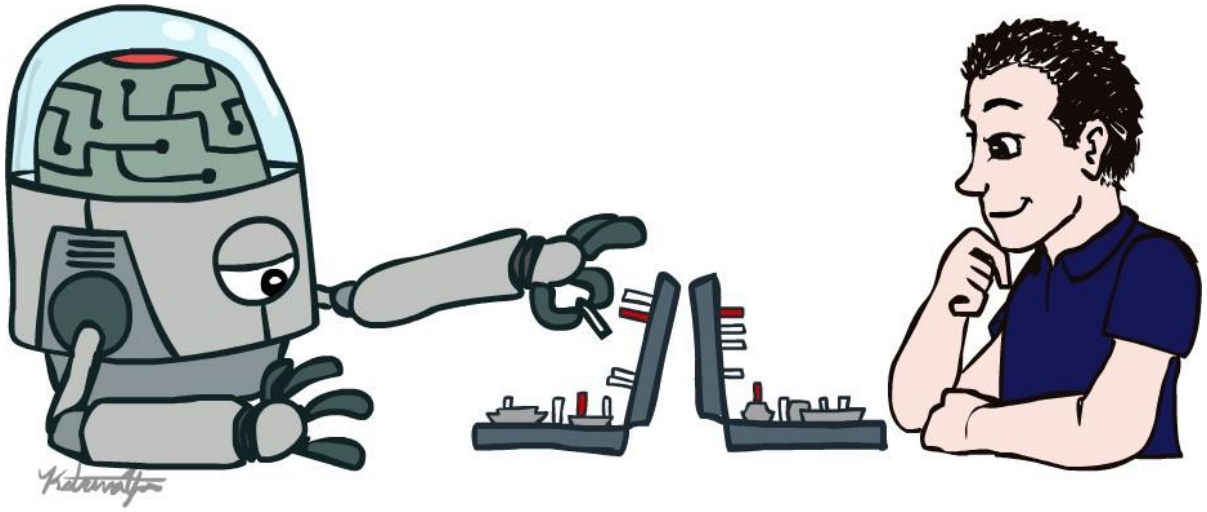
Artificial Intelligence

Introduction



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University of Baltistan, Skardu

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

Course Structure: Lectures

- You are here!
- Tuesday /Friday & Saturday
- Attendance will be taken

Course Structure: Discussions

- We offer three types of discussions
  - Regular discussions
  - Exam prep discussions
  - Extended-time discussions
  - We'll try to make recordings, but no promises

Course Structure: Exams

- Save the dates!
  - Midterm: Wednesday, October 1-10, 9:00–12:00 PM PT
  - Final exam: Thursday, December 5-10, 9:00 AM–12:00 PM PT

Resources

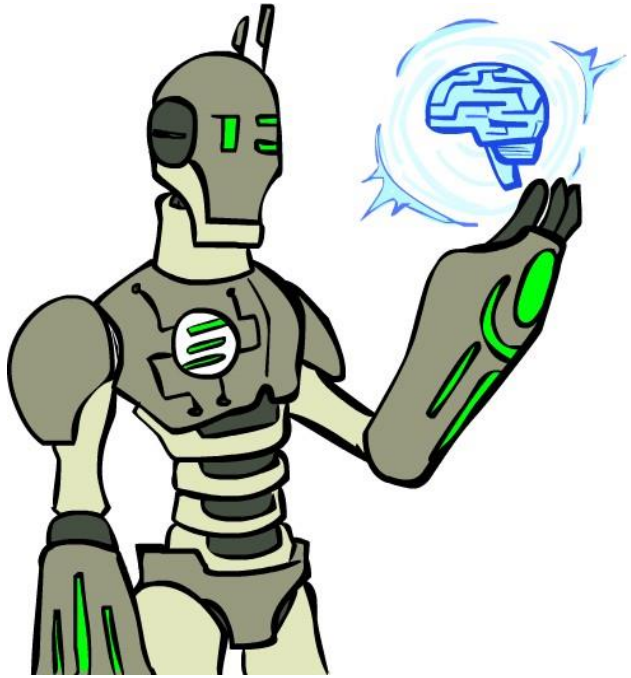
- Course website: https://github.com/ZeeshanAbbas/TR/tree/main/AI
  - All resources (slides, notes, etc.) posted here
- Staff email for private concerns: zeeshanabbas5 at Hotmail dot com

Grading Structure

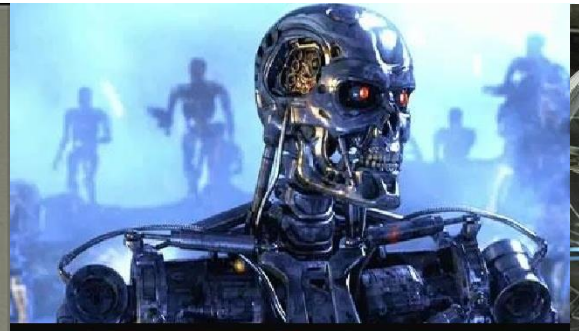
- Projects (20%)
  - Python programming assignments, autograded
  - You can optionally work with a partner
  - Reduced credit for submitting late, unless you have an extension
- Homework + Presentation (20%)
  - Electronic homework: Autograded on Gradescope
  - Written homework: One question per week, graded by TAs on correctness
  - Submit individually (but feel free to discuss with others)
  - No late submissions, unless you have an extension
- Midterm (15%), Final Exam (35%)

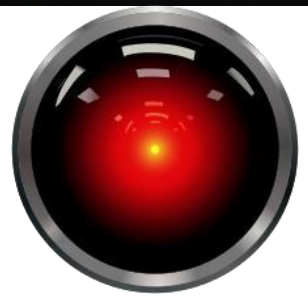
Second Half of Today: What is AI?

