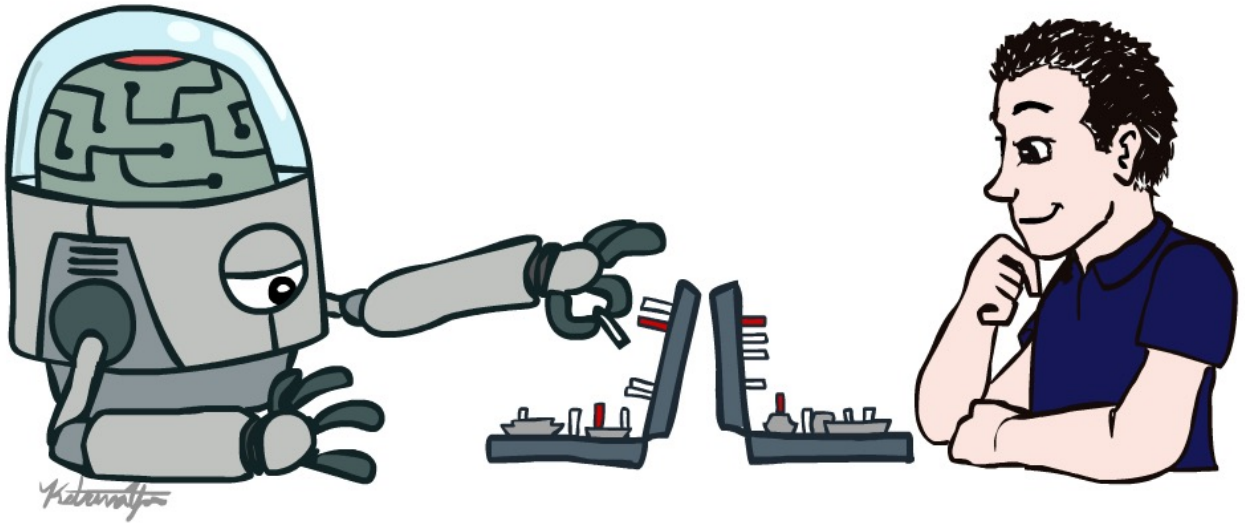
CSE 473: Artificial Intelligence

Introduction



slides adapted from
Stuart Russel, Dan Klein, Pieter Abbeel from ai.berkeley.edu
And Hanna Hajishirzi, Jared Moore, Dan Weld,

Course Information

- Course staff
- Communication:
  - Announcements, questions on Ed
  - Assignments on Gradescope
  - Office hours: TBA
- Work:
  - Projects (50%), homework (50%)
  - Class / Ed participation (up to 5%)

- Late Policy:
  - **Six** penalty-free late days for the whole quarter;
  - Maximum 4 days per assignment.
  - No late day for the final HW

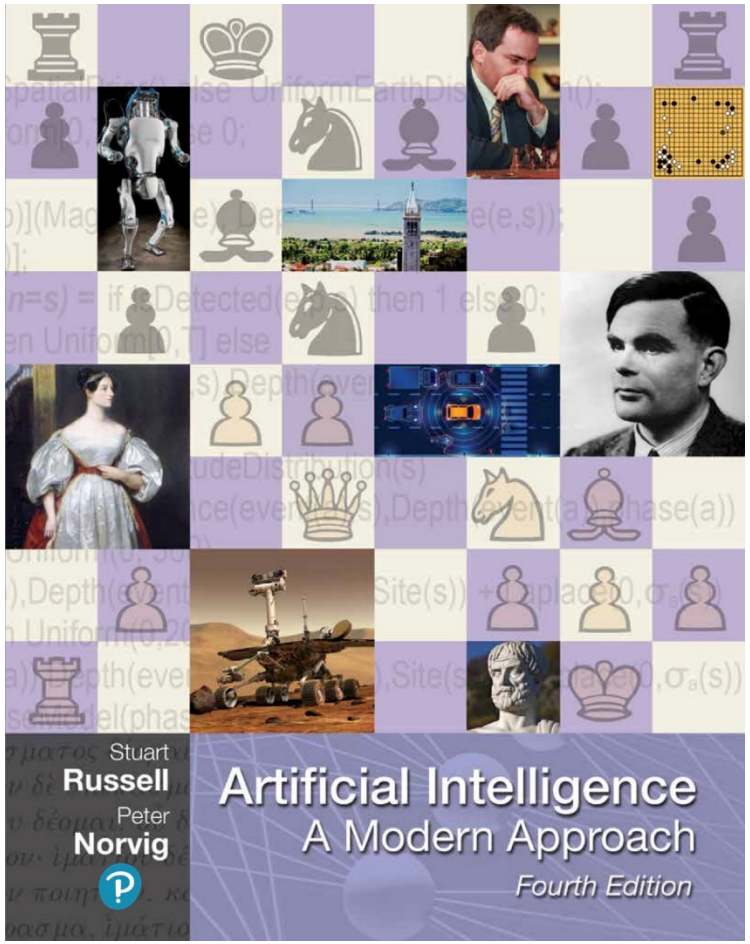
https://courses.cs.washington.edu/courses/cse473/22au/

Announcements

- Upcoming due dates
  - PR0 available online. Optional but very highly recommended unless you are already very good with Python.

