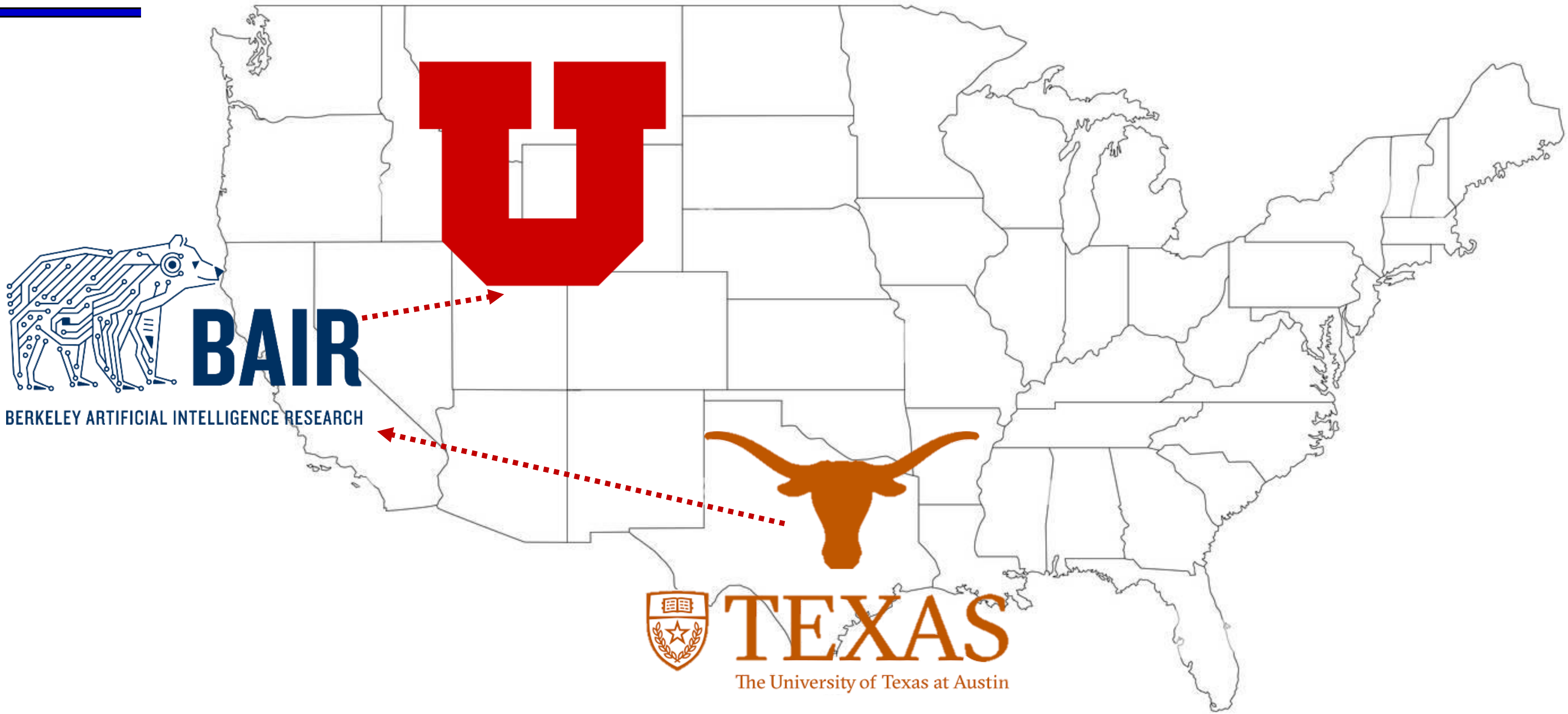
Important for this week

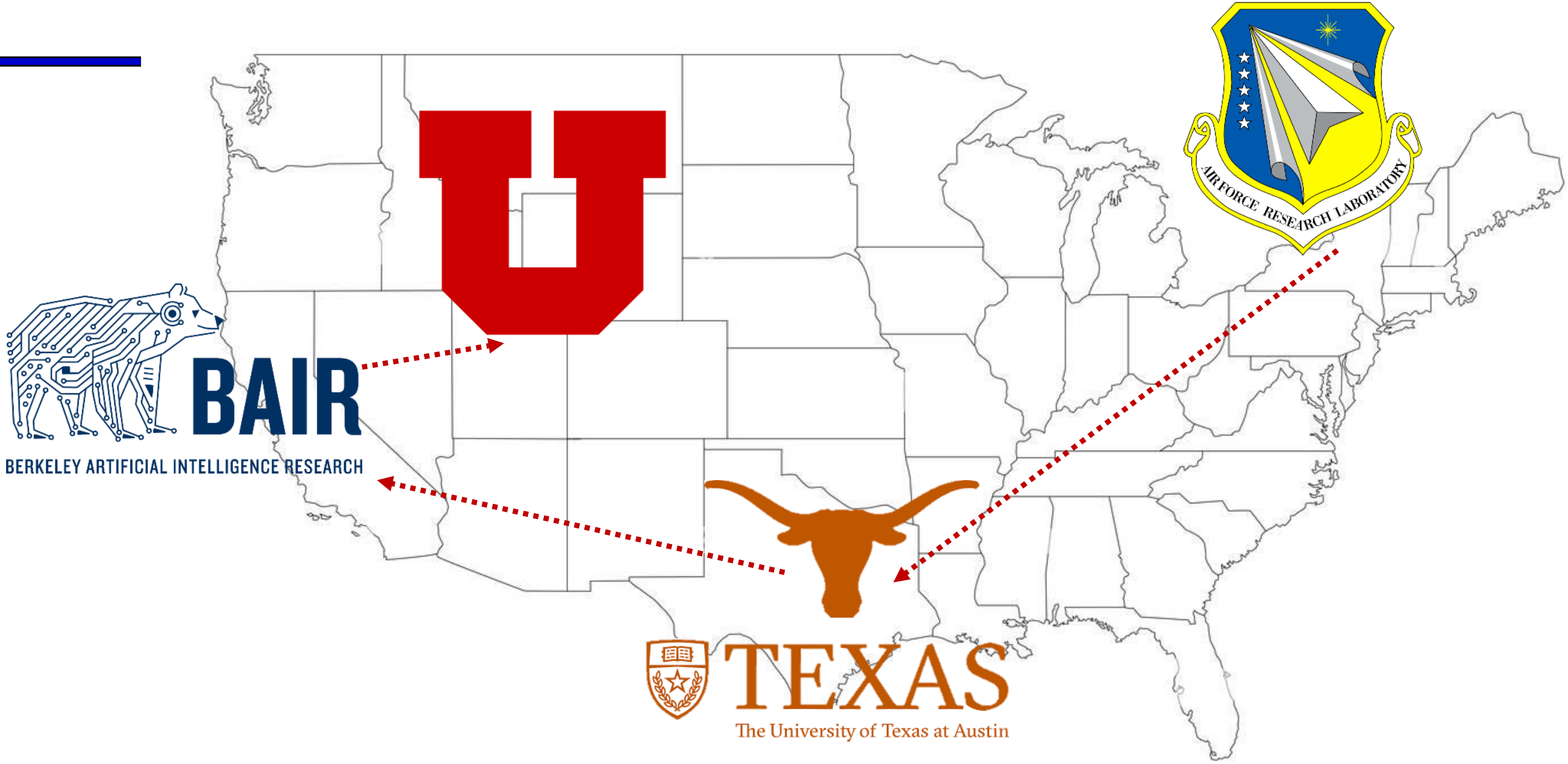
- Register for class on Piazza
- Brush up on Python if you’re rusty (see links on class website)