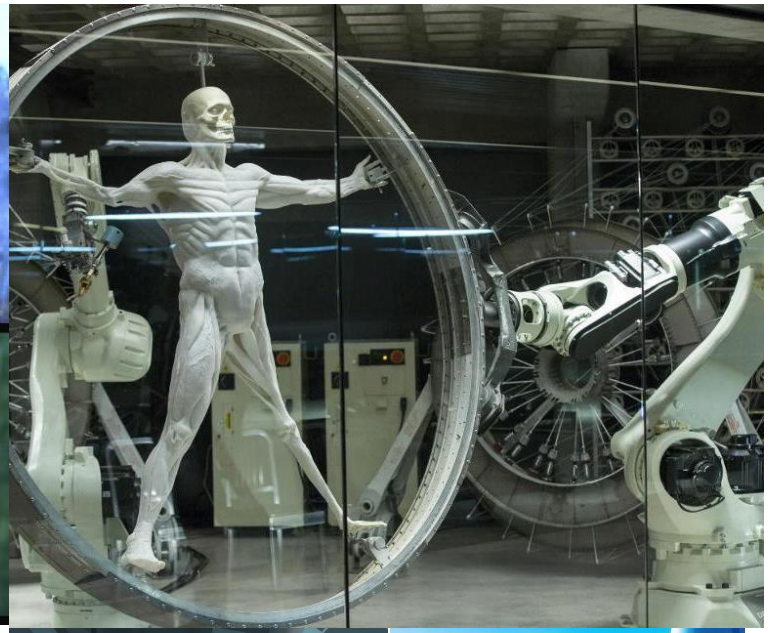
- What is artificial intelligence?
- What can AI do?
  - What should we worry about?
  - What can we do about those things?
  - What should we not worry about?
- What is this course?

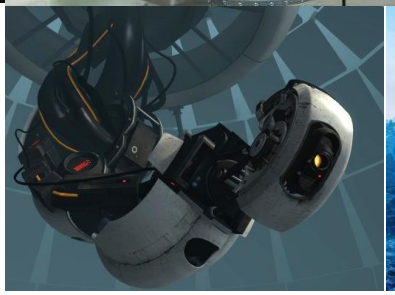


Sci-Fi AI?









Real-World AI?

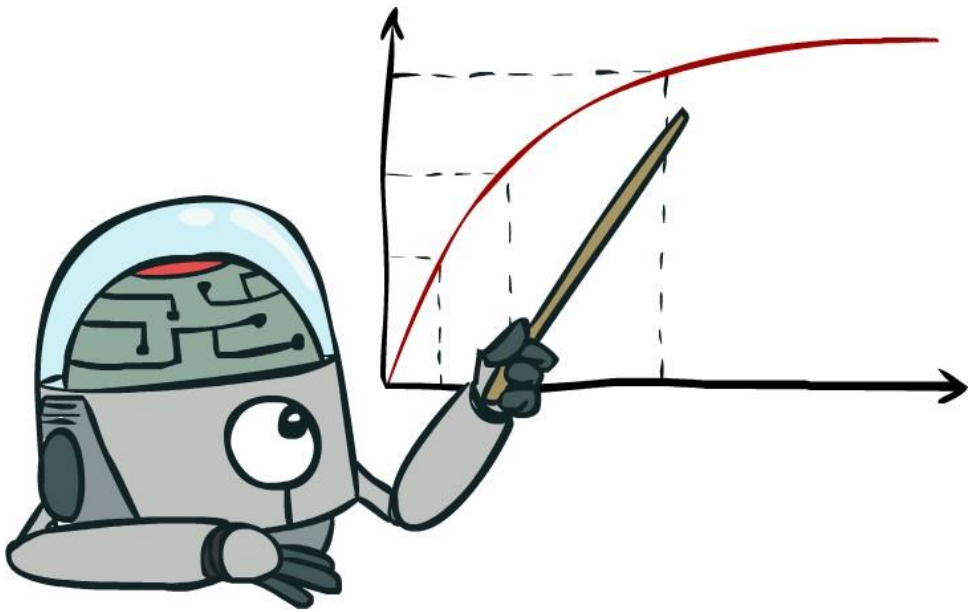
Rational Decisions

- 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**

A better title for this course would be:

