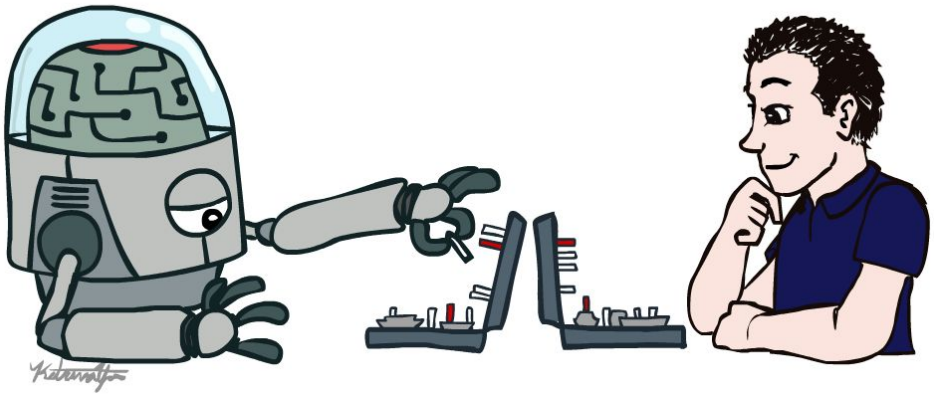
CS 188: Artificial Intelligence

Introduction



Instructors: Dan Klein and Pieter Abbeel

University of California, Berkeley

[These slides were created by Dan Klein and Pieter Abbeel for CS188 Intro to AI at UC Berkeley. All materials available at http://ai.berkeley.edu.]

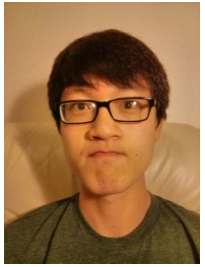
Course Staff

Professors

Dan Klein

Pieter Abbeel

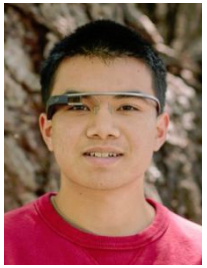
GSIs



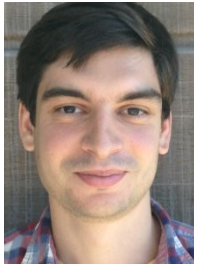
John Du

James Ferguson

Sergey Karayev

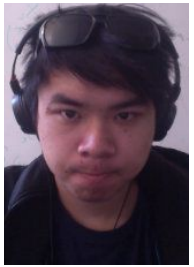


Michael Liang



Teodor Moldovan

Evan Shelhamer



Alvin Wong

Ning Zhang

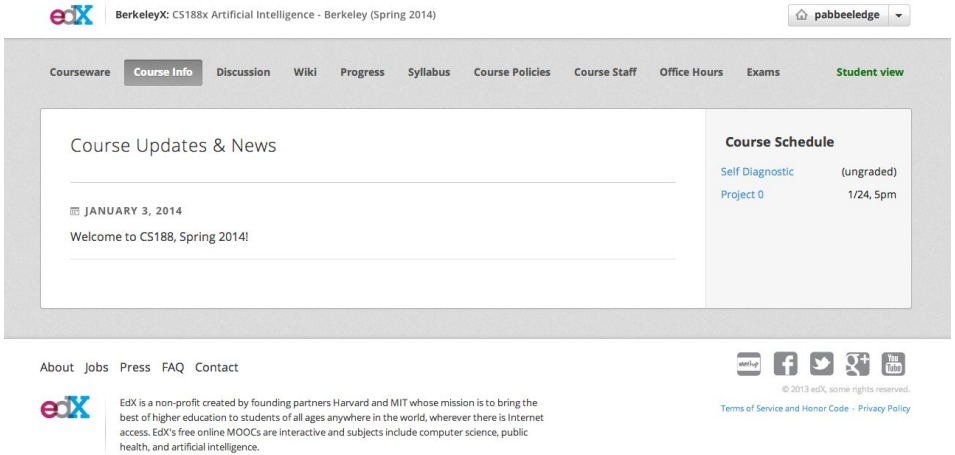
Course Information

- Communication:
  - Announcements on webpage
  - Questions? Discussion on piazza
  - Staff email: cs188-staff@lists
  - This course is webcast (Sp14 live videos)

  + Fa12 edited videos (1-11)

  + Fa13 live videos
- Course technology:
  - New infrastructure
  - Autograded projects, interactive homeworks (unlimited submissions!) + regular homework
  - Help us make it awesome!