Textbook Strongly Suggested

Russell & Norvig, AI: A Modern Approach, 4th Ed.



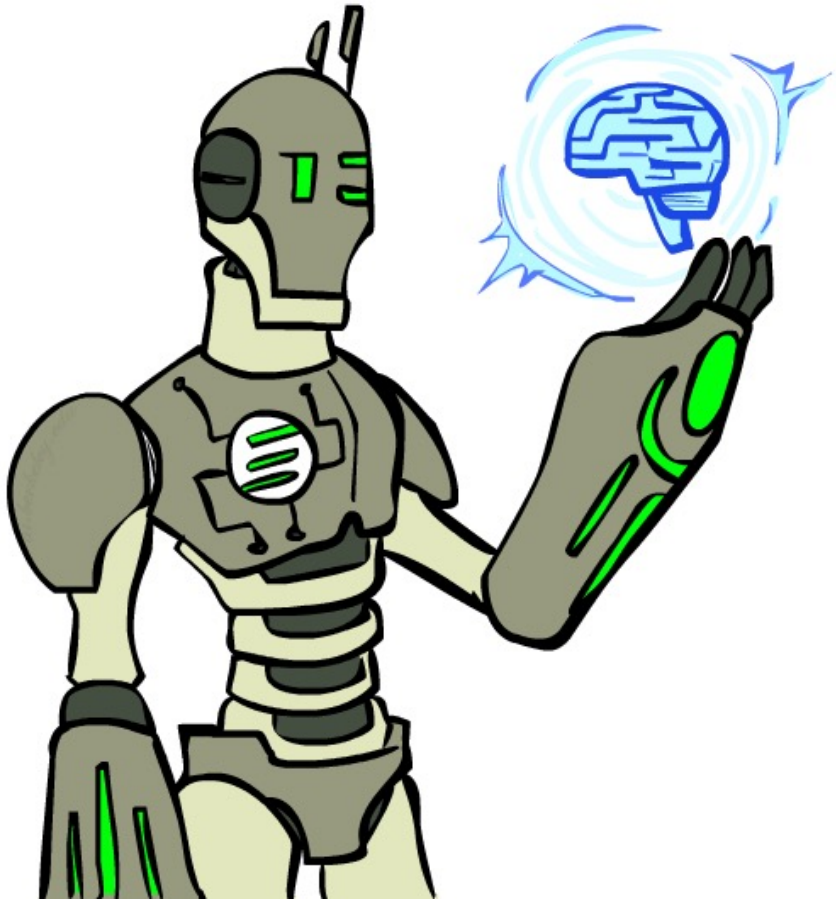
Policies (see website)

- Follow UW guidelines on Covid
- Class is primarily in person
  - I will record to Zoom, but we will have limited ability to interact there
- We're here help
  - Accommodations
  - Academic integrity policies
  - Mental health

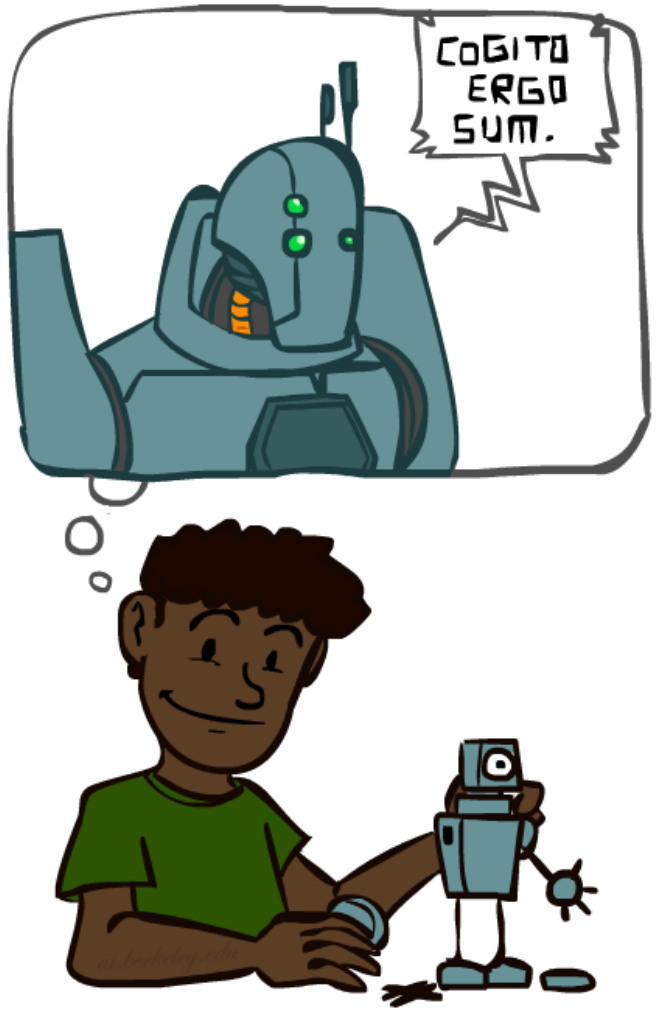
Today

- What is artificial intelligence?

