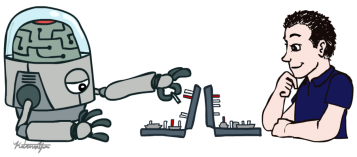
CS 188: Artificial Intelligence

Introduction



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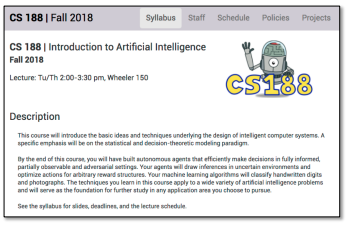
Course Information

http://inst.cs.berkeley.edu/~cs188



- Communication:
  - Announcements on Piazza
  - Questions? Discussion on Piazza
  - Staff email: cs188@berkeley.edu
- Course technology:
  - Website
  - Piazza
  - Gradescope
  - This course is webcast (= Fa18 videos) + edited videos from past semester

Course Information

- Prerequisites:
  - (CS 61A or CS 61B) and (CS 70 or Math 55)
    - Recommended: CS 61A and CS 61B and CS 70
  - There will be a lot of math (and programming)
- Work and Grading:
  - 5 programming projects: Python, groups of 1 or 2
    - 5 late days for semester, maximum 2 per project
  - 11 homework assignments:
    - Electronic component: Online, interactive, solve alone/together, submit alone
    - Written component: On paper, solve alone/together, submit alone, self-asses
  - Two midterms, One final
  - Fixed scale
  - Participation can help on margins
  - Academic integrity policy
- Contests!

Exam Dates

- Midterm 1: October 9th, 7:30-9:30pm
- Midterm 2: November 15th, 7:30-9:30pm
- Final Exam: December 11th, 8-11am

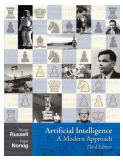
- There will be no alternate exams

Discussion Section (Optional Attendance)

- Topic: review / warm-up exercises
- Currently, none of you are assigned to sections
- You are welcome to attend any section of your preference
- Piazza survey later this week to help keep sections balanced
- From past semesters' experience we know sections will be (over)crowded the first two weeks of section, but then onwards section attendance will be lower and things will sort themselves out
- There will be a webcast of section
- There is no section in the current week (8/20-8/24).

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.*

Laptops in Lecture

- Laptops can easily distract students behind you

  Please consider sitting towards the back if using your laptop in lecture

Announcements This Week

- Important this week:
  - **Check out website:** https://inst.eecs.berkeley.edu/~cs188/fa18
  - **Register** on **Gradescope and Piazza** (check your email for links)
  - **HW0: Math self-diagnostic** is online now (due on Monday 8/27 at 11:59pm)
  - **P0: Python tutorial** is online now (due on Monday 8/27 at 11:59pm)
  - **One-time (optional) P0 lab hours** (Friday 3-6pm, 330 Soda Hall)
  - **Inst accounts:** not needed, but if you want one, check instructions on Piazza
- Also important:
  - **Sections** will be loosely assigned via Piazza poll (check the cs188 Piazza page)
  - **Sections** start next week. You may go to any section that has space.
  - The **waitlist** might take a while to sort out. We don't control enrollment. Please see https://eecs.berkeley.edu/resources/undergrads/cs/degree-reqs/enrollment-policy for information regarding enrollment into CS classes, including email contact for staff if you have additional enrollment-related questions.

Instruction vs. Assessment

Instruction

Grow knowledge, collaborate, work until success

Assessment

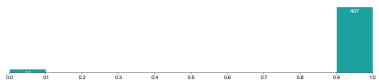
Measure knowledge, each student on their own, stopped before success

Our experience: these two goals don't mix

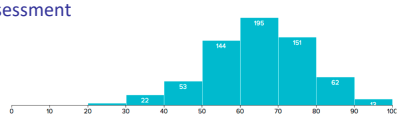
- Lecture / Section / OH / Piazza / Homework / Projects are instruction
  - collaborative, work until success (but please no spoilers)
- Exams are assessment
  - on your own

Some Historical Statistics

- Homework and projects: work alone/together, iterate/learn till you nailed it



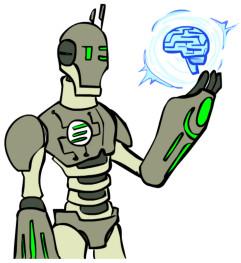
- Exams: assessment



- New this year: written component to homework (= old exam questions)
- Suggestion: assess yourself by first spending some time working alone

Today

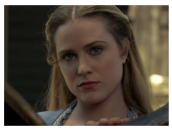
- What is artificial intelligence?
- What can AI do?
- What is this course?