Sign up at: inst.eecs.berkeley.edu/~cs188

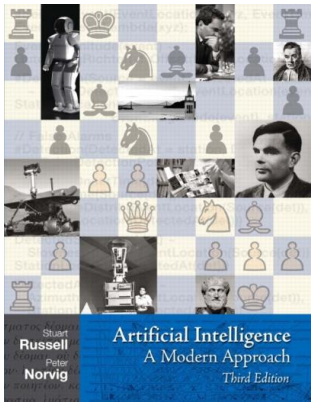


Course Information

- Prerequisites:
  - (CS 61A or B) and (Math 55 or CS 70)
  - Strongly recommended: CS61A, CS61B and CS70
  - 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
  - ~9 homework assignments:
    - Part 1: interactive, solve together, submit alone
    - Part 2: written, solve together, write up alone, electronic submission through pandagrader [these problems will be questions from past exams]
  - Two midterms, one final
  - Participation can help on margins
  - Fixed scale
  - Academic integrity policy
- Contests!

Textbook

- Not required, but for students who want to read more we recommend
  - Russell & Norvig, AI: A Modern Approach, 3rd Ed.



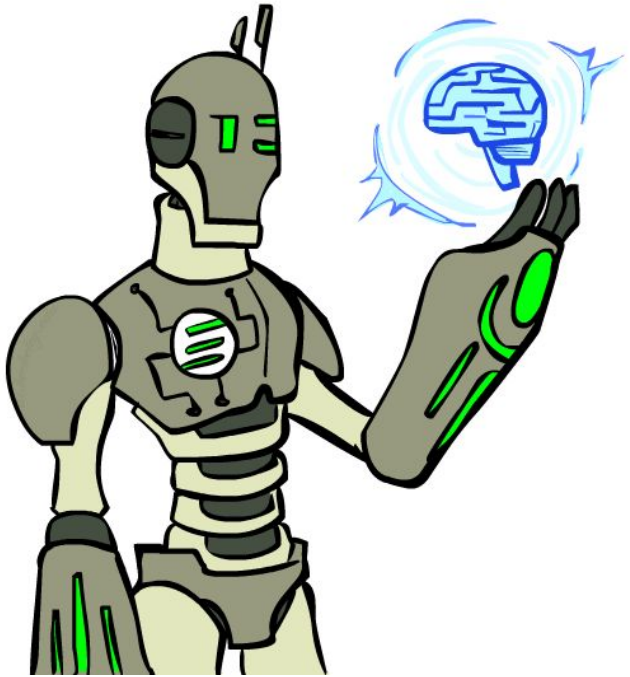
  - Warning: Not a course textbook, so our presentation does not necessarily follow the presentation in the book.

Important This Week

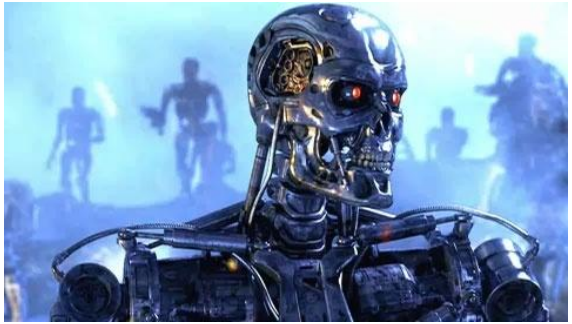
- Important this week:
  - **Register** for the class on edx
  - **Register** for the class on piazza --- our main resource for discussion and communication
  - **P0: Python tutorial** is out (due on Friday 1/24 at 5pm)
  - **One-time (optional) P0 lab hours** this week
    - Wed 2-3pm, Thu 4-5pm --- all in 330 Soda
  - Get (optional) **account forms** in front after class
  - **Math self-diagnostic** up on web page --- important to check your preparedness for second half
- Also important:
  - **Sections** start next week. You are free to attend any section, priority in section you signed up for if among first 35 to sign up. Sign-up first come first served on Friday at 2pm on piazza poll.
  - **If you are wait-listed,** you might or might not get in depending on how many students drop. Contact Michael-David Sasson (msasson@cs.berkeley.edu) with any questions on the process.
  - **Office Hours** start next week, this week there are the P0 labs and you can catch the professors after lecture