A little about me

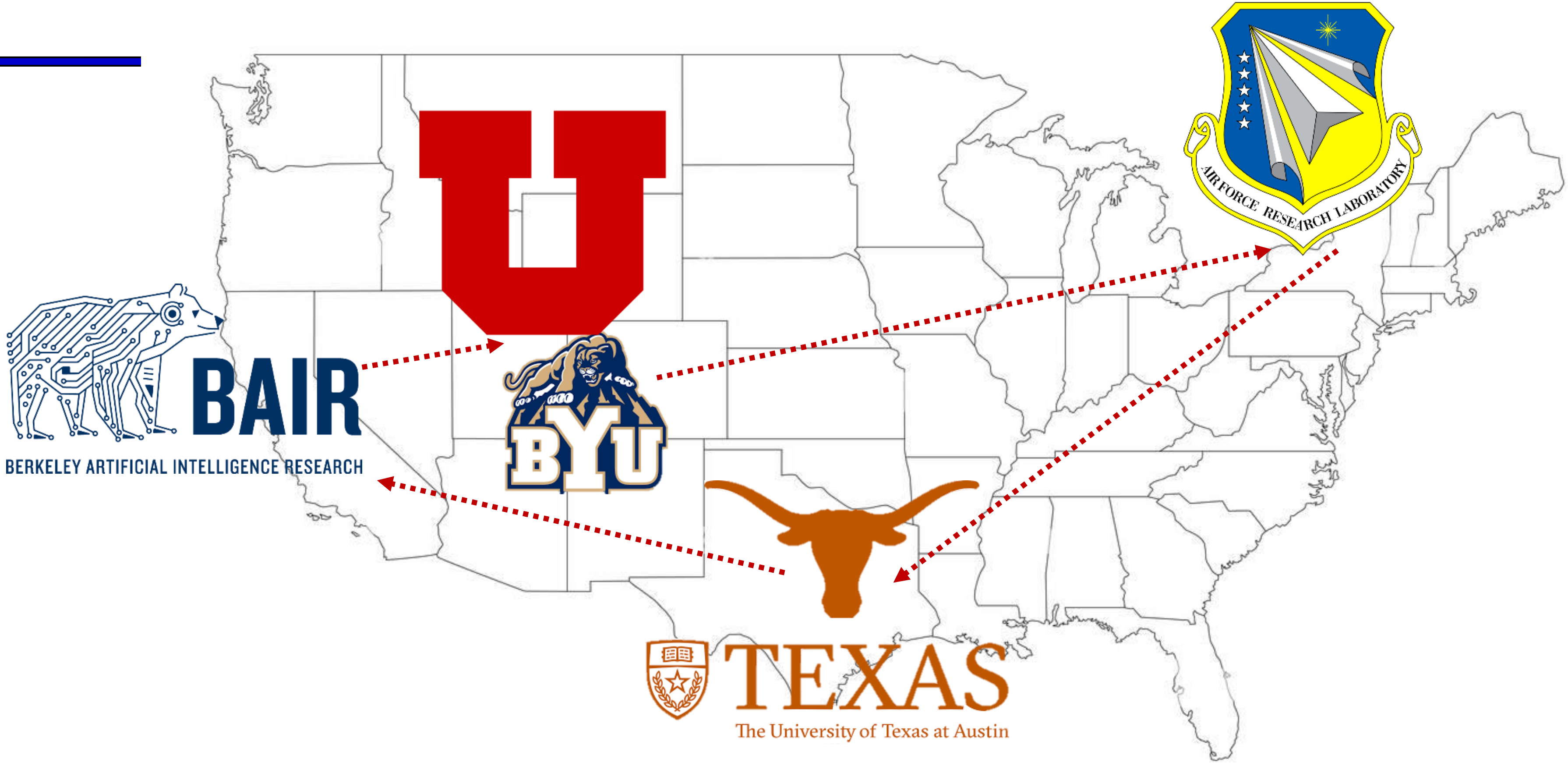


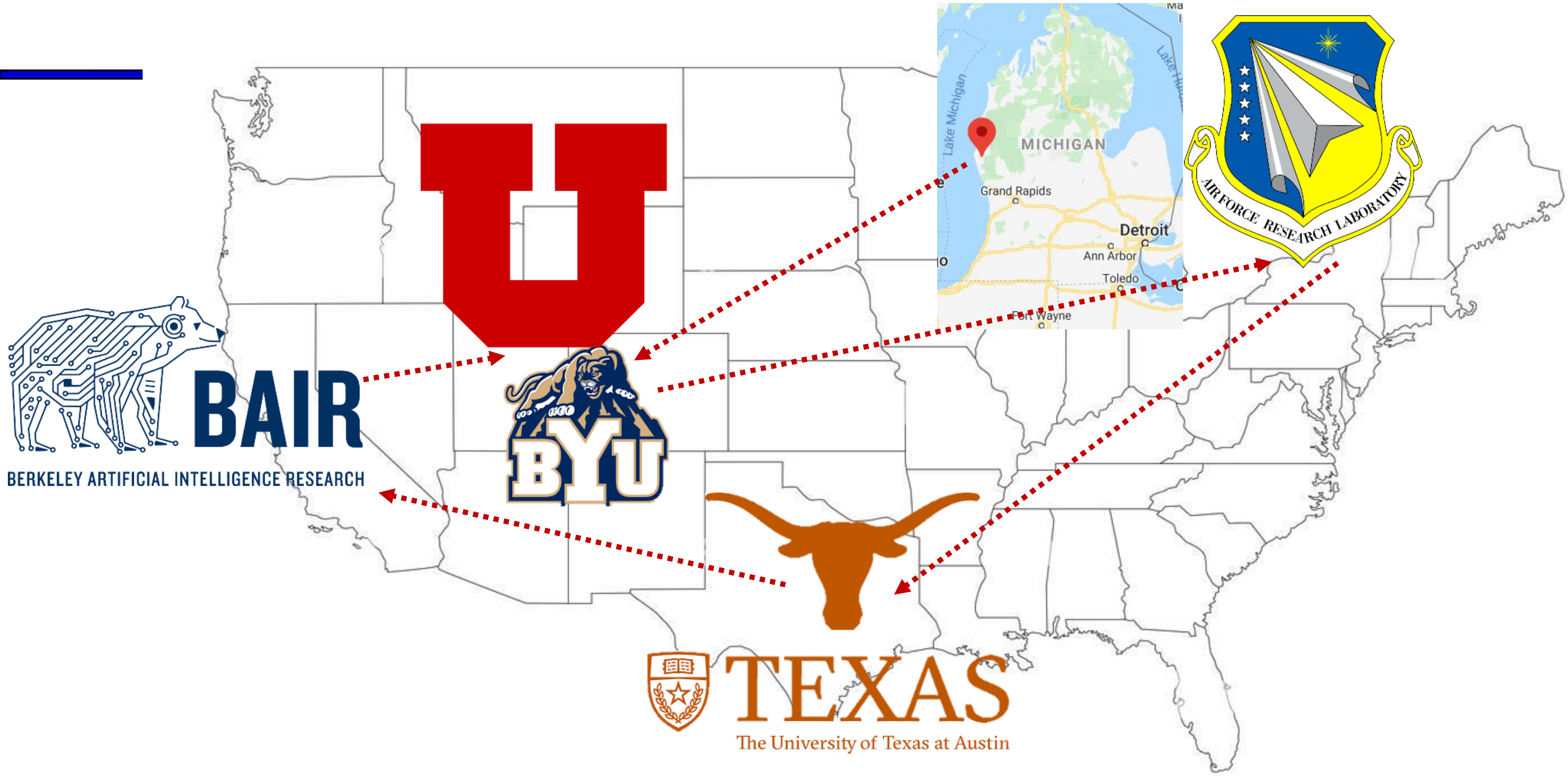

BAIR
BERKELEY ARTIFICIAL INTELLIGENCE RESEARCH

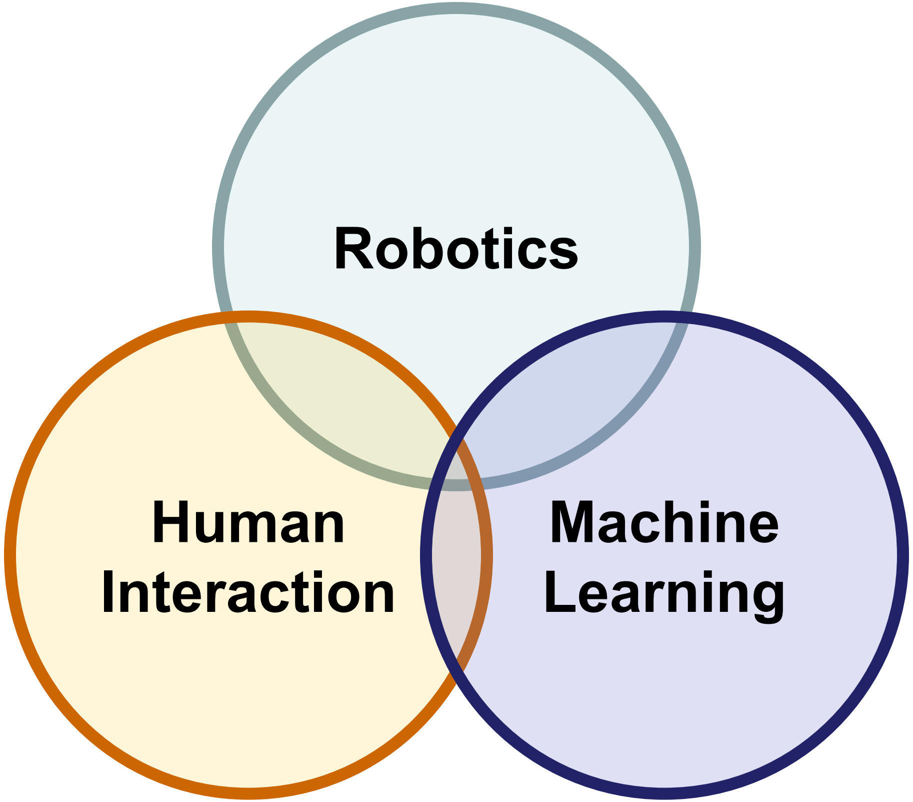

BAIR
BERKELEY ARTIFICIAL INTELLIGENCE RESEARCH
TEXAS
The University of Texas at Austin


AIR FORCE RESEARCH LABORATORY
BAIR
BERKELEY ARTIFICIAL INTELLIGENCE RESEARCH
TEXAS
The University of Texas at Austin

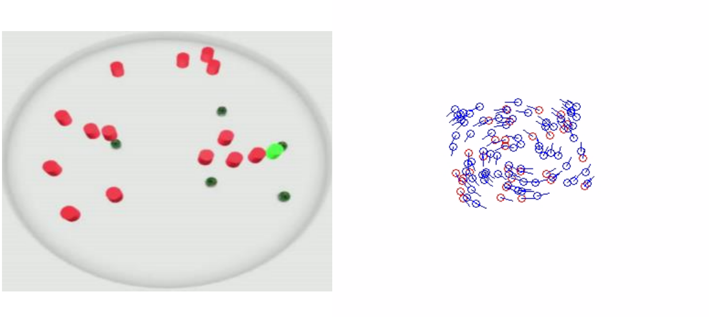
BAIR
BERKELEY ARTIFICIAL INTELLIGENCE RESEARCH
U
BYU
AIR FORCE RESEARCH LABORATORY
TEXAS
The University of Texas at Austin


BAIR
BERKELEY ARTIFICIAL INTELLIGENCE RESEARCH
BYU
AIR FORCE RESEARCH LABORATORY
TEXAS
The University of Texas at Austin

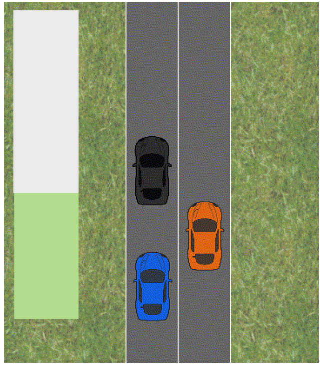

MICHIGAN
Lake Michigan
Lake Huron
Grand Rapids
Detroit
Ann Arbor
Toledo
Fort Wayne
AIR FORCE RESEARCH LABORATORY
BAIR
BERKELEY ARTIFICIAL INTELLIGENCE RESEARCH
U
BYU
TEXAS
The University of Texas at Austin