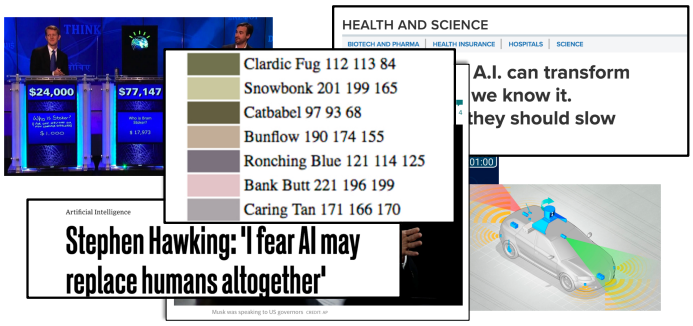
Sci-Fi AI?







News AI?



What is AI?

The science of making machines that:

Rational Decisions

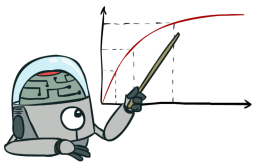
We'll use the term **rational** in a very specific, technical way:

- 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



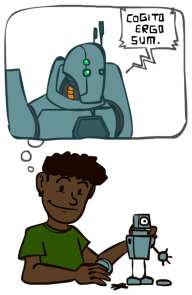
What About the Brain?

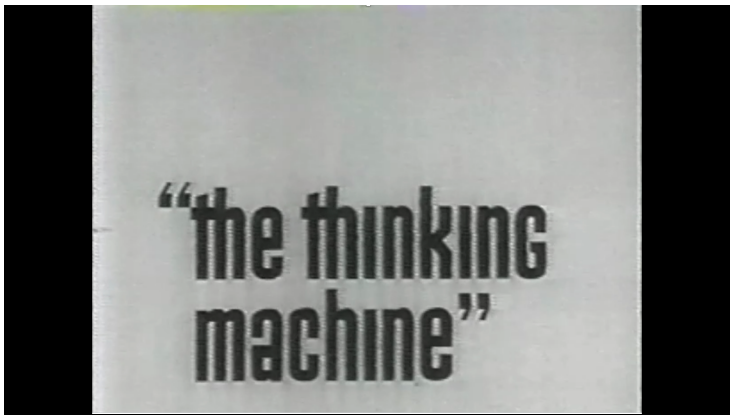
- Brains (human minds) are very good at making rational decisions, but not perfect
- Brains aren't as modular as software, so hard to reverse engineer!
- "Brains are to intelligence as wings are to flight"
- Lessons learned from the brain: memory (data) and simulation (computation) are key to decision making

Course Topics

- Part I: Intelligence from Computation
  - Fast search / planning
  - Constraint satisfaction
  - Adversarial and uncertain search
- Part II: Intelligence from Data
  - Bayes' nets
  - Decision theory
  - Machine learning
- Throughout: Applications
  - Natural language, vision, robotics, games, …

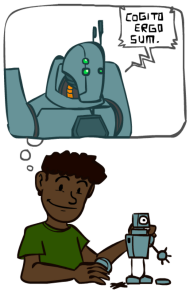
A (Short) History of AI





A (Short) History of AI

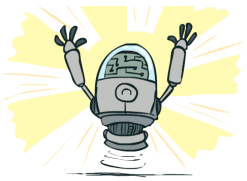
- 1940-1950: Early days
  - 1943: McCulloch & Pitts: Boolean circuit model of brain
  - 1950: Turing's "Computing Machinery and Intelligence"
- 1950—70: Excitement: Look, Ma, no hands!
  - 1950s: Early AI programs, including Samuel's checkers program, Newell & Simon's Logic Theorist, Gelernter's Geometry Engine
  - 1956: Dartmouth meeting: "Artificial Intelligence" adopted
  - 1965: Robinson's complete algorithm for logical reasoning
- 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
  - General increase in technical depth
  - Agents and learning systems… "AI Spring"?
- 2012— ___: Excitement: Look, Ma, no hands again?
  - Big data, big compute, neural networks
  - Some re-unification of sub-fields
  - AI used in many industries