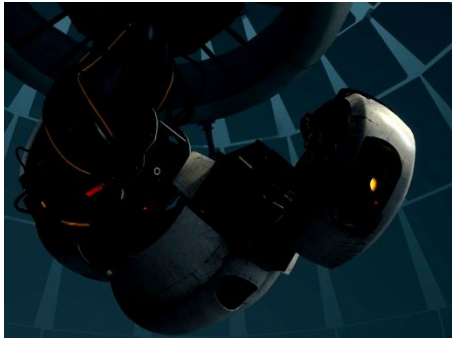
Today

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



Sci-Fi AI?





What is AI?

The science of making machines that:

Rational Decisions

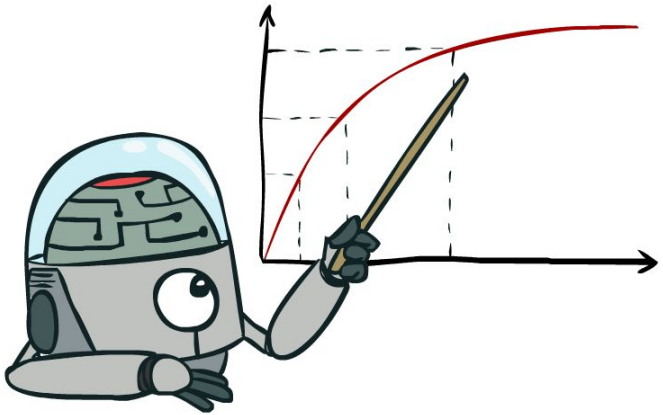
We'll use the term **rational** in a very specific, technical way:

- 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:

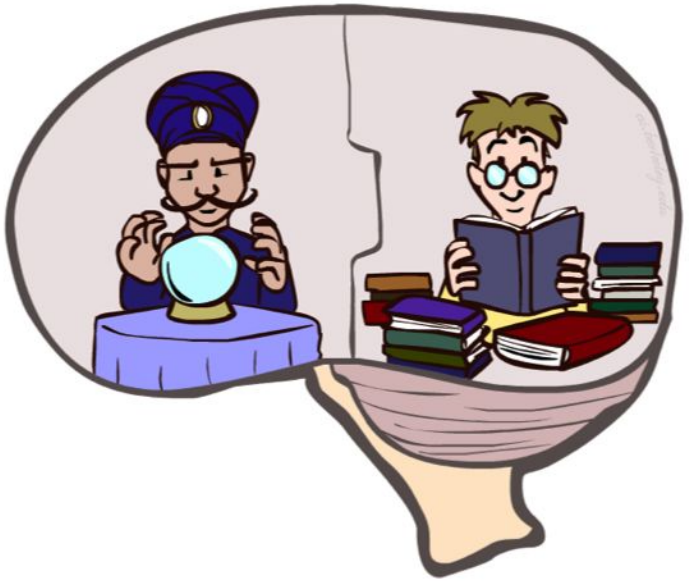
Computational Rationality

Maximize Your Expected Utility

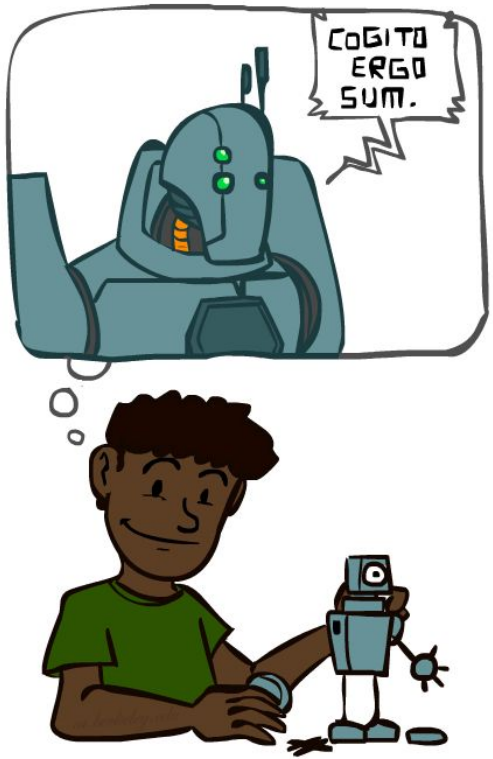


What About the Brain?