Robotics
Human Interaction
Machine Learning

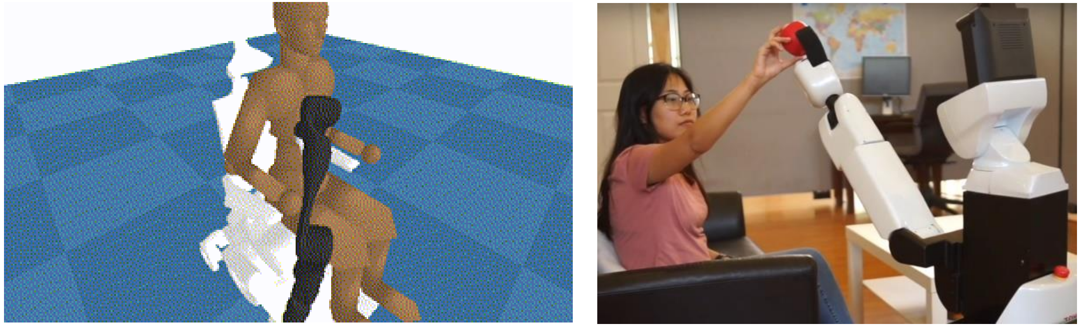
Human-Robot Interaction



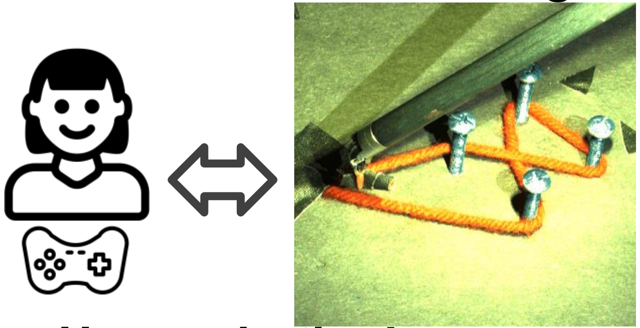
Human Swarm Interactions



Autonomous Driving

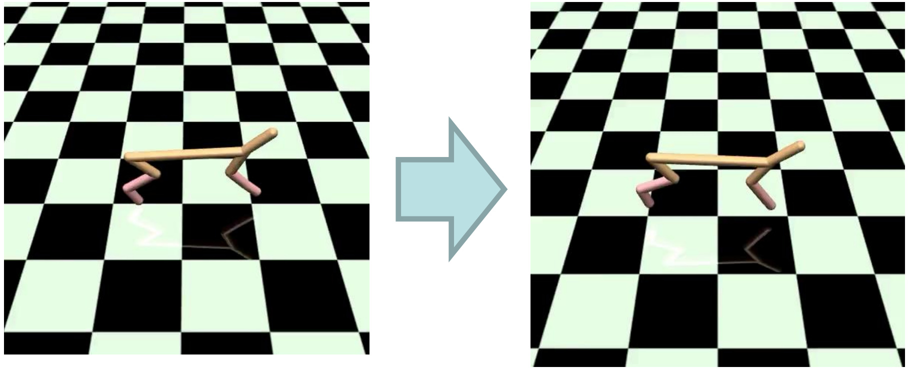


Shared Autonomy and Assistive Robotics

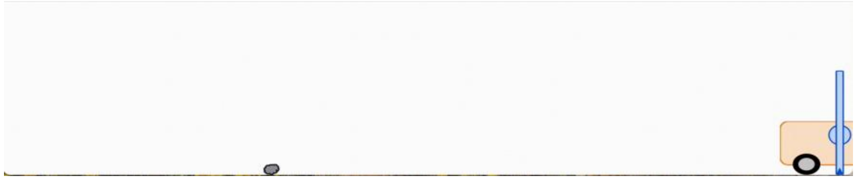


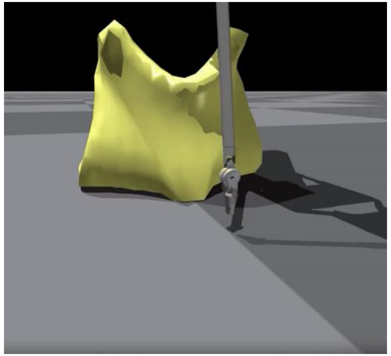
Human-in-the-Loop Robot Learning

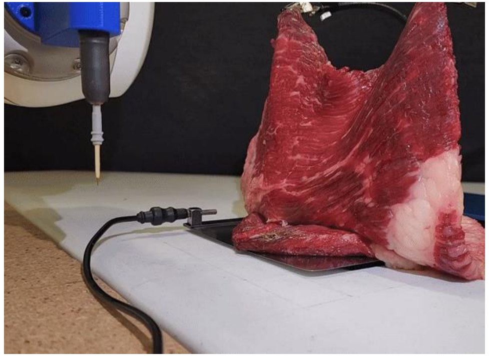
Learning models of human preferences



“Great weather today!”

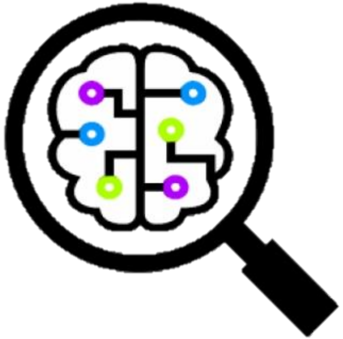






“Didn’t get the job offer…”

AI Safety and Robustness



Today

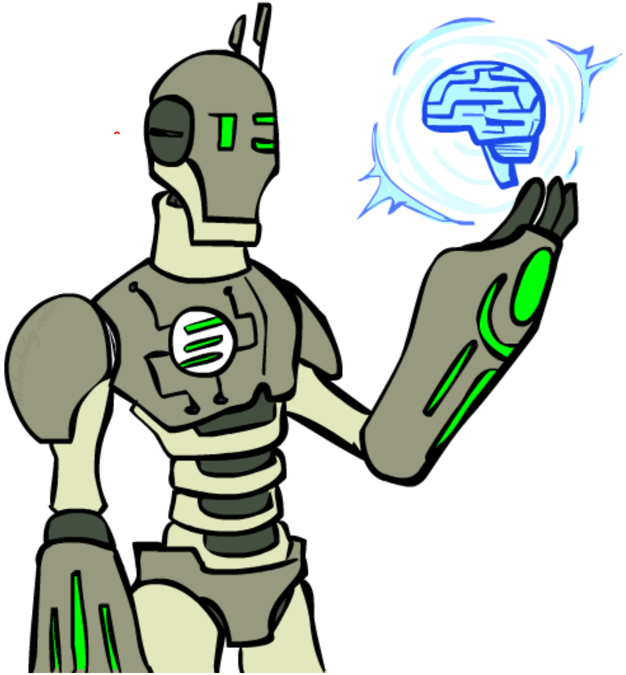
- What is artificial intelligence?

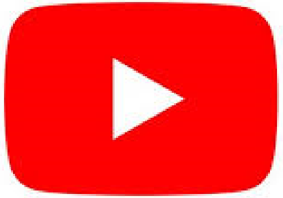
decision making

- How is it different from machine learning?

$x \to y$

- What will we cover in this class?





stability.ai

Chat GPT

ambi
ROBOTICS

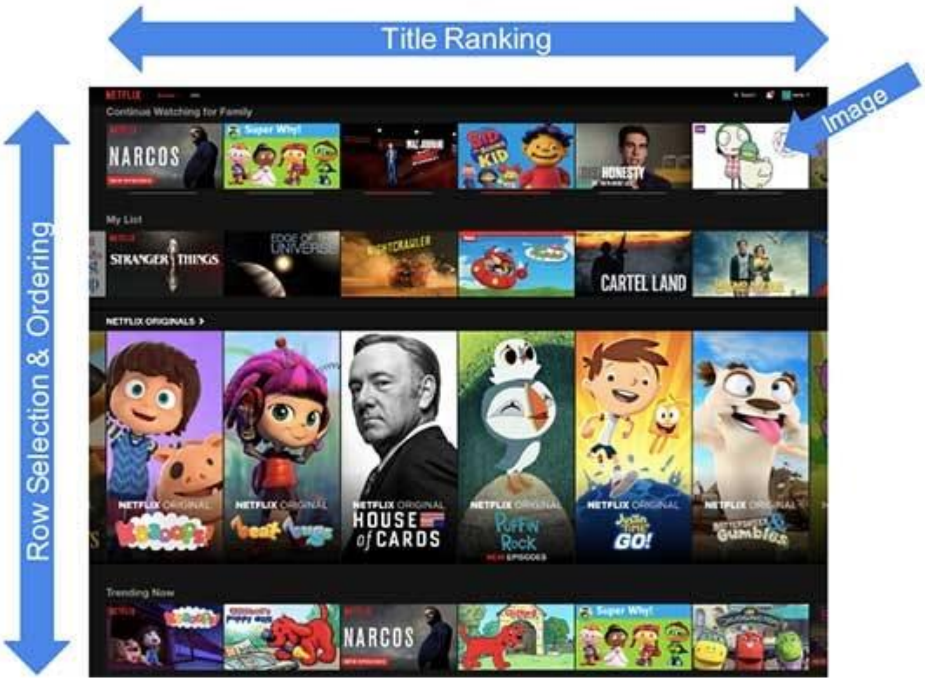
foods, better choices

WAYMO

Smart Chatbots

Entertainment

Everything is a Recommendation

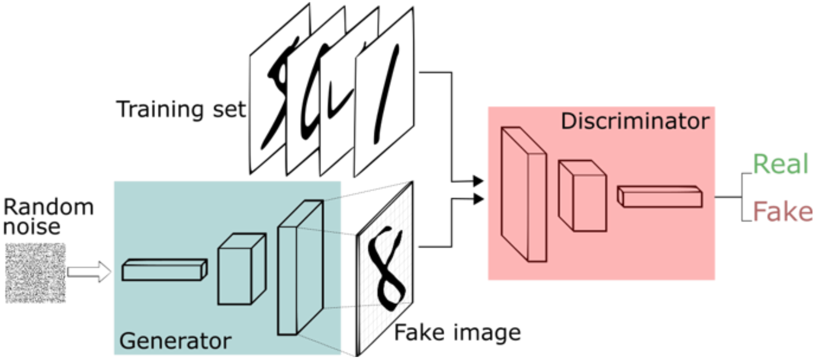


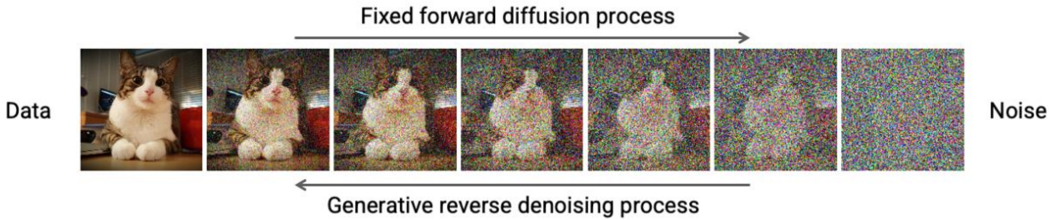
Recommendations are driven by machine learning algorithms