- Past: how did the ideas in AI come about?
- Present: what is the state of the art?
- Future: will robots take over the world?



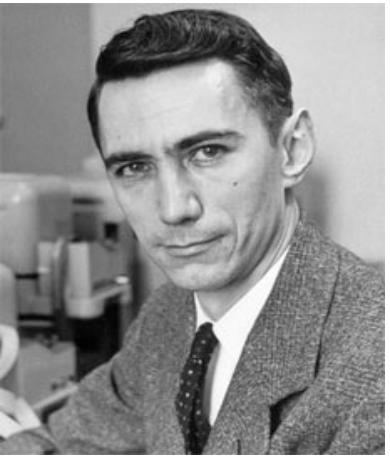
A (Short) History of AI



A short prehistory of AI

- Prehistory:
  - **Philosophy** (reasoning, planning, learning, science, automation)
  - **Mathematics** (logic, probability, optimization)
  - **Neuroscience** (neurons, adaptation)
  - **Economics** (rationality, game theory)
  - **Control theory** (feedback)
  - **Psychology** (learning, cognitive models)
  - **Linguistics** (grammars, language change / evolution)
- Near miss (1842):
  - Babbage design for universal machine
  - Lovelace: “a thinking machine” for “all subjects in the universe.”

AI's official birth: Dartmouth, 1956

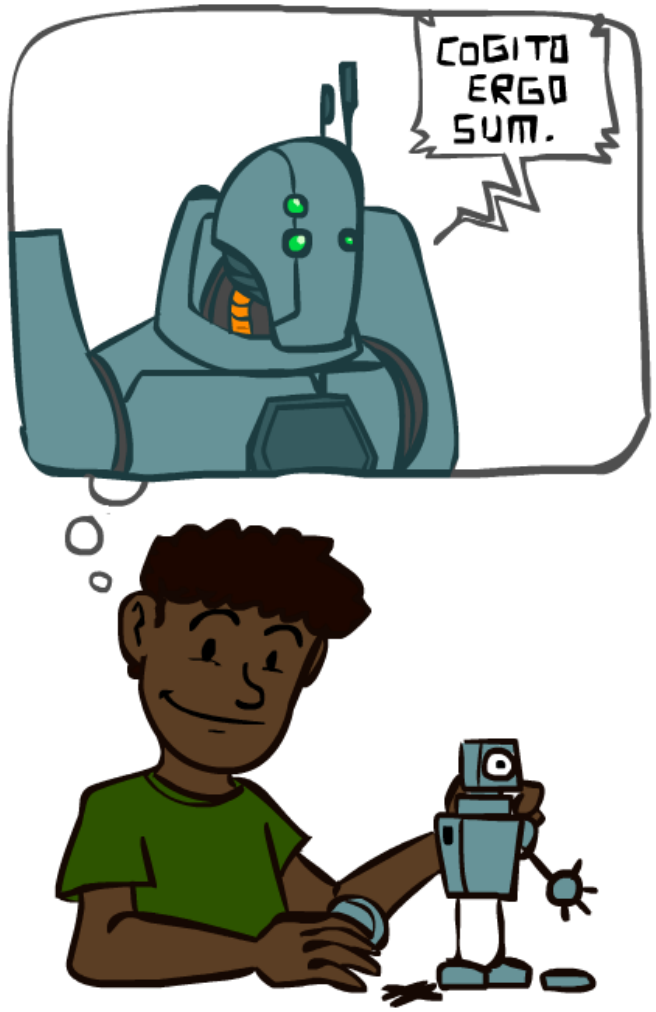


"An attempt will be made to find how to make machines use language, form abstractions and concepts, solve kinds of problems now reserved for humans, and improve themselves. ***We think that a significant advance can be made if we work on it together for a summer."***

John McCarthy and Claude Shannon
Dartmouth Workshop Proposal

A (Short) History of AI

- 1940-1950: Early days
  - 1943: McCulloch & Pitts: Boolean circuit model of brain
  - 1950: Turing's “Computing Machinery and Intelligence”
- 1950—70: Excitement!
  - 1950s: Early AI programs: chess, checkers (RL), theorem proving
  - 1956: Dartmouth meeting: “Artificial Intelligence” adopted
  - 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— 2012: Statistical approaches + subfield expertise
  - Resurgence of probability, focus on uncertainty
  - Agents and learning systems… “AI Spring”?
- 2012— ___: Excitement
  - Big data, big compute, deep learning
  - AI used in many industries