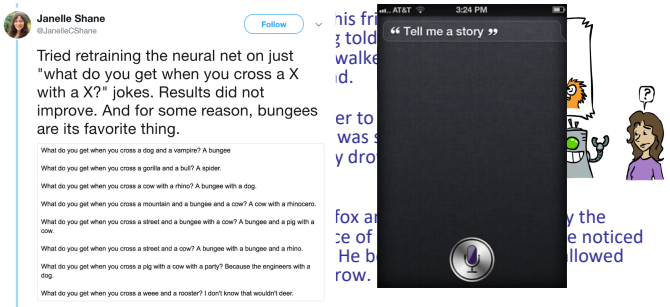
What Can AI Do?

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

- ✓ Play a decent game of table tennis?
- ✓ Play a decent game of Jeopardy?
- ✓ Drive safely along a curving mountain road?
- ? 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?
- ✗ Converse successfully with another person for an hour?
- ? Perform a surgical operation?
- ✓ Translate spoken Chinese into spoken English in real time?
- ? Fold the laundry and put away the dishes?
- ✗ Write an intentionally funny story?



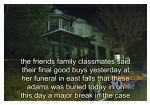
Unintentionally Funny Stories



[Shank, Tale-Spin System, 1984]

Natural Language

- Speech technologies (e.g. Siri)
  - Automatic speech recognition (ASR)
  - Text-to-speech synthesis (TTS)
  - Dialog systems



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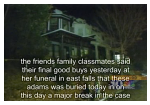


- Language processing technologies
  - Question answering
  - Machine translation

  - Web search
  - Text classification, spam filtering, etc…

Vision (Perception)

PIXELS -> INFO/DECISION

E.g.:

Face detection and recognition

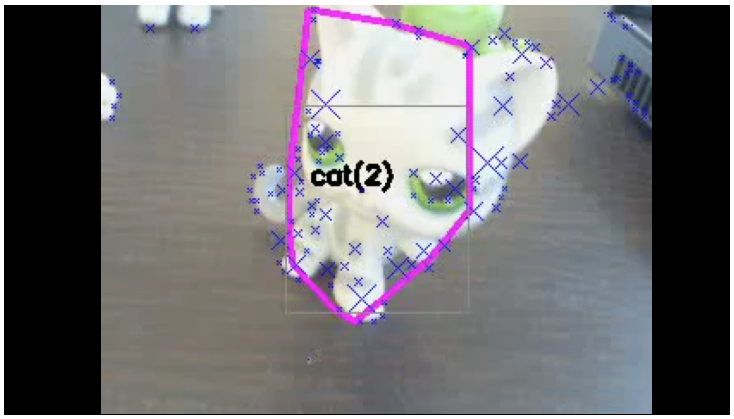
Source: TechCrunch

Semantic Scene Segmentation

[Caesar et al, ECCV 2017]

3-D Understanding

[DensePose]