Computational Rationality

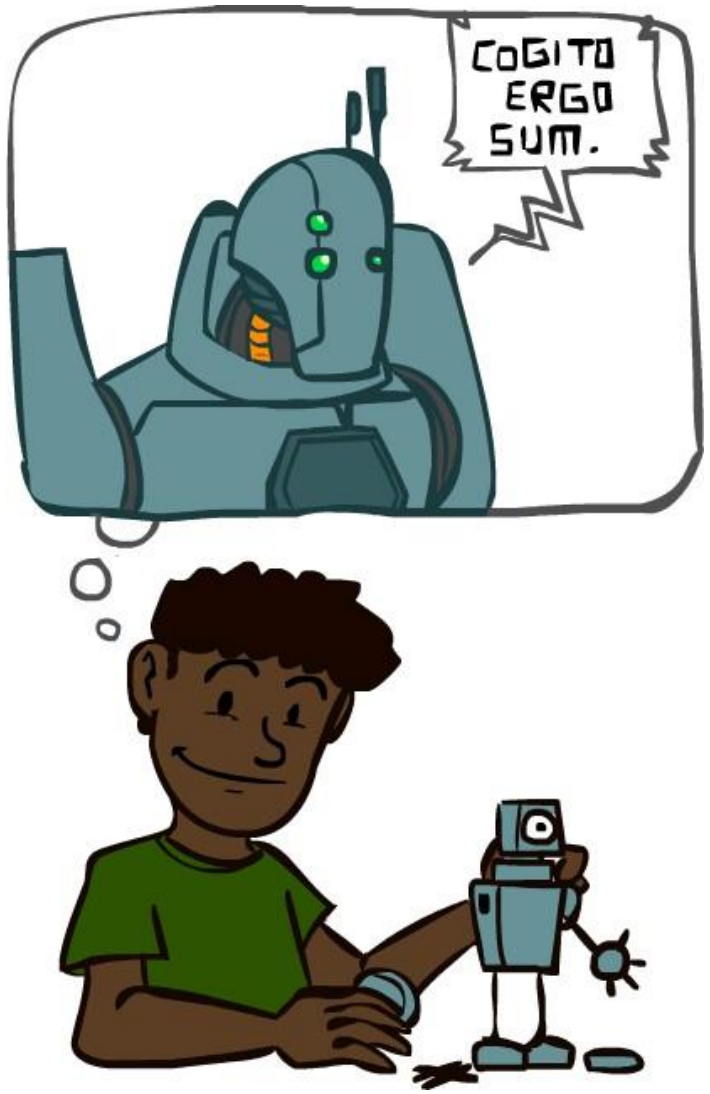
Maximize Your Expected Utility



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

A (Short) History of AI

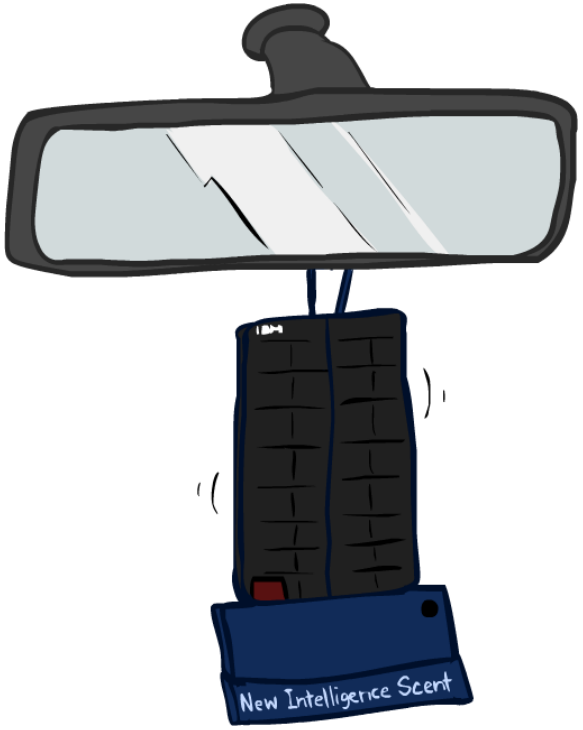


A (Short) History of AI

- 1940-1950: Early days
  - 1943: McCulloch & Pitts: Boolean circuit model of brain
  - 1950: Turing's “Computing Machinery and Intelligence”
- 1950—70: Excitement: 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
  - 1965: Robinson's complete algorithm for logical reasoning

A (Short) History of AI

- 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
  - A general increase in technical depth
  - Agents and learning systems… “AI Spring”?
  - 1996: Kasparov defeats Deep Blue at chess
  - 1997: Deep Blue defeats Kasparov at chess



“I could feel --- I could smell --- a new kind of intelligence across the table.” ~Kasparov

A (Short) History of AI

- 2000—: Where are we now?
  - Big data, big compute, neural networks
  - Some re-unification of sub-fields
  - AI is used in many industries
  - Chess engines running on ordinary laptops can defeat the world's best chess players
  - 2011: IBM's Watson defeats Ken Jennings and Brad Rutter at Jeopardy!
  - 2016: Google's AlphaGo beats Lee Sedol at Go