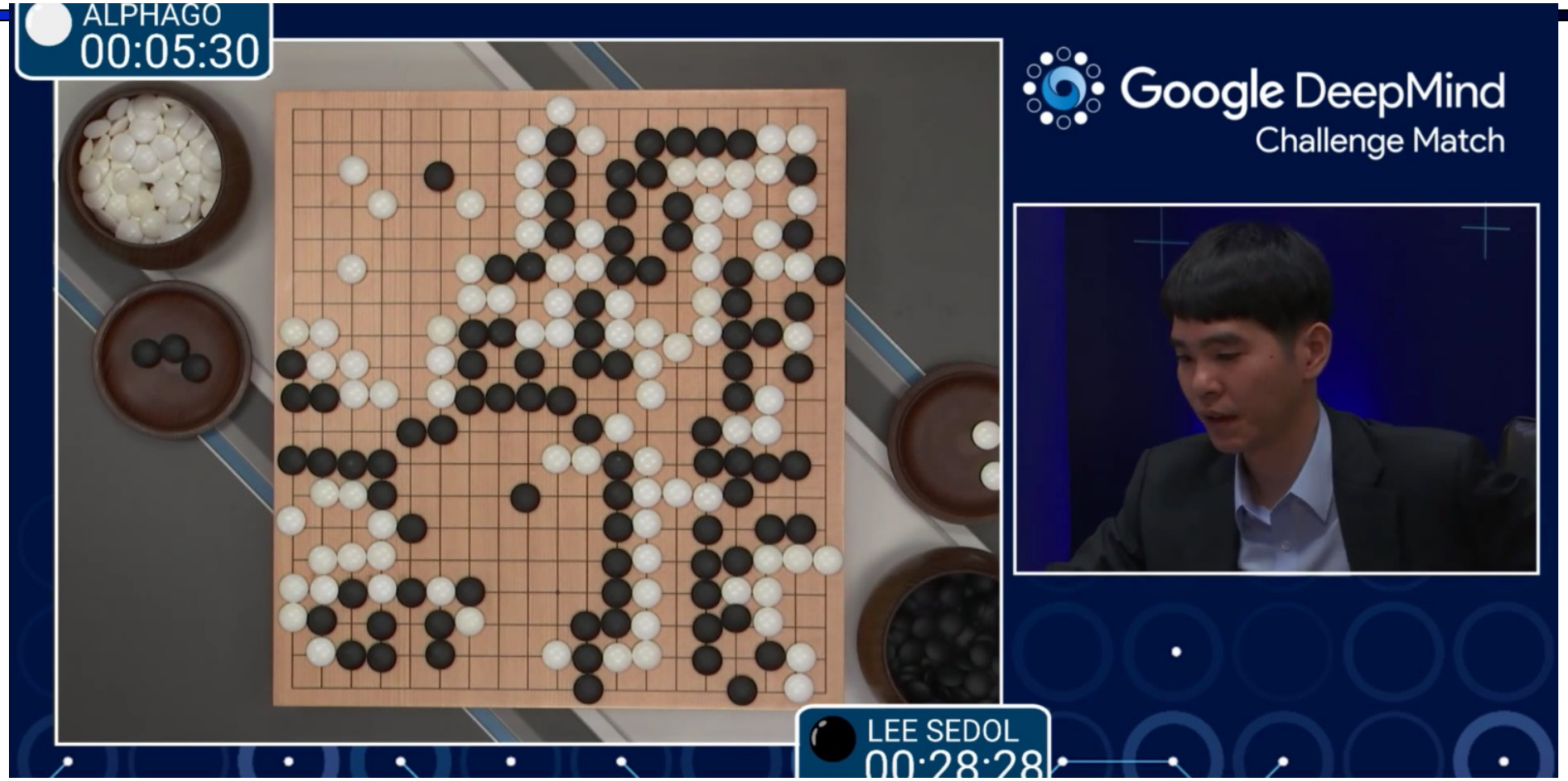


Jeopardy - 2011

http://www.youtube.com/watch?v=WFR3lOm_xhE

Start at 20 sec

Go - 2016



AlphaGo deep RL defeats Lee Sedol (4-1)

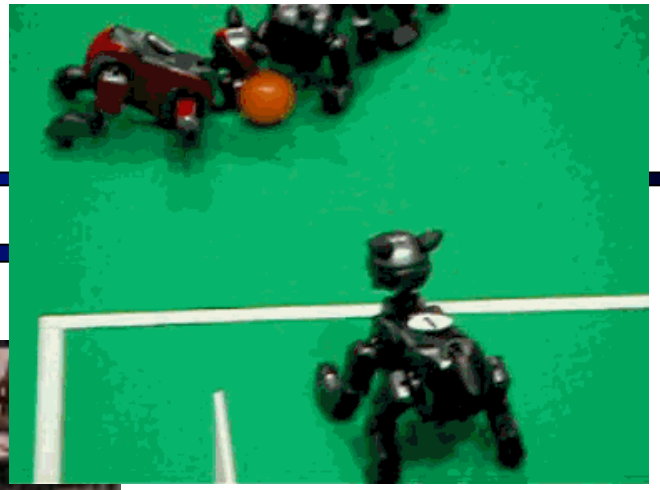
Dota2 - 2019

OpenAI beats OG world champions team of 5 pros

AI controlled 5 bots using different layers of same network

- Trained with RL & self-play
- Equivalent to 45000 years (over 10 months)