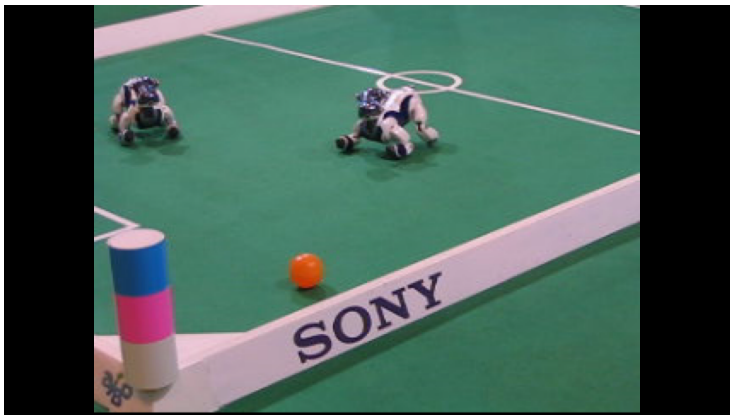


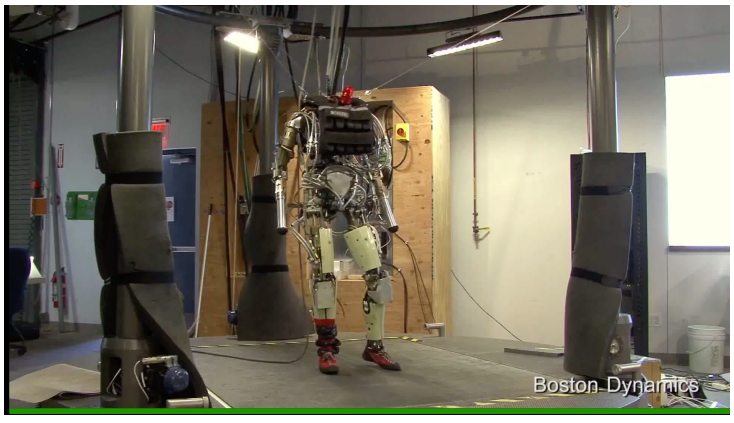
Robotics

- Robotics
  - Part mech. eng.
  - Part AI
  - Reality much harder than simulations!
- Technologies
  - Vehicles
  - Rescue
  - Soccer!
  - Lots of automation…
- In this class:
  - We ignore mechanical aspects
  - Methods for planning
  - Methods for control



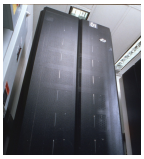
Images from UC Berkeley, RoboCup, Google/Waymo, Boston Dynamics





Game Playing

- Classic Moment: May, '97: Deep Blue vs. Kasparov
  - First match won against world champion
  - "Intelligent creative" play
  - 200 million board positions per second
  - Humans understood 99.9 of Deep Blue's moves
  - Can do about the same now with commodity parts
  - 1996: Kasparov beats Deep Blue: "I could feel --- I could smell --- a new kind of intelligence across the table."
  - 1997: Deep Blue beats Kasparaov: "Deep Blue hasn't proven anything."
- Open question:
  - How does human cognition deal with the search space explosion of chess?
  - Or: how can humans compete with computers at all??
- 2016: AlphaGo beats Lee Sedol – huge advance: sparse rollouts and self-play
- Right now: OpenAI Five vs Team paiN (human pros) -- some caveats!
  - "[The AI play] was just something like completely different." Austin Walsh



Text from Bart Selman, image from IBM's Deep Blue pages

Logic

- Logical systems
  - Theorem provers
  - NASA fault diagnosis
  - Question answering
- Methods:
  - Deduction systems
  - Constraint satisfaction
  - Satisfiability solvers (huge advances!)

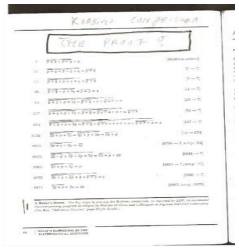
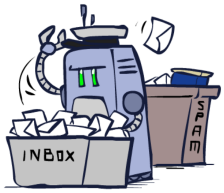


Image from Bart Selman

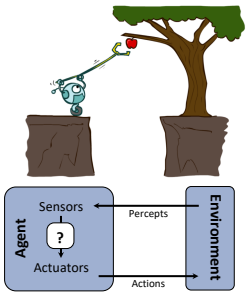
AI is starting to be everywhere…

- Applied AI automates all kinds of things
  - Search engines
  - Route planning, e.g. maps, traffic
  - Logistics, e.g. packages, inventory
  - Medical diagnosis
  - Automated help desks
  - Spam / fraud detection
  - Smarter devices, e.g. cameras
  - Product recommendations
  - … 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:
  - 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