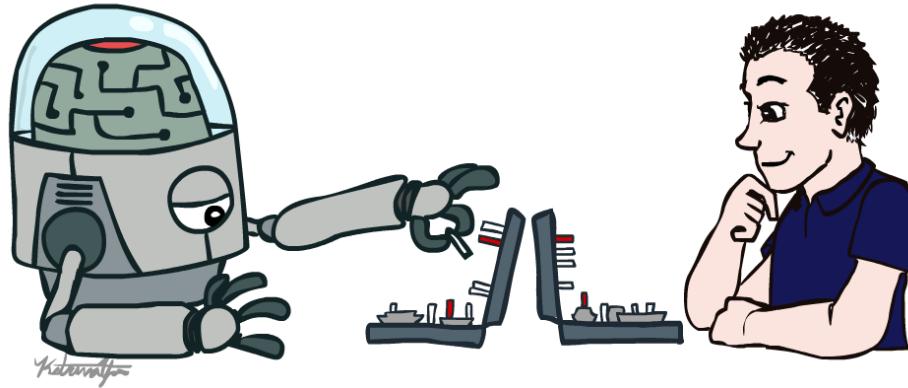


CS 188: Artificial Intelligence

Introduction



Instructors: Pieter Abbeel & Anca Dragan

University of California, Berkeley

(slides by Dan Klein, Pieter Abbeel, Anca Dragan)

Course Staff

Professors



Anca Dragan



Pieter Abbeel

GSIs



Tianhao
Zhang



Alex
Lee



Abhishek
Gupta



Chris
Lin



Coline
Devin



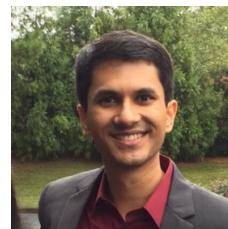
Davis
Foote



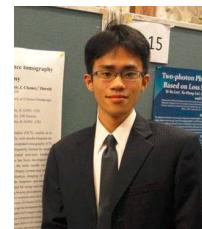
Gregory
Kahn



Jacob
Andreas



Karthik
Narayan



Wei-Cheng
Kuo

Course Information

- **Communication:**

- Announcements on webpage
- Questions? Discussion on piazza
- Staff email: cs188-staff@lists
- This course is webcast (Sp16 live videos)
 - + Fa12 edited videos (1-11)
 - + Sp15 edited videos (12-23)

- **Course technology:**

- Somewhat new infrastructure
- Autograded projects, interactive homework (unlimited submissions!)
- Help us make it awesome!

Sign up: see piazza welcome post

The screenshot shows the edX course page for CS188x-SP16 Artificial Intelligence - Berkeley (Spring 2016). The top navigation bar includes links for Courseware, Course Info (which is selected), Discussion, Progress, Syllabus, Course Policies, Course Staff, Office Hours, and Exams. A dropdown menu "View this course as:" is set to "Student". The main content area has a section titled "Course Updates & News" which is currently empty. To the right is a "Course Schedule" table:

Course Schedule	
Self Diagnostic	(ungraded)
P0	F 1/22, 5pm
HW1	M 2/1, 11:59pm
P1	F 2/5, 5pm
Contest 1	Su 2/7, 11:59pm
HW2	M 2/8, 11:59pm
HW3	M 2/15, 11:59pm
P2	F 2/19, 5pm
Contest 2	Su 2/21, 11:59pm
HW4	M 2/29, 11:59pm
HW5	M 3/29, 11:59pm
P3	F 3/4, 5pm
HW6	M 3/7, 11:59pm
HW7	M 3/14, 11:59pm
Practice Midterm	
Tu 3/15, 11:59pm	
Midterm	TBD
(Spring Break)	
M 3/21 - F 3/25	
P4	F 4/1, 5pm
HW8	M 4/4, 11:59pm
P5	F 4/8, 5pm
HW9	M 4/11, 11:59pm

Course Information

- Prerequisites:
 - CS 61A and CS 61B and CS 70
 - **There will be a lot of math (and programming)**
- Work and Grading:
 - 6 programming projects: Python, groups of 1 or 2
 - 5 late days for semester, maximum 2 per project
 - ~11 homework assignments:
 - Online, interactive, solve together, submit alone
 - One midterm, one final
 - Fixed scale
 - Participation can help on margins
 - Academic integrity policy
- Contests!