Robocup in 2018



Waymo Self-Driving Car 2019

https://www.youtube.com/watch?v=2hqTnmn51Fg

22 – 55 sec

GPT-3 Story Generation 2020

Title: United Methodists Agree to Historic Split
Subtitle: Those who oppose gay marriage will form their own denomination
Article: After two days of intense debate, the United Methodist Church has agreed to a historic split - one that is expected to end in the creation of a new denomination, one that will be "theologically and socially conservative," according to The Washington Post. The majority of delegates attending the church's annual General Conference in May voted to strengthen a ban on the ordination of LGBTQ clergy and to write new rules that will "discipline" clergy who officiate at same-sex weddings. But those who opposed these measures have a new plan: They say they will form a separate denomination by 2020, calling their church the Christian Methodist denomination.
The Post notes that the denomination, which claims 12.5 million members, was in the early 20th century the "largest Protestant denomination in the U.S.," but that it has been shrinking in recent decades. The new split will be the second in the church's history. The first occurred in 1968, when roughly 10 percent of the denomination left to form the Evangelical United Brethren Church. The Post notes that the proposed split "comes at a critical time for the church, which has been losing members for years," which has been "pushed toward the brink of a schism over the role of LGBTQ people in the church." Gay marriage is not the only issue that has divided the church. In 2016, the denomination was split over ordination of transgender clergy, with the North Pacific regional conference voting to ban them from serving as clergy, and the South Pacific regional conference voting to allow them.

GPT-3, OpenAI

Figure 3.14: The GPT-3 generated news article that humans had the greatest difficulty distinguishing from a human written article (accuracy: 12%).

Text -> Images 2022

Stable diffusion, KerasCV implementation

First, we construct a model:

```
model = keras_cv.models.StableDiffusion(img_width=512, img_height=512)
```

Next, we give it a prompt:

```
images = model.text_to_image("photograph of an astronaut riding a horse", batch_size=3)


def plot_images(images):
    plt.figure(figsize=(20, 20))
    for i in range(len(images)):
        ax = plt.subplot(1, len(images), i + 1)
        plt.imshow(images[i])
        plt.axis("off")


plot_images(images)
```

```
25/25 [==============================] - 19s 317ms/step
```

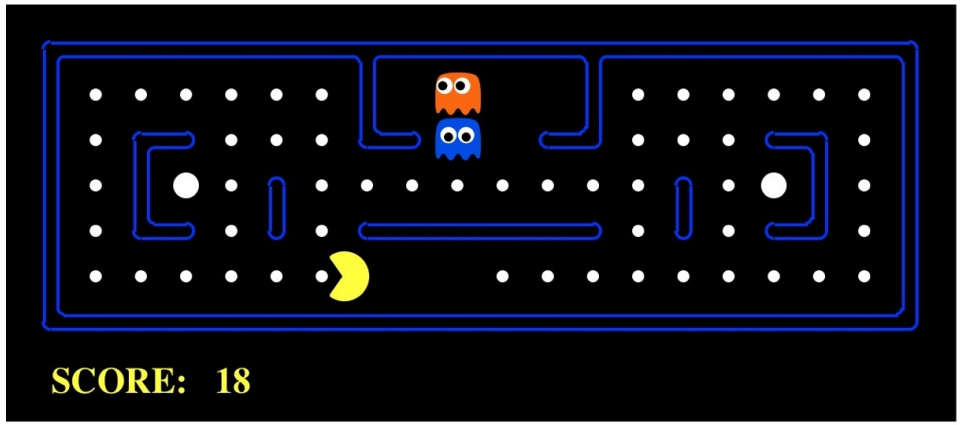
Text -> Images
2022

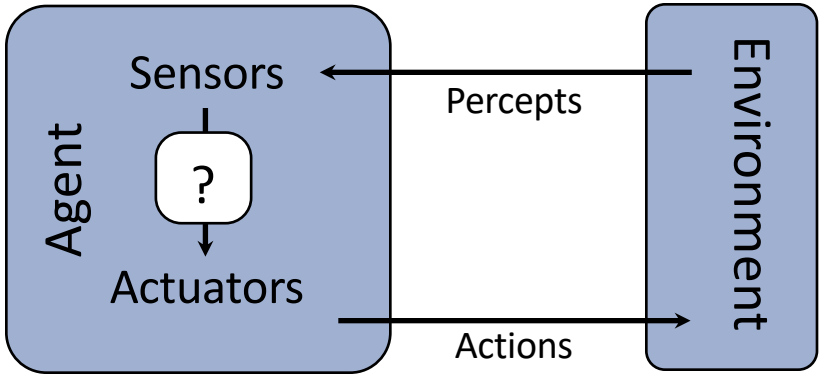
“Falcon knight”

https://twitter.com/DiffusionPics/status/1574546126954528770/

AI as 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 **sensors, actuators, and environment** dictate techniques for selecting rational actions
- This course is about:
  - General AI techniques for many problem types
  - Learning to choose and apply the technique appropriate for each problem