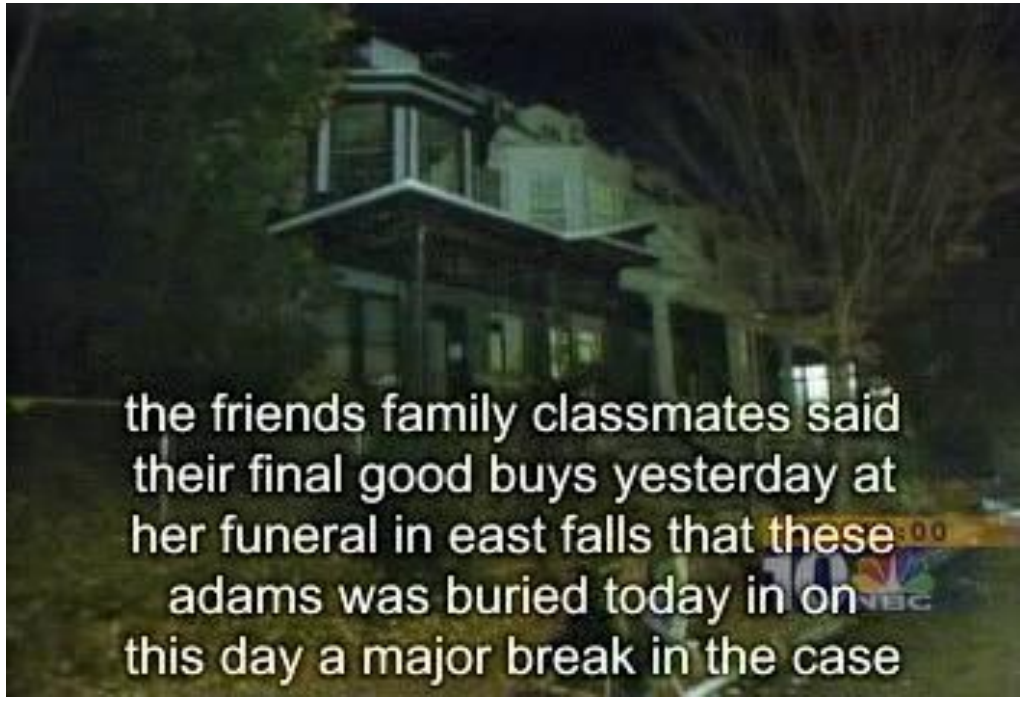
What Can AI Do?

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

- ✓ Play a decent game of Jeopardy?
- ✓ Win against any human at chess?
- ✓ Win against the best humans at Go?
- ✓ Play a decent game of tennis?
- ✓ Grab a particular cup and put it on a shelf?
- ✗ Unload any dishwasher in any home?
- ? Drive safely along the highway?
- ✗ Drive safely along Telegraph Avenue?
- ✓ 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?
- ✗ Unload a know dishwasher in collaboration with a person?
- ✓ Translate spoken Chinese into spoken English in real time?
- ✗ Write an intentionally funny story?

Natural Language

- Speech technologies
  - 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…



Computer Vision

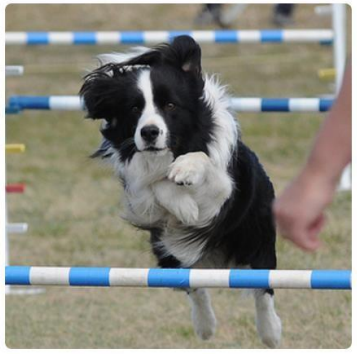
"man in black shirt is playing guitar."

"construction worker in orange safety vest is working on road."

"two young girls are playing with lego toy."

"boy is doing backflip on wakeboard."

"girl in pink dress is jumping in air."



"black and white dog jumps over bar."

"young girl in pink shirt is swinging on swing."

"man in blue wetsuit is surfing on wave."

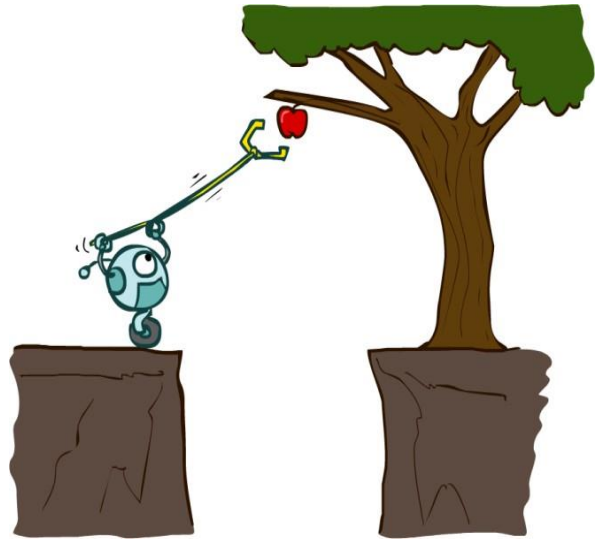
Karpathy & Fei-Fei, 2015; Donahue et al., 2015; Xu et al, 2015; many more

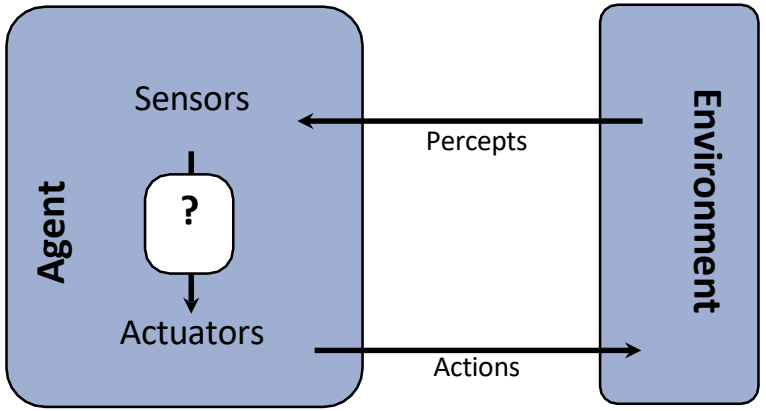
Course Topics

- Part 1: Intelligence from Computation
  - Fast search/planning
  - Constraint satisfaction (e.g. scheduling)
  - Adversarial and uncertain search (e.g. routing, navigation)
- Part 2: Intelligence from Data
  - Probabilistic inference with Bayes' nets (e.g. robot localization)
  - Decision theory
  - Supervised machine learning (e.g. spam detection)
- Applications
  - Natural language, vision, robotics, games, etc.