Over 80% of what members watch comes from our recommendations

Education

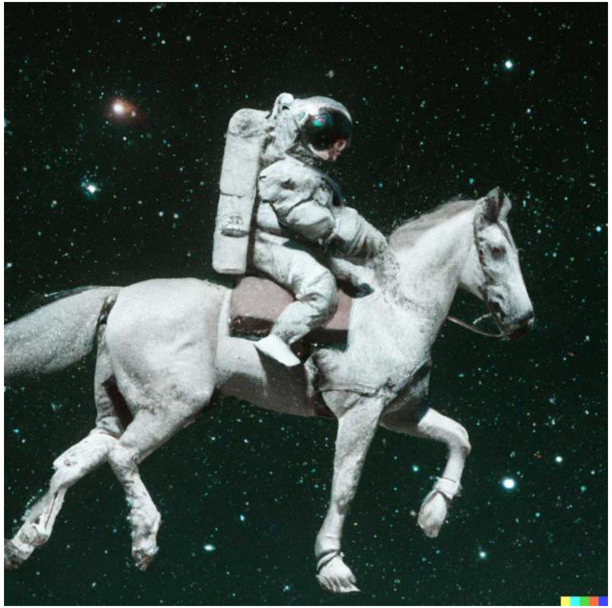
Generating Images

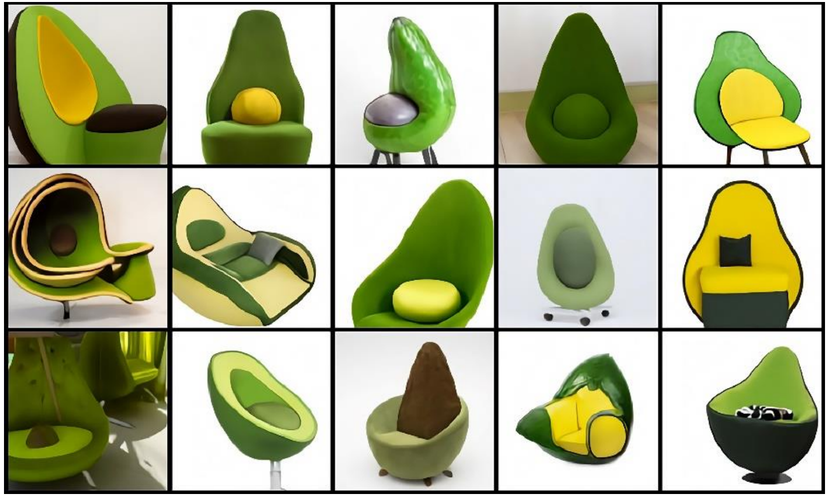



Fixed forward diffusion process
Data
Noise
Generative reverse denoising process

Text to Images (DALL-E)

- “An astronaut riding a horse in a photo-realistic way”

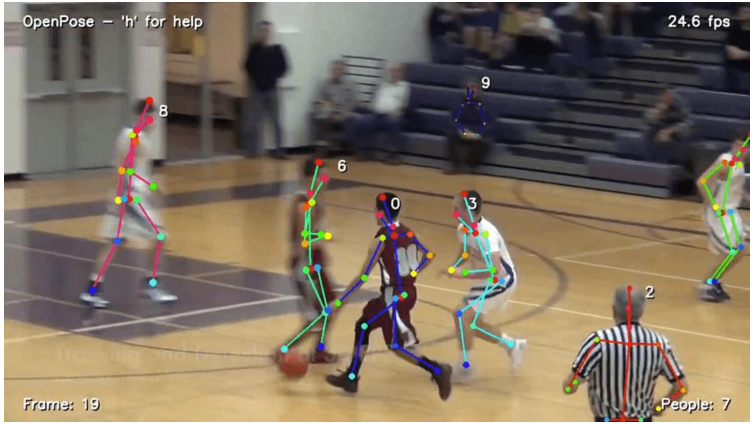


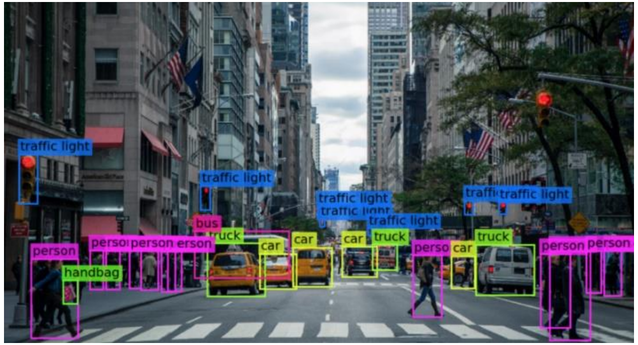


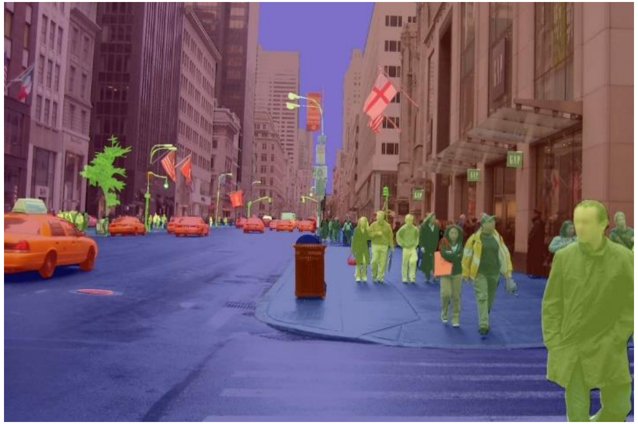
- “An armchair in the shape of an avocado.”

Vision (Perception)

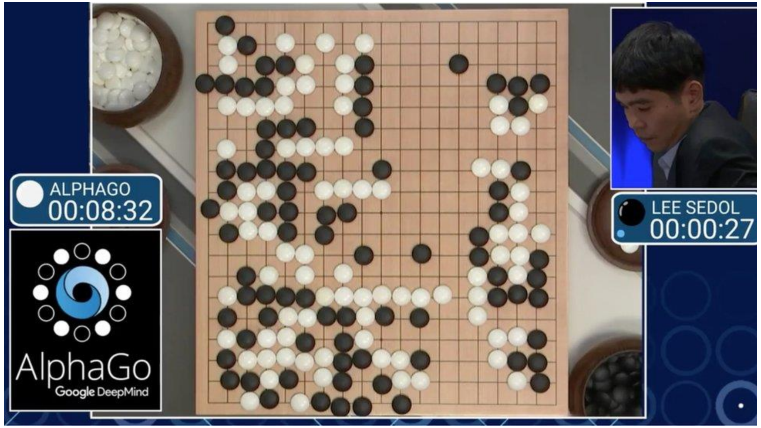
- Object and face recognition
- Scene segmentation
- Image classification