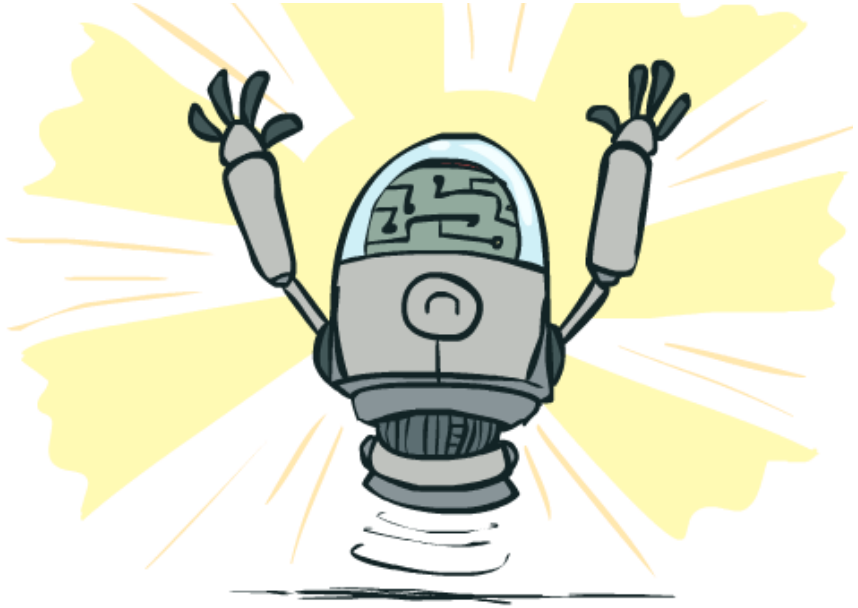




Pac-Man is a registered trademark of Namco-Bandai Games, used here for educational purposes

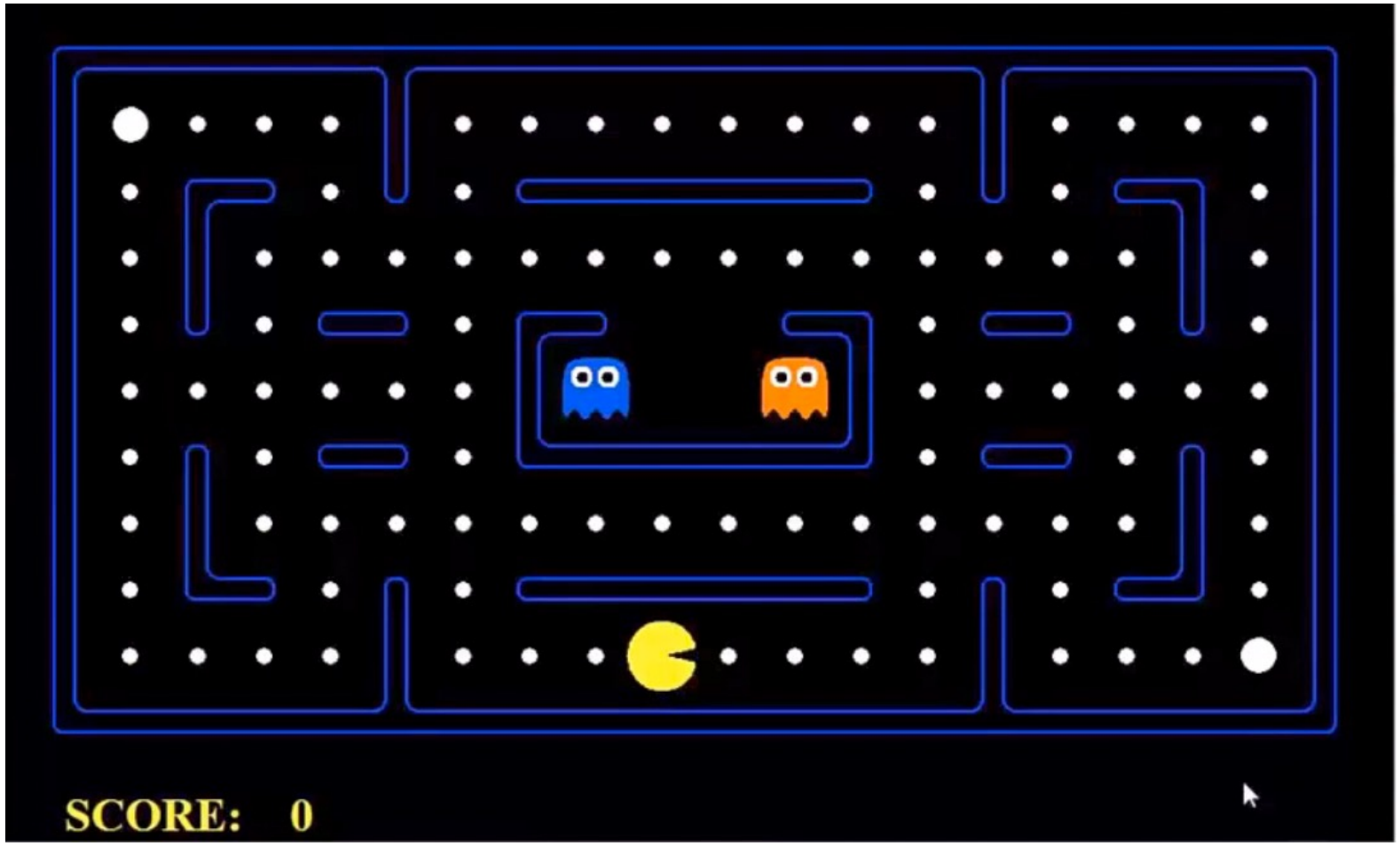
What Can AI Do?