- 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 and simulation are key to decision making



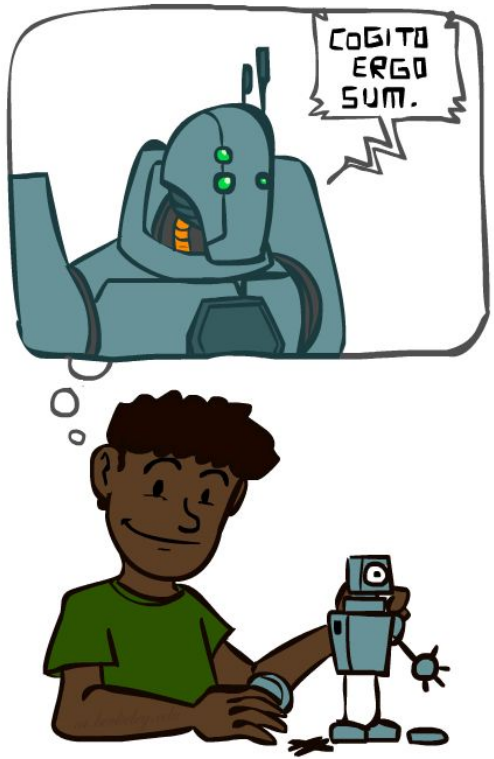
A (Short) History of AI



Demo: HISTORY – MT1950.wmv

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—: Statistical approaches
  - Resurgence of probability, focus on uncertainty
  - General increase in technical depth
  - Agents and learning systems… “AI Spring”?
- 2000—: Where are we now?



What Can AI Do?

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

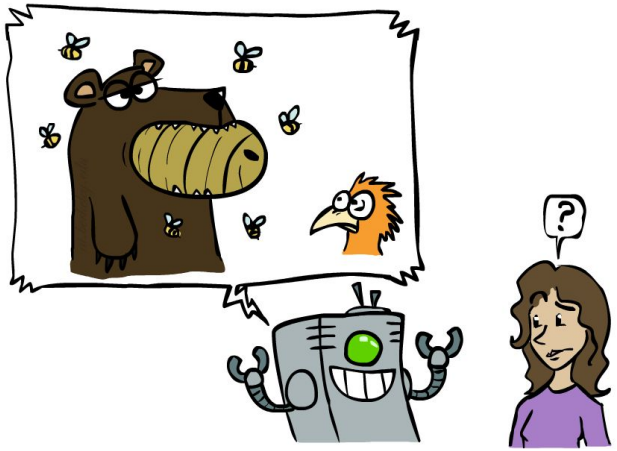
- ✓ Play a decent game of table tennis?
- ✓ Play a decent game of Jeopardy?
- ✓ Drive safely along a curving mountain road?
- ? Drive safely along Telegraph Avenue?
- ✓ Buy a week's worth of groceries on the web?
- ✗ Buy a week's worth of groceries at Berkeley Bowl?
- ? Discover and prove a new mathematical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

Unintentionally Funny Stories

- One day Joe Bear was hun
  Irving Bird where some ho
  there was a beehive in the
  the oak tree. He ate the b

- Henry Squirrel was thirsty.
  river bank where his good
  Henry slipped and fell in th
  The End.