Super-Human Performance at Games

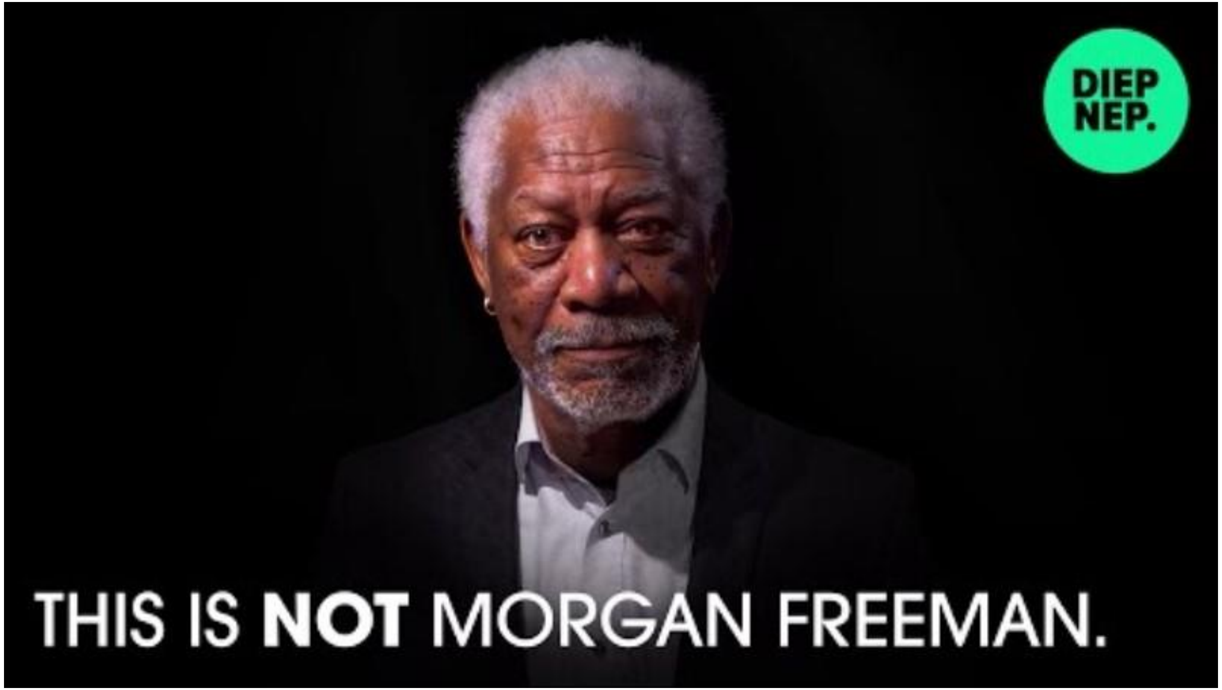


Boston Dynamics Atlas

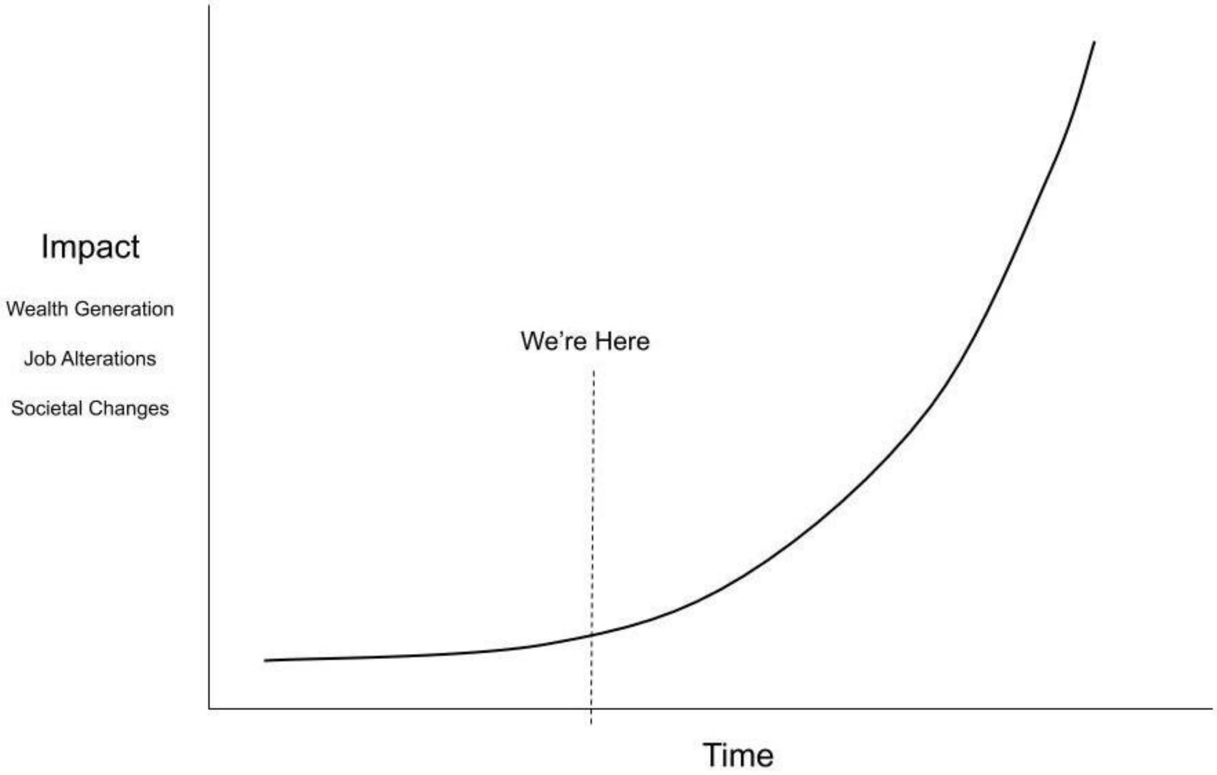
https://vision-locomotion.github.io/

Videos

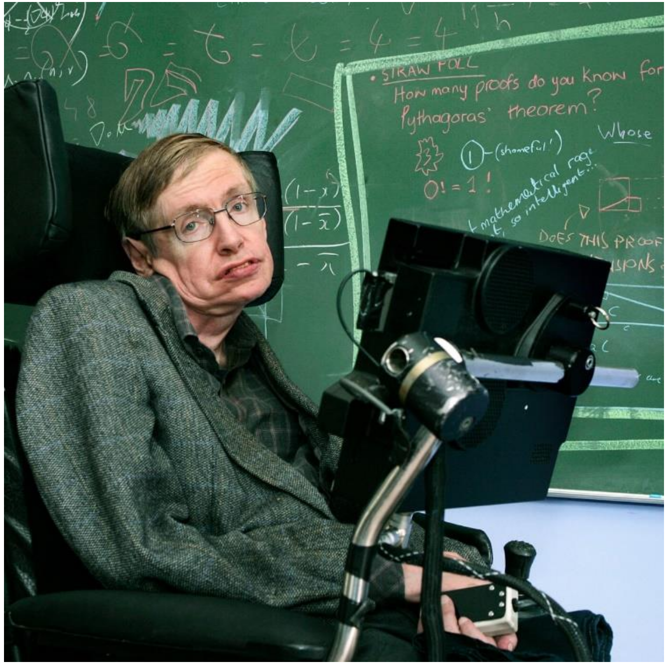
Deep Fakes and Reality



Progress is expected to continue!



Should we be worried?



"The development of full artificial intelligence could spell the end of the human race.“

-Stephen Hawking

Should we be worried?

“AI is a fundamental existential risk for human civilization.”