Quiz: Which of the following can be done by AI methods now?



- ✓ Play a decent game of table tennis?
- ✓ Play a decent game of Jeopardy?
- ✓ Drive safely along a curving mountain road?
- ✗ Drive safely along The Ave?
- ✓ Buy a week's worth of groceries on the web?
- ✗ Buy a week's worth of groceries at Safeway?
- ? Discover and prove a new mathematical theorem?
- ✗ Converse successfully with another person for an hour?
- ? Perform a surgical operation?
- ✓ Translate spoken Chinese into spoken English in real time? (How well?)
- ? Fold the laundry and put away the dishes?
- ✗ Write an intentionally funny story?

Assignments: Pac-man



Originally developed at UC Berkeley:
http://www-inst.eecs.berkeley.edu/~cs188/pacman/pacman.html

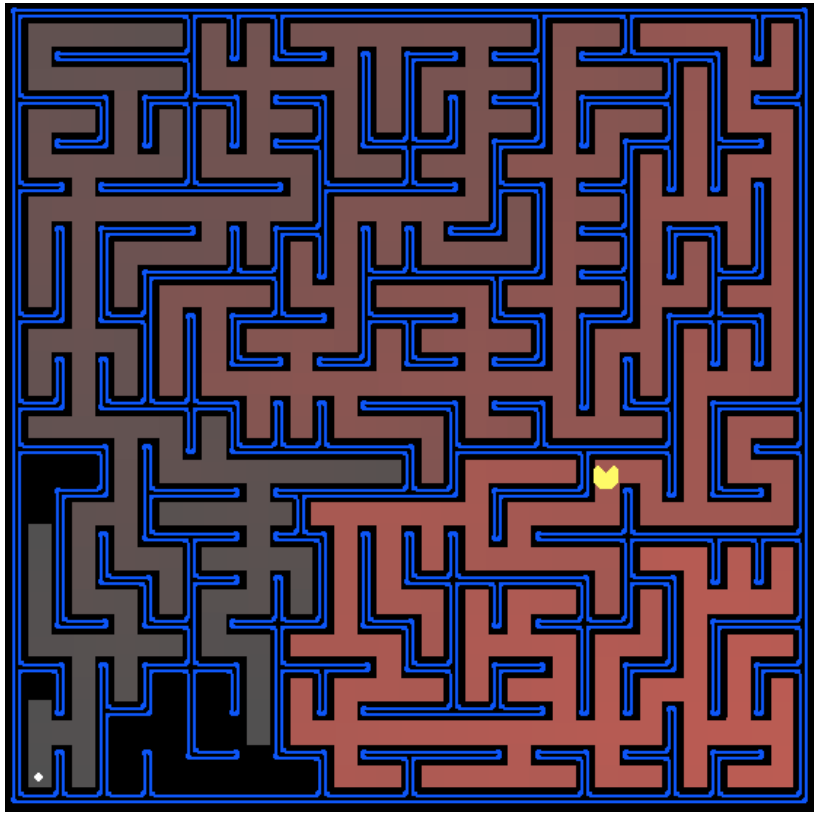
PS1: Search

Goal:

- Help Pac-man find his way through the maze

Techniques:

- Search: breadth-first, depth-first, etc.
- Heuristic Search: Best-first, A*, etc.