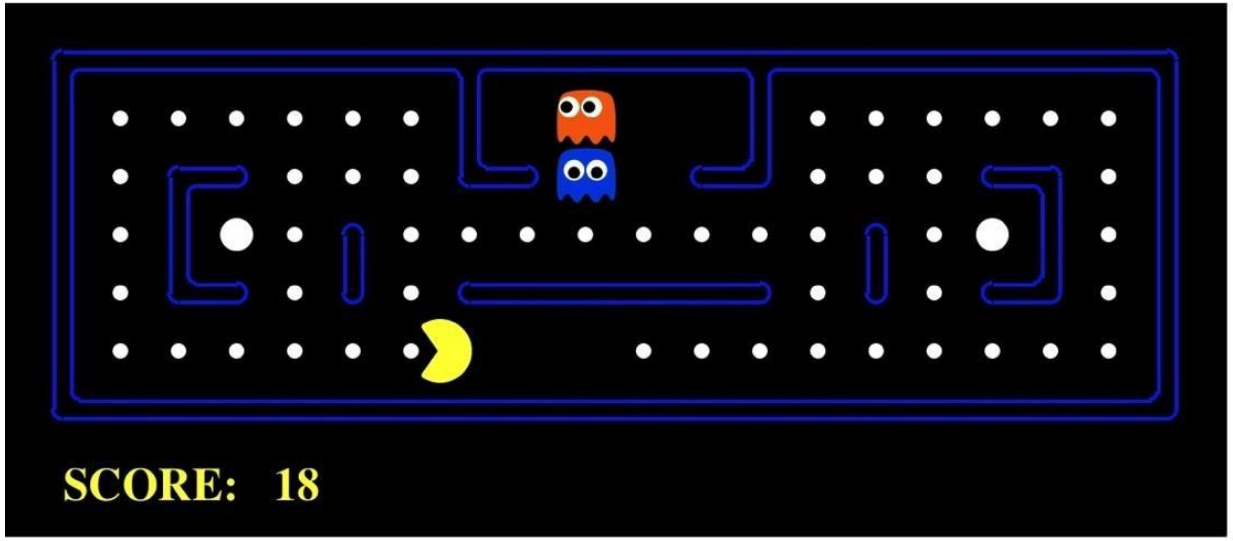
Designing Rational Agents

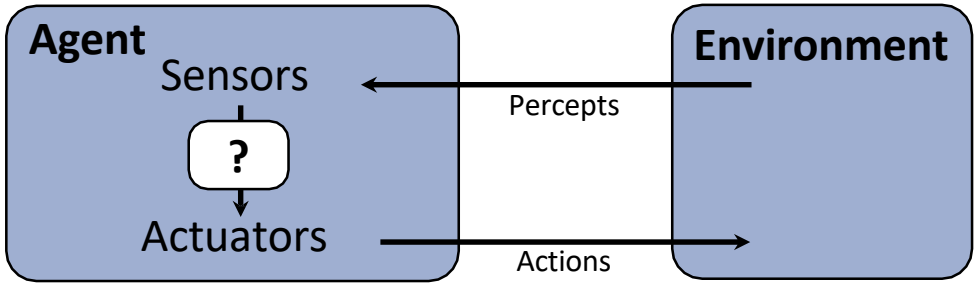
- An **agent** is an entity that perceives and acts.
- A **rational agent** selects actions that maximize its (expected) **utility**.
- Characteristics of the **percepts**, **environment**, and **action space** dictate techniques for selecting rational actions.
- This course is about:
  - General AI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