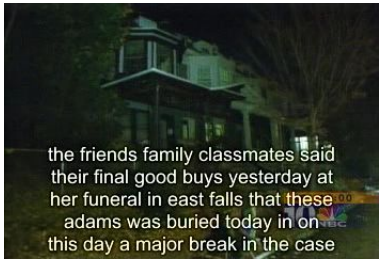
- Once upon a time there w
  was sitting in his tree, hold
  he was holding the piece o
  cheese. The fox walked ov



[Shank, Tale-Spin System, 1984]

Natural Language

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



Demo: NLP – ASR tvsample.avi

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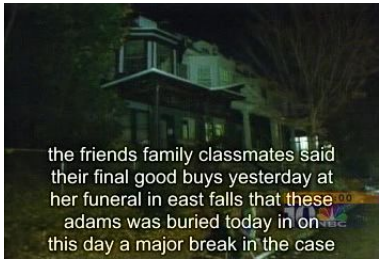
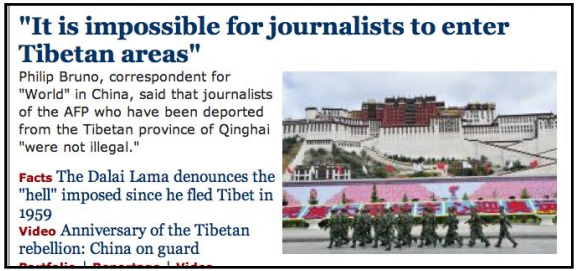


- Language processing technologies
  - Question answering
  - Machine translation

"Il est impossible aux journalistes de rentrer dans les régions tibétaines"

Bruno Philip, correspondant du "Monde" en Chine, estime que les journalistes de l'AFP qui ont été expulsés de la province tibétaine du Qinghai "n'étaient pas dans l'illégalité".

Les faits Le dalaï-lama dénonce l'"enfer" imposé au Tibet depuis sa fuite, en 1959
Vidéo Anniversaire de la rébellion


"It is impossible for journalists to enter Tibetan areas"

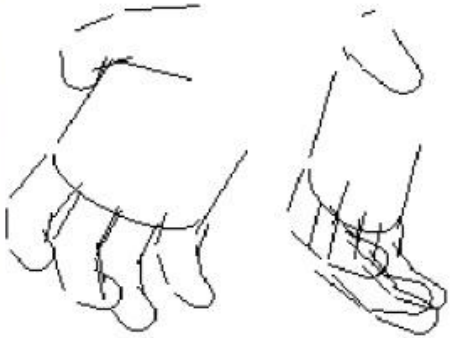
Philip Bruno, correspondent for "World" in China, said that journalists of the AFP who have been deported from the Tibetan province of Qinghai "were not illegal."

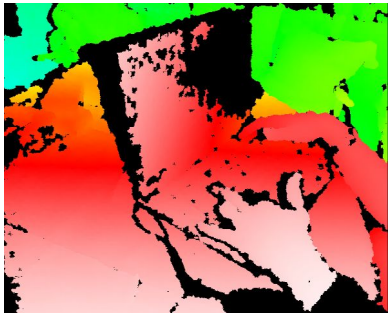
Facts The Dalai Lama denounces the "hell" imposed since he fled Tibet in 1959
Video Anniversary of the Tibetan rebellion: China on guard

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

Vision (Perception)

- Object and face recognition
- Scene segmentation
- Image classification





Images from Erik Sudderth (left), wikipedia (right)

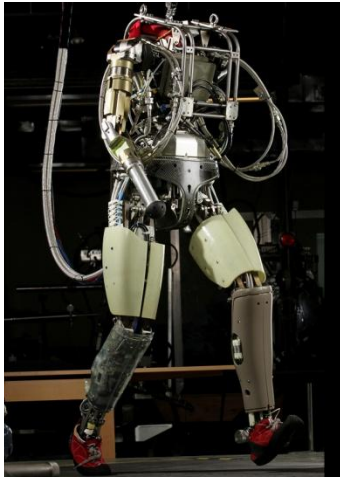
Demo1: VISION – lec_1_t2_video.flv

Demo2: VISION – lec_1_obj_rec_0.mpg

Robotics

Demo 1: ROBOTICS – soccer.avi
Demo 2: ROBOTICS – soccer2.avi
Demo 3: ROBOTICS – gcar.avi
Demo 4: ROBOTICS – laundry.avi
Demo 5: ROBOTICS – petman.avi

- 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, Boston Dynamics, RoboCup, Google