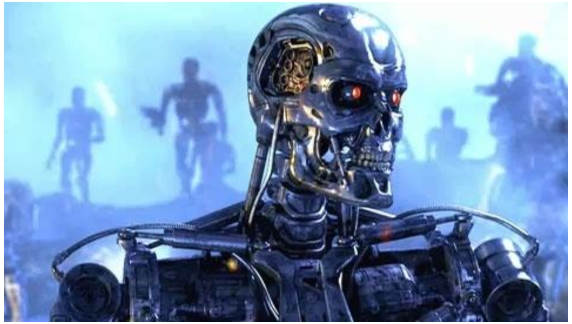
-Elon Musk

Geoffrey Hinton speaks out about the risks of AI

Worries about Advanced AI

- AI enabling people to do bad things:
  - Enabling cyber attacks, bio-terrorism, disinformation, etc.
- Self-improvement loop
  - AI automates AI research and development
- Unintended consequences
  - Deception, scheming, and manipulation
  - Power seeking
  - AI gets out of control

What is AI?



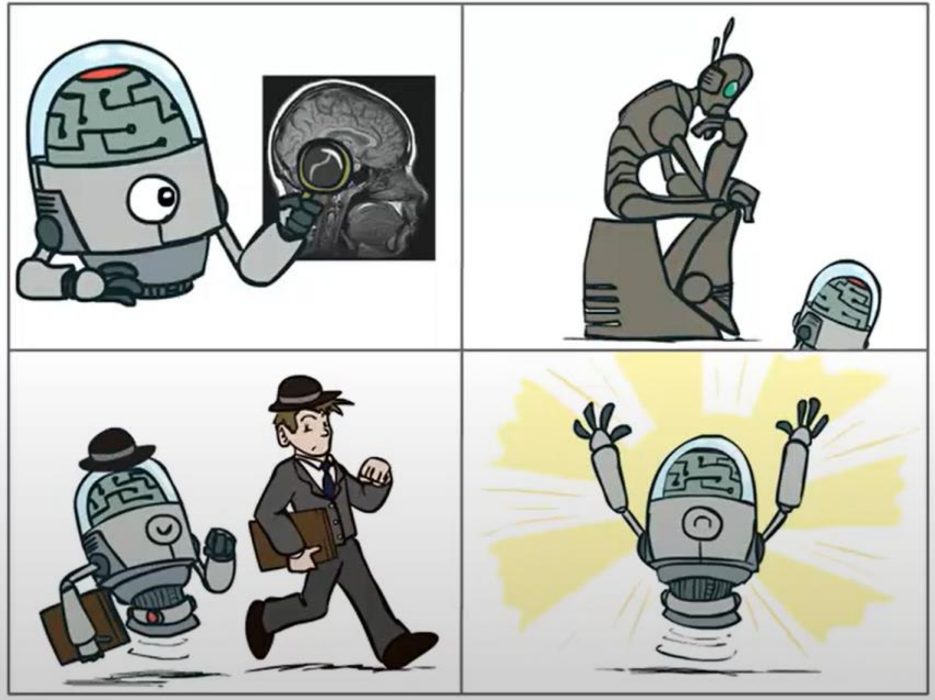
August
11
29°
Iron Man Jarvis AI Desktop Voice Assistant
JARVIS

What is AI?

- **John McCarthy (1955) (He coined the term AI)**
  - *"The science and engineering of making intelligent machines."*
- **Alan Turing (1950)**:
  - *"A machine that can mimic any aspect of human intelligence.“*
- **European Commission (2018)**:
  - *"Artificial intelligence refers to systems that display intelligent behavior by analyzing their environment and taking actions—with some degree of autonomy—to achieve specific goals."*

What is AI?

The science of making machines that:



Think like people

Think rationally

Act like people

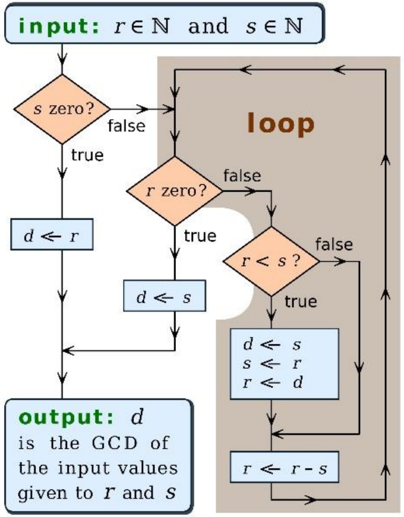
Act rationally

What about machine learning?

- **"Machine Learning is the study of computer algorithms that improve automatically through experience and by the use of data.“** Tom M. Mitchell (1997)
  - It’s a critical tool for achieving AI

Brief History of AI

Algorithms -- 1980s (TELL)

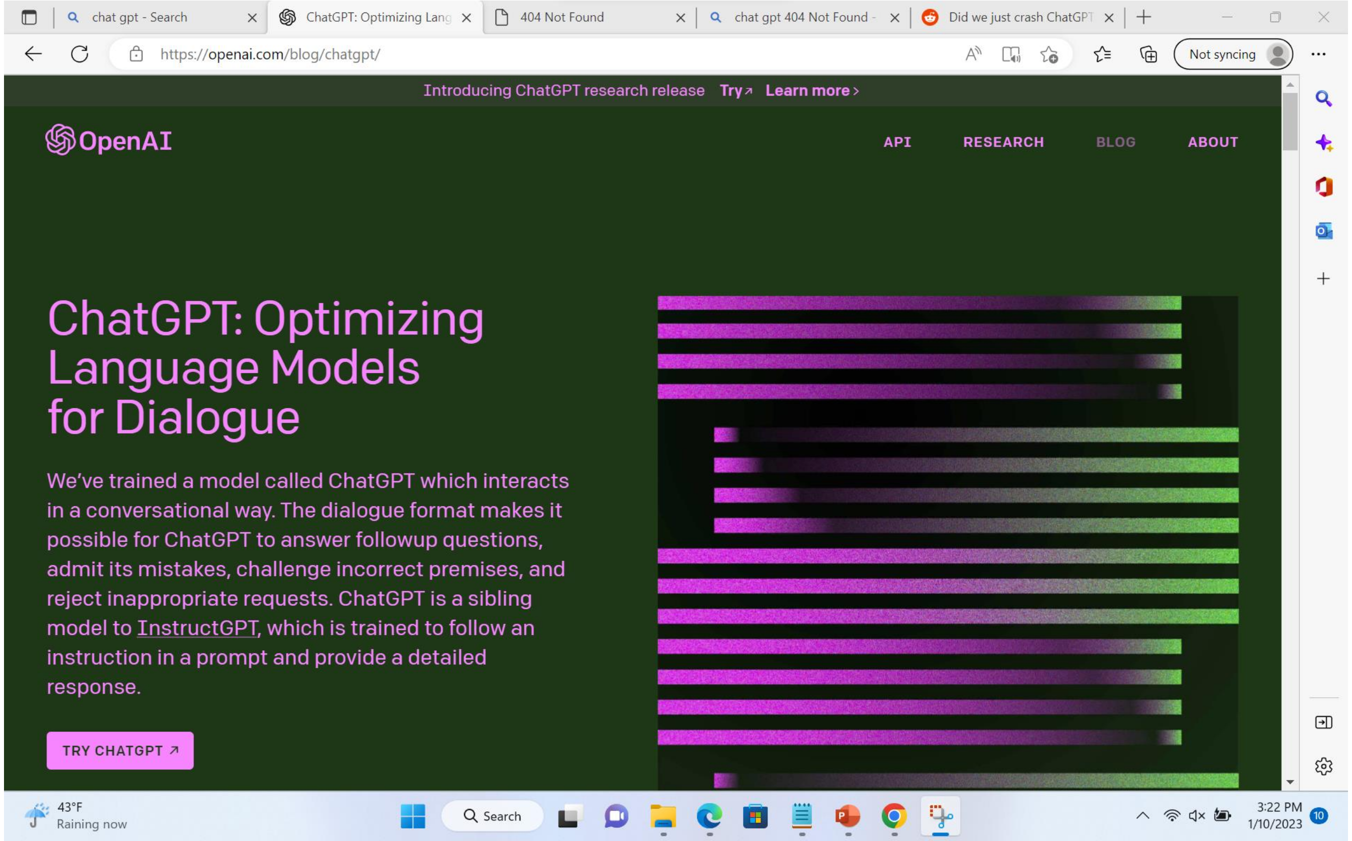


Big Data -- 2000s (SHOW)