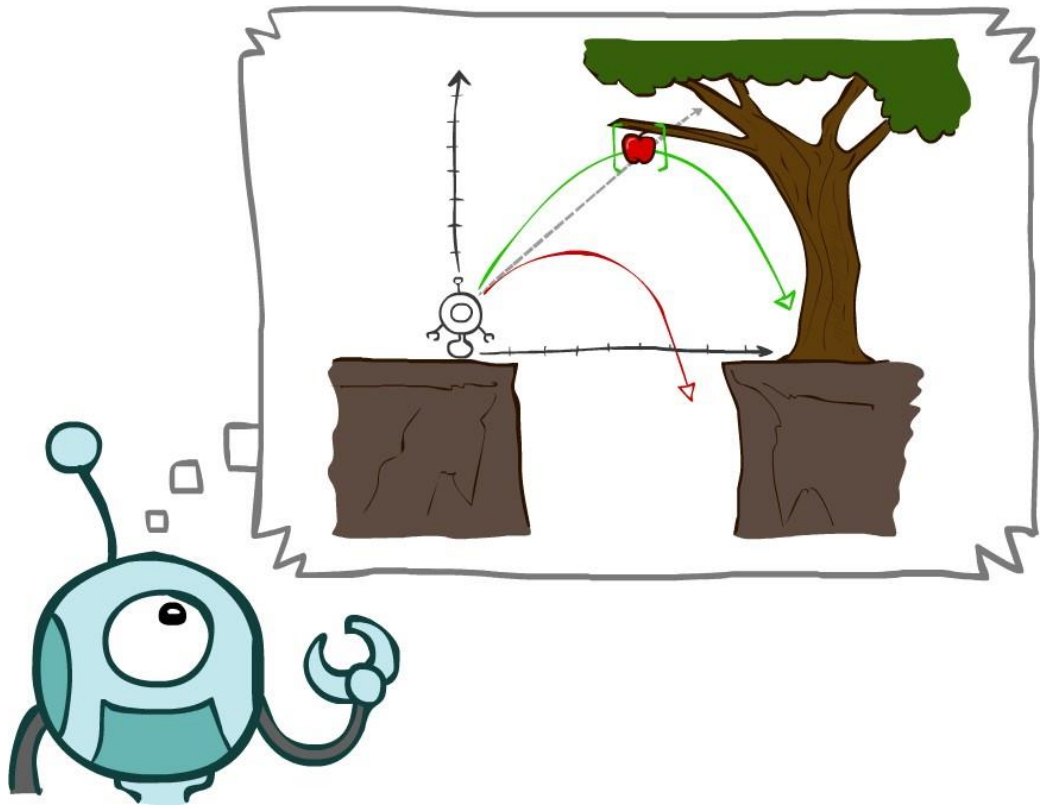
Pac-Man as an Agent



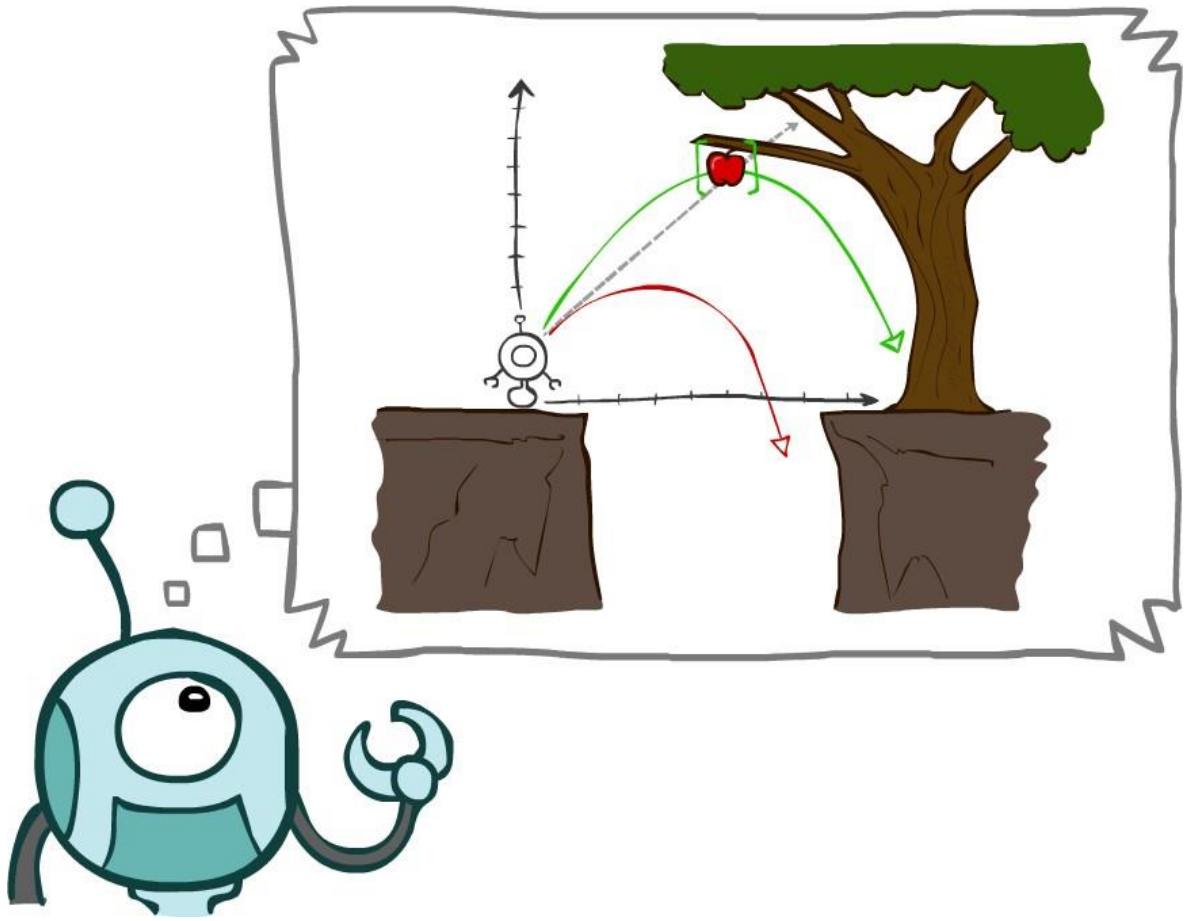


Today

- Agents that Plan Ahead
- Search Problems
- Uninformed Search Methods
  - Depth-First Search
  - Breadth-First Search
  - Uniform-Cost Search

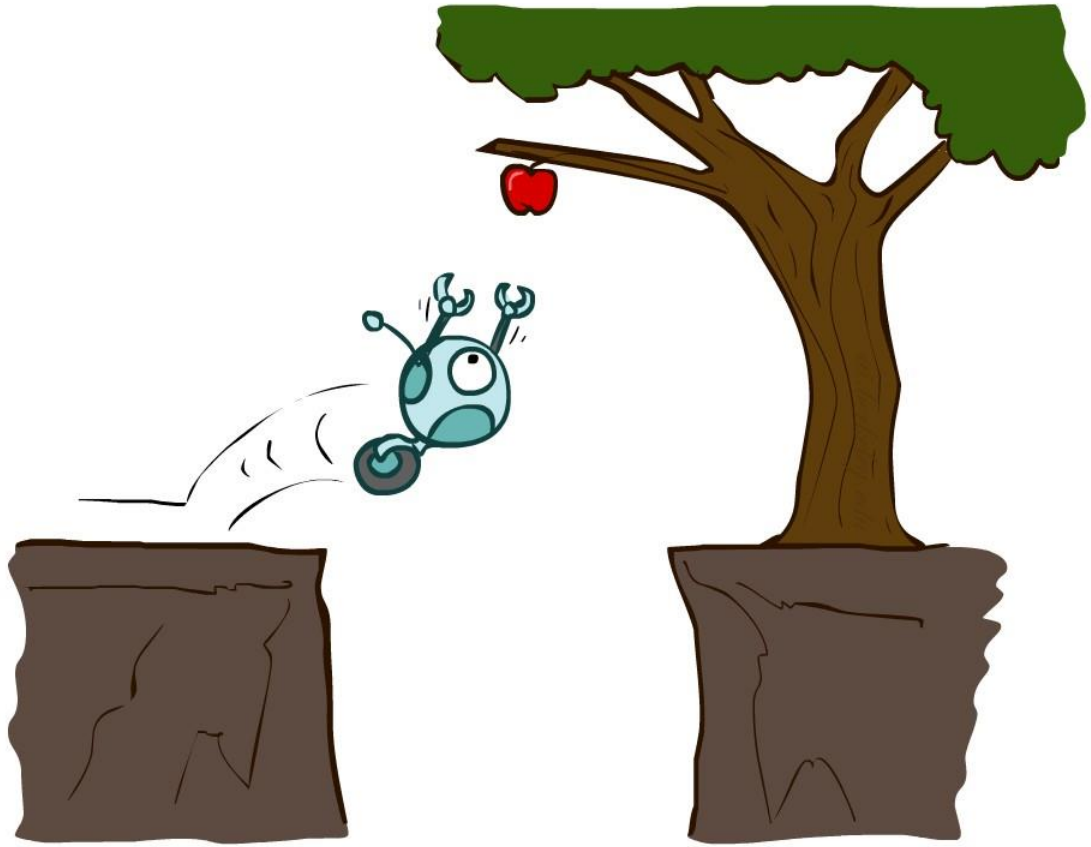


Agents that Plan



Reflex Agents

- Reflex agents:
  - Choose action based on current percept (and maybe memory)
  - May have memory or a model of the world's current state
  - Do not consider the future consequences of their actions
  - Consider how the world IS
- Can a reflex agent be rational?