Logic

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

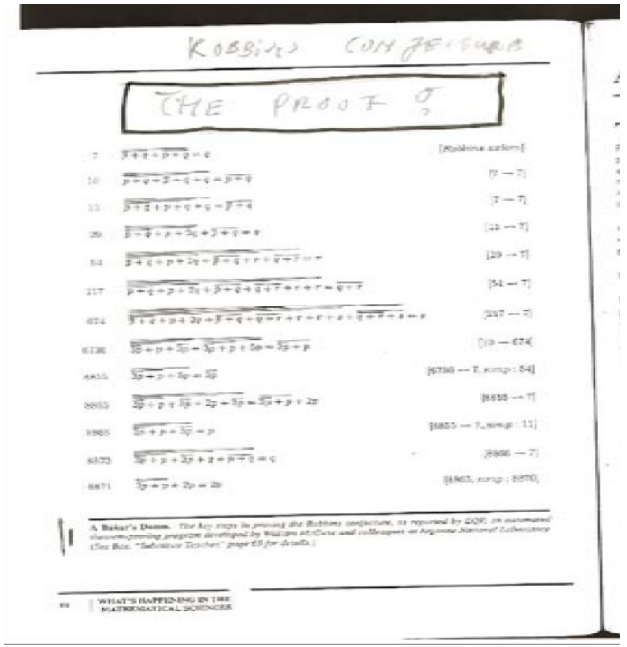
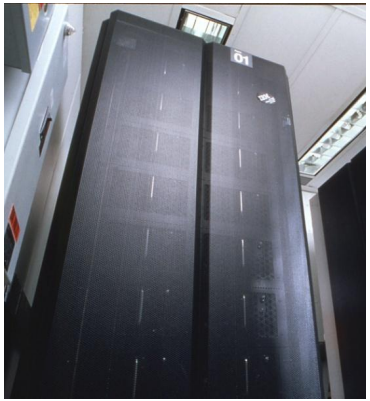


Image from Bart Selman

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 a PC cluster



- Open question:
  - How does human cognition deal with the search space explosion of chess?
  - Or: how can humans compete with computers at all??

- 1996: Kasparov Beats Deep Blue
  “I could feel --- I could smell --- a new kind of intelligence across the table.”
- 1997: Deep Blue Beats Kasparov
  “Deep Blue hasn't proven anything.”
- Huge game-playing advances recently, e.g. in Go!

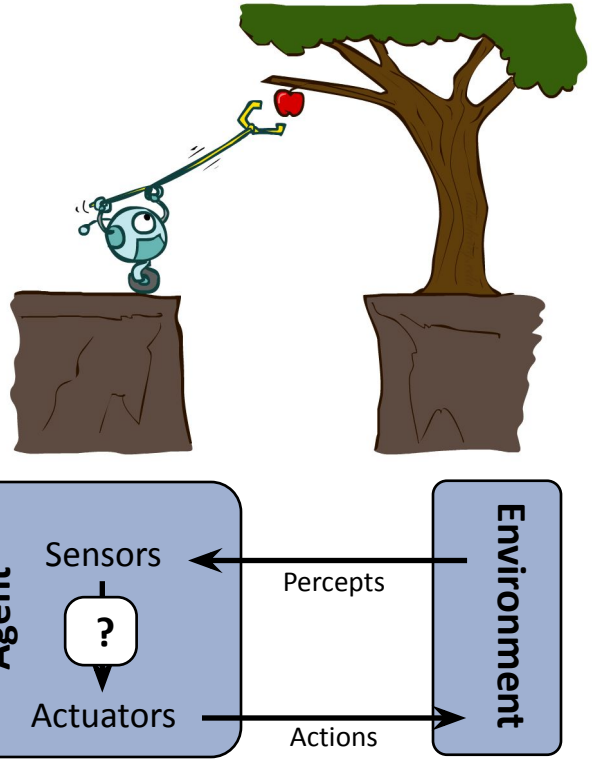
Text from Bart Selman, image from IBM’s Deep Blue pages