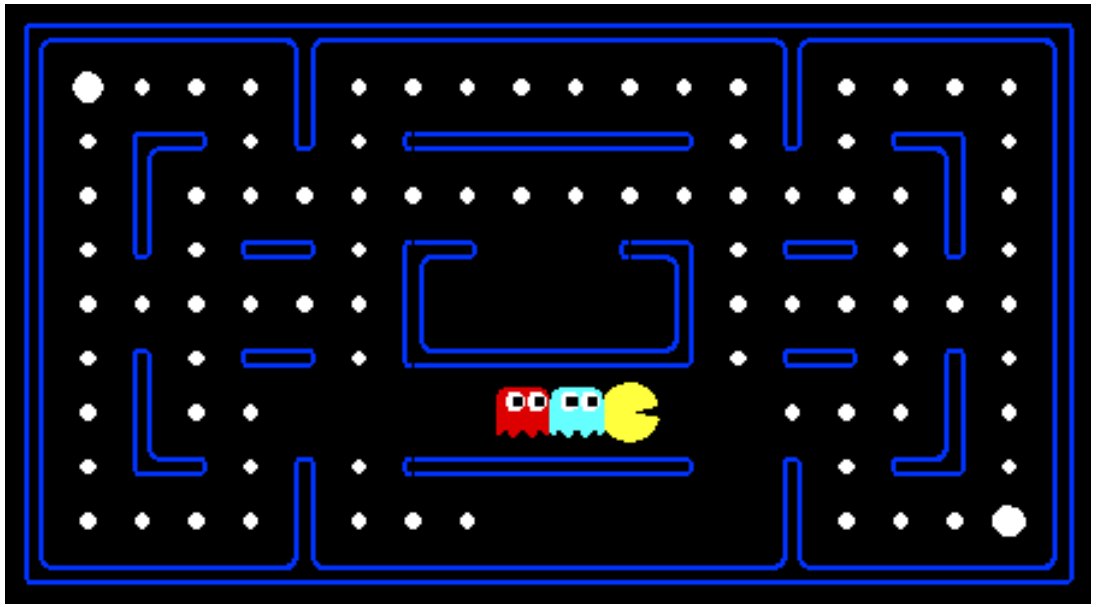
PS2: Game Playing

Goal:

- Play Pac-man!

Techniques:

- Adversarial Search: minimax, alpha-beta, expectimax, etc.



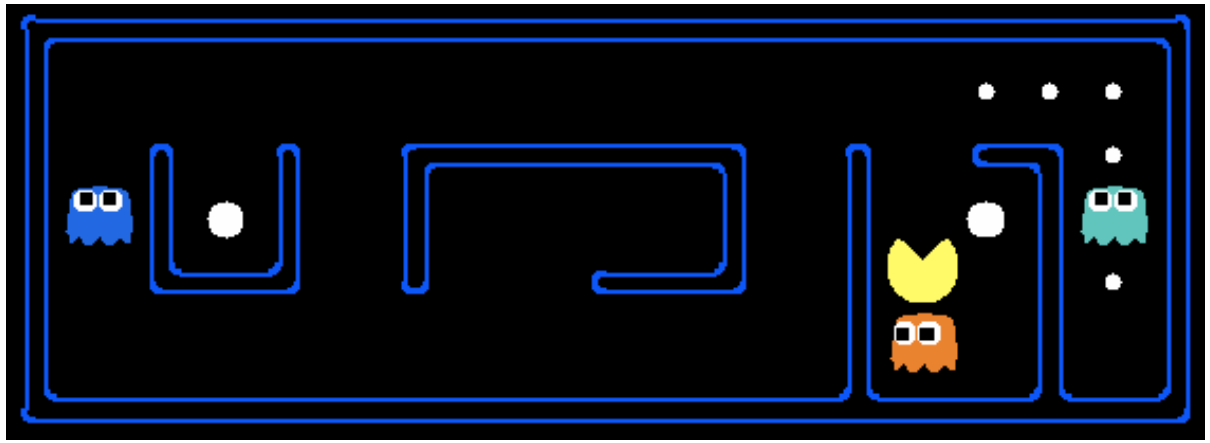
PS3: Reinforcement Learning

Goal:

- Help Pac-man learn about the world

Techniques:

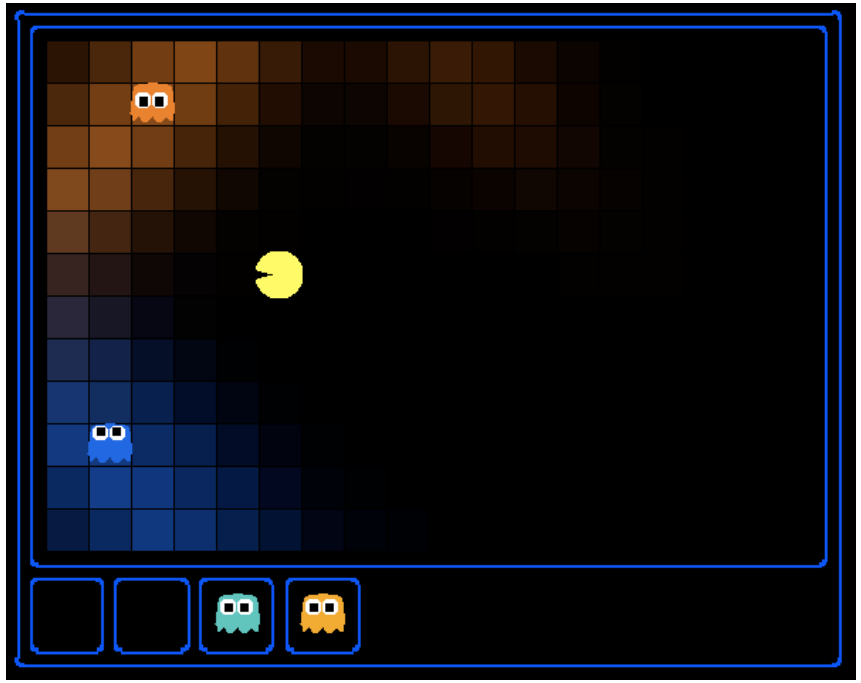
- Planning: MDPs, Value Iterations
- Learning: Reinforcement Learning



PS4: Ghostbusters

Goal:

- Help Pac-man hunt down the ghosts

Techniques:

- Probabilistic models: HMMS, Bayes Nets
- Inference: State estimation and particle filtering