Objectives -- 2020s (WANT/NEED)

Credit: Peter Norvig

Natural Language Processing

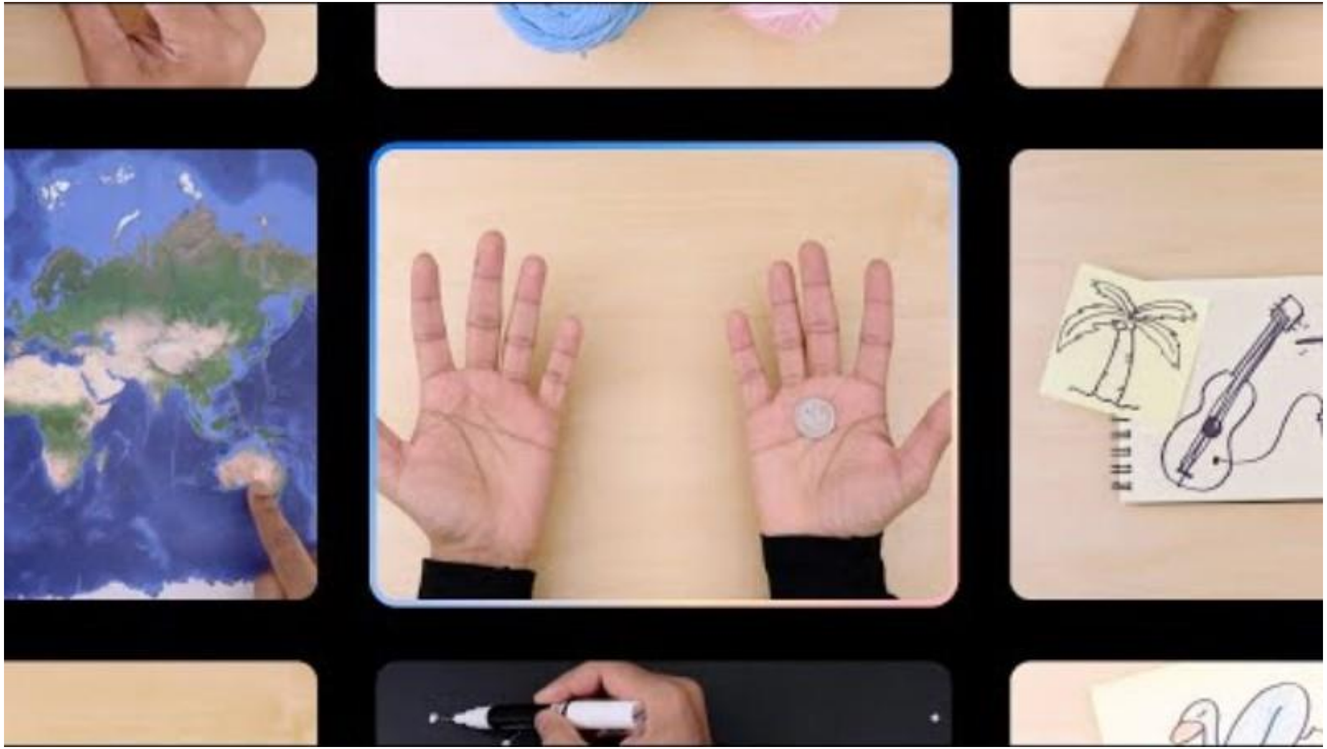


ChatGPT: Optimizing Language Models for Dialogue

We've trained a model called ChatGPT which interacts in a conversational way. The dialogue format makes it possible for ChatGPT to answer followup questions, admit its mistakes, challenge incorrect premises, and reject inappropriate requests. ChatGPT is a sibling model to InstructGPT, which is trained to follow an instruction in a prompt and provide a detailed response.

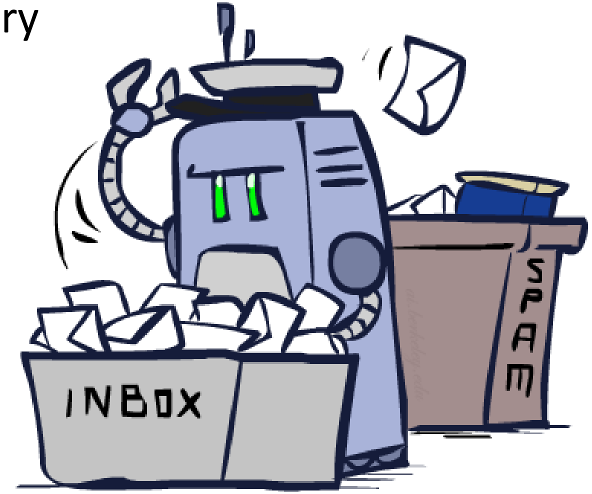
TRY CHATGPT ↗

Multi-Modal Models



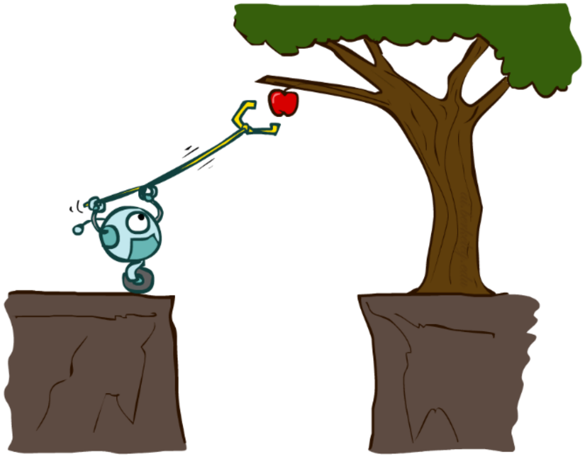
Decision Making

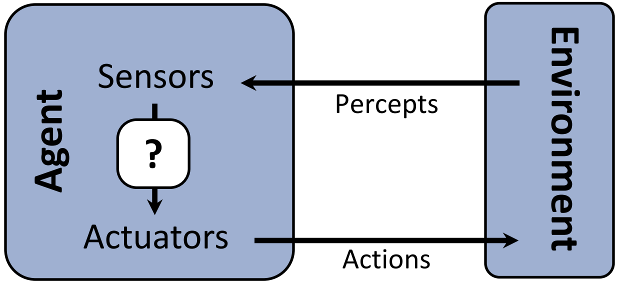
- Applied AI involves many kinds of automation
  - Scheduling, e.g. airline routing, military
  - Route planning, e.g. Google maps
  - Medical diagnosis
  - Web search engines
  - Spam classifiers
  - Automated help desks
  - Fraud detection
  - Product recommendations
  - Service robots
  - … Lots more!



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:
  - AI techniques for a variety of problem types
  - We will use machine learning to design agents/policies





Main Course Topics

- Learning to make decisions from examples via supervised learning (behavioral cloning)
- Learning to make one-step decisions from evaluative feedback (multi-armed bandits)
- Learning to make multi-step decisions from evaluative feedback (Reinforcement Learning)
  - Lots on this!
- Learning rewards from human feedback
- AI Safety and Alignment