Decision Making

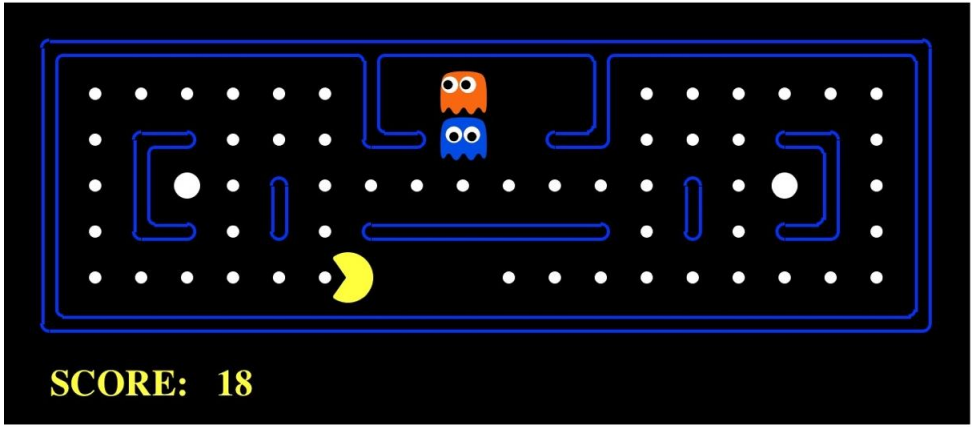
- Applied AI involves many kinds of automation
  - Scheduling, e.g. airline routing, military
  - Route planning, e.g. Google maps
  - Medical diagnosis
  - Web search engines
  - Spam classifiers
  - Automated help desks
  - Fraud detection
  - Product recommendations
  - … Lots more!

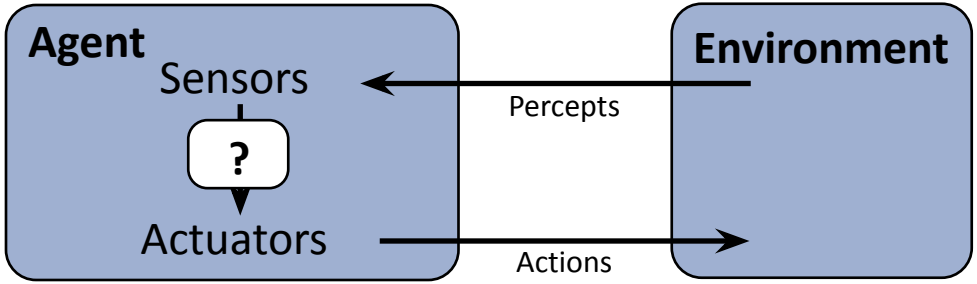
Designing Rational Agents

- 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



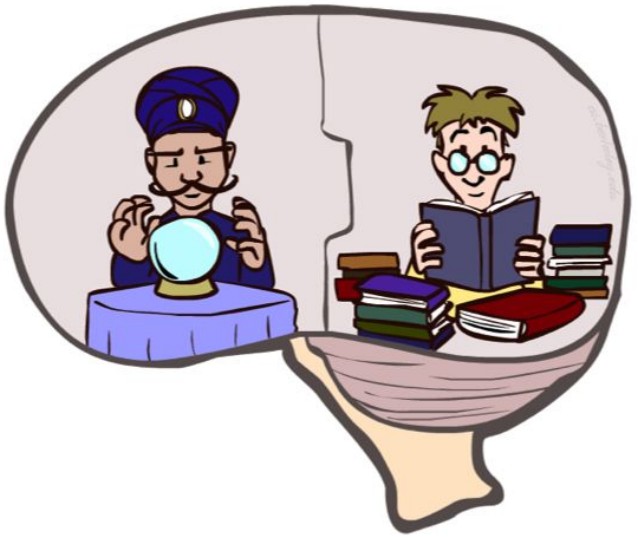
Pac-Man as an Agent





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

Demo1: pacman-l1.mp4 or L1D2

Course Topics

- Part I: Making Decisions
  - Fast search / planning
  - Constraint satisfaction
  - Adversarial and uncertain search
- Part II: Reasoning under Uncertainty
  - Bayes' nets
  - Decision theory
  - Machine learning
- Throughout: Applications
  - Natural language, vision, robotics, games, …