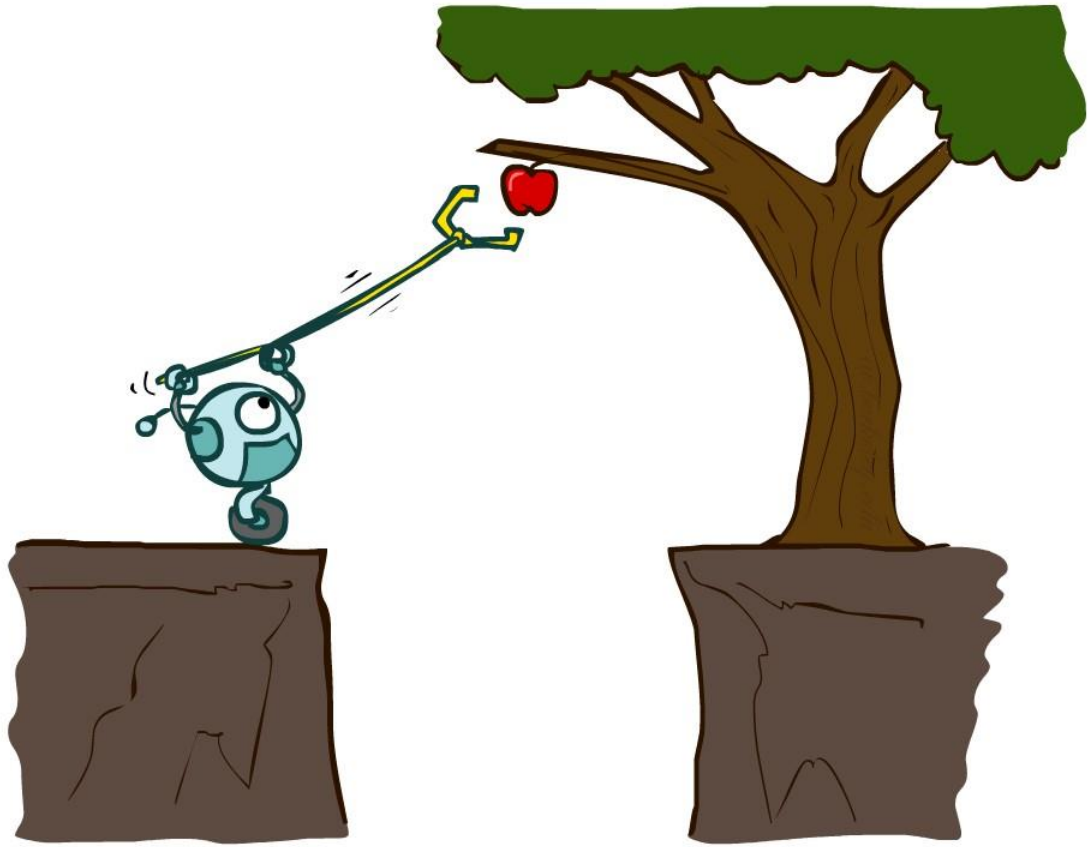


[Demo: reflex optimal (L2D1)]

[Demo: reflex optimal (L2D2)]

Planning Agents

- Planning agents:
  - Ask “what if”
  - Decisions based on (hypothesized) consequences of actions
  - Must have a model of how the world evolves in response to actions
  - Must formulate a goal (test)
  - Consider how the world WOULD BE
- Optimal vs. complete planning
- Planning vs. replanning

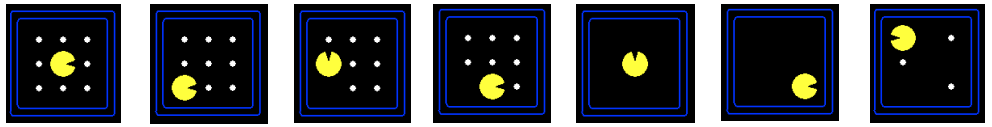


[Demo: re-planning (L2D3)]
[Demo: mastermind (L2D4)]

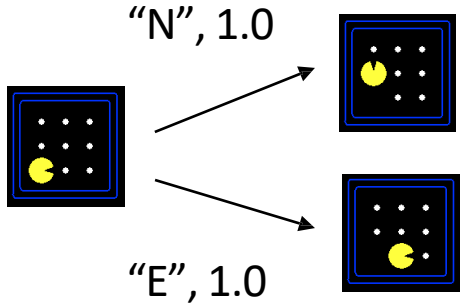
Search Problems

Search Problems

- A search problem consists of:
  - A state space



  - A successor function (with actions, costs)

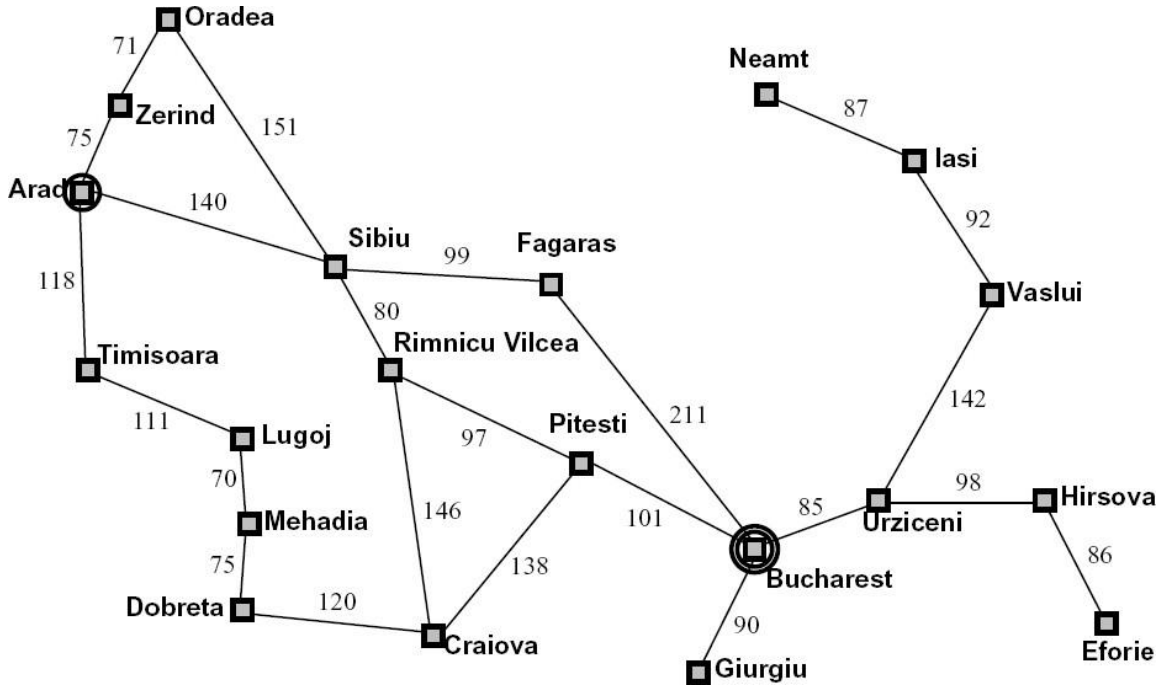


  - A start state and a goal test

- A solution is a sequence of actions (a plan) which transforms the start state to a goal state

Search Problems Are Models

Example: Traveling in Romania



- State space:
  - Cities
- Successor function:
  - Roads: Go to adjacent city with cost = distance
- Start state:
  - Arad
- Goal test:
  - Is state == Bucharest?
- Solution?