Exam Dates

- Midterm: Week of 3/14-18, evening midterm
- Final Exam: Thursday 5/12, 8-11am

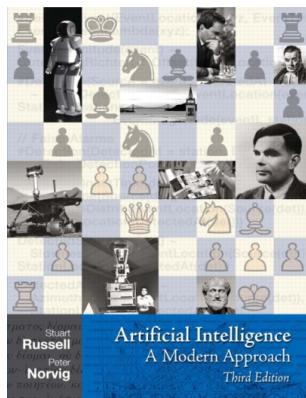
Laptops in Lecture

- Laptops can easily distract students behind you

Consider sitting towards the back if using your laptop in lecture

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.

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.
- There is no section in the current week (1/18 - 1/22).

Exam Practice Sessions (Optional Attendance)

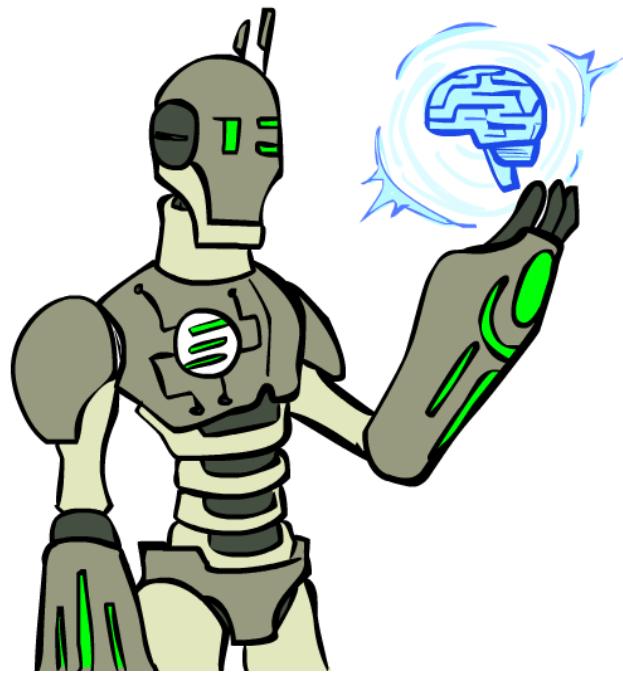
- Sessions dedicated to solving past exam problems. GSIs will be present to guide you through these old exam problems.
- Similar to sections, there will be a poll on Piazza later this week soliciting which session you intend to attend.
- These will start the week of 2/8 - 2/12.
- There will be a webcast.

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 1/22 at 5pm)
 - **One-time (optional) P0 lab hours** this week on Thursday and Friday (exact time TBA)
 - **Instructional accounts forms:** not needed for CS188, but can obtain online, see “Welcome” post on piazza
 - **Math self-diagnostic** up on web page --- important to check your preparedness for second half
 - **Mark exam dates in your calendars**
- **Also important:**
 - **Sections** start next week.
 - **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.
 - **Regular Office Hours** start next week, this week there are the P0 office hours and professors will be available after lecture.

Today

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



Sci-Fi AI?



AI in the News

the guardian
Winner of the Pulitzer prize

US world opinion sports soccer tech arts lifestyle fashion business money travel environment all sections

home > tech games

Artificial intelligence (AI)

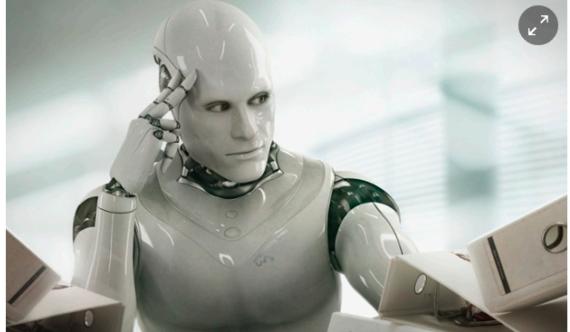
Elon Musk: artificial intelligence is our biggest existential threat

The AI investor says that humanity risks 'summoning a demon' and calls for more regulatory oversight

Samuel Gibbs
[@SamuelGibbs](#)

Monday 27 October 2014
06.26 EDT

[f](#) [t](#) [e](#) [in](#)
< Shares 7853 Comments 673



Artificial intelligence should be regulated, says Elon Musk. Photograph: Blutgruppe/Blutgruppe/Corbis

Elon Musk has spoken out against artificial intelligence (AI), declaring it the most serious threat to the survival of the human race.

Musk made the comments to students from Massachusetts Institute of Technology (MIT) during an interview at the AeroAstro Centennial Symposium, talking about computer science, AI, space exploration and the colonisation of Mars.

Source: The Guardian, 10/27/2014

AI in the News

SCIENCE

Study to Examine Effects of Artificial Intelligence

By JOHN MARKOFF DEC. 15, 2014



Email



Share



Tweet



Pin



Save



More



Scientists have begun what they say will be a century-long study of the effects of artificial intelligence on society, including on the economy, war and crime, officials at [Stanford University](#) announced Monday.

The project, hosted by the university, is unusual not just because of its duration but because it seeks to track the effects of these technologies as they reshape the roles played by human beings in a broad range of endeavors.

"My take is that A.I. is taking over," said Sebastian Thrun, a well-known roboticist who led the development of Google's self-driving car. "A few humans might still be 'in charge,' but less and less so."

Artificial intelligence describes computer systems that perform tasks traditionally requiring human intelligence and perception. In 2009, the president of the Association for the Advancement of Artificial Intelligence, Eric Horvitz, organized a meeting of computer scientists in California to discuss the possible ramifications of A.I. advances. The group concluded that the advances [were largely positive](#) and lauded the "relatively graceful" progress.

But now, in the wake of recent technological advances in computer vision, speech recognition and robotics, scientists say they are increasingly concerned that artificial intelligence technologies may permanently displace human workers, [roboticize warfare](#) and make Orwellian surveillance techniques easier to develop, among other disastrous effects.

Source: NY Times, 12/15/2014

AI in the News

Elon Musk Donates \$10M To Make Sure AI Doesn't Go The Way Of Skynet

Posted Jan 15, 2015 by [Darrell Etherington \(@drizzled\)](#)

8,386
SHARES



[Next Story](#)



Tesla and SpaceX chief executive Elon Musk has gone on record before proclaiming the potential risks of artificial intelligence, and now he's putting his money where his mouth is. The intrepid inventor and entrepreneur [announced a donation of \\$10 million](#) to help fund research to "keep AI beneficial" to humanity today. The funds go to the Future of Life Institute (FLI), an organization run by volunteers dedicated to research aimed at "mitigate[ing] existential risks facing humanity," and specifically those related to our ongoing progress towards AI that can approach human capabilities.

Source: TechCrunch, 1/15/2015

AI in the News

Elon Musk's Open A.I. reached \$1 billion funding in hopes to develop Artificial Intelligence



December 13 9:24 PM
2015

by Money Times
0 Comments

Print This Article
Share it With Friends

Tesla Motors Inc CEO Elon Musk and other prominent tech company executives raised \$1 billion through an initiative called Open A.I. to fund an artificial intelligence research company.

Source: vcpost, 12/13/2015

Let's take a (rudimentary) look at hardware

Architecture	Num neurons	Num synapses
---------------------	--------------------	---------------------

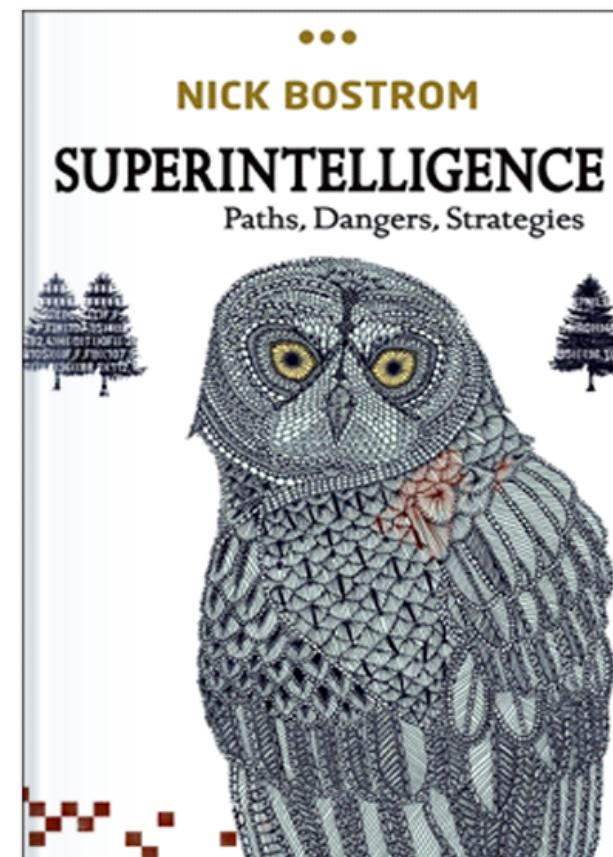
If each synapse is 1 FLOP (i.e., can fire / not fire once per second),

Then human brain requires 10^{15} flops = 1 petaflop.

100,000 current CPUs

costs \$5000 / hr on Amazon's EC2.

AI and the World



Why Take The Class?

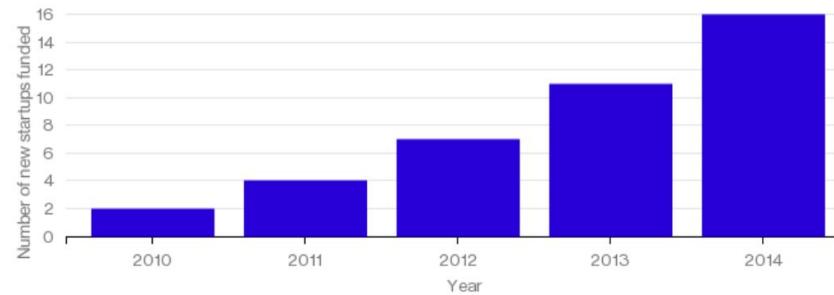
- My 2002 answer:
 - Largely because you want to learn about AI...
 - ... maybe even want to continue to learn even more about AI during a PhD ...
 - ... but not exactly the class that's going to maximize your job opportunities ;)

- My 2016 answer:
 - I am still hoping because you really want to learn about AI...
 - ... but a lot of jobs have started to emerge

Industry Activity

HAL 9000 Is Coming

Newly funded artificial intelligence startups, by year



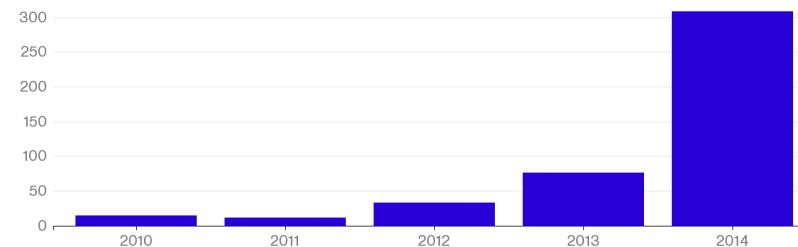
Data: CB Insights

Bloomberg

Artificial Intelligence, Real Money

Total venture capital money for pure AI startups, by year

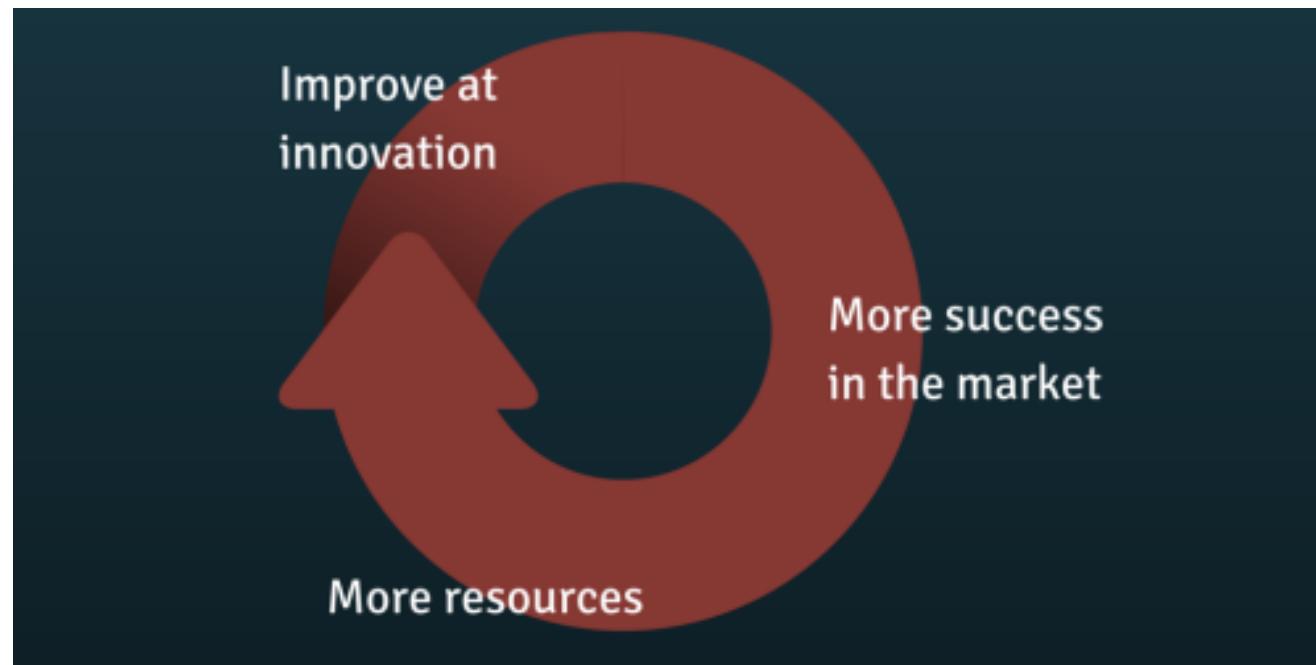
\$350 million



Source: CB Insights

Bloomberg

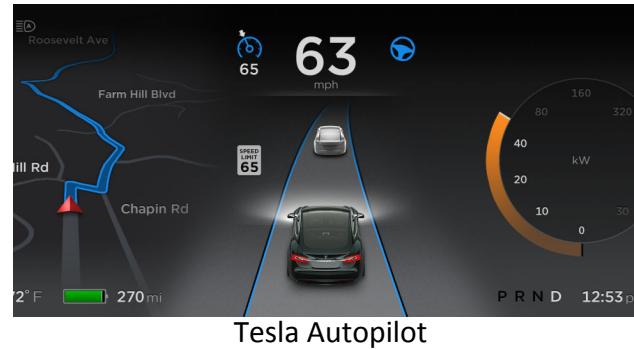
Cycle of Innovation / AI



Examples



Google Search I'm Feeling Lucky



What is AI?

The science of making machines that:

Rational Decisions

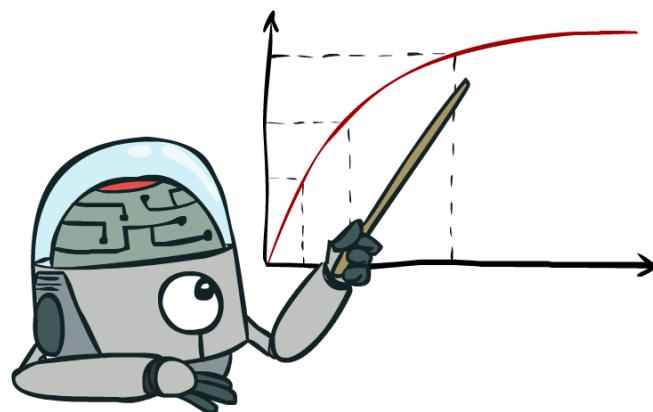
We'll use the term **rational** in a very specific, technical way:

- 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:

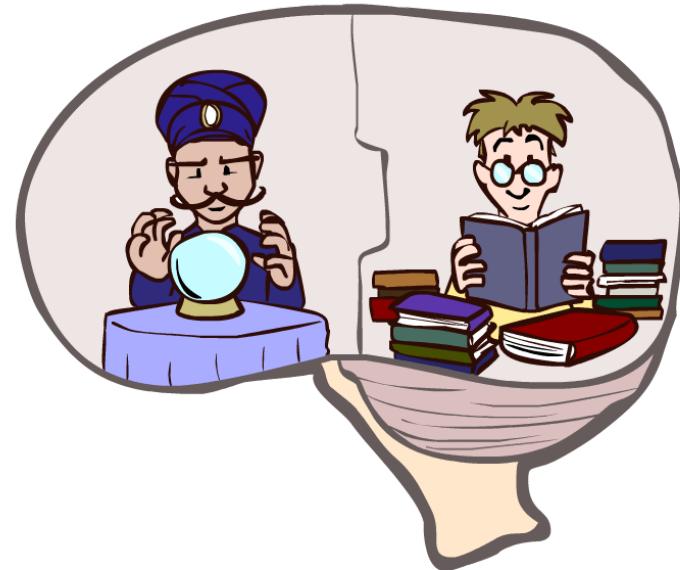
Computational Rationality

Maximize Your Expected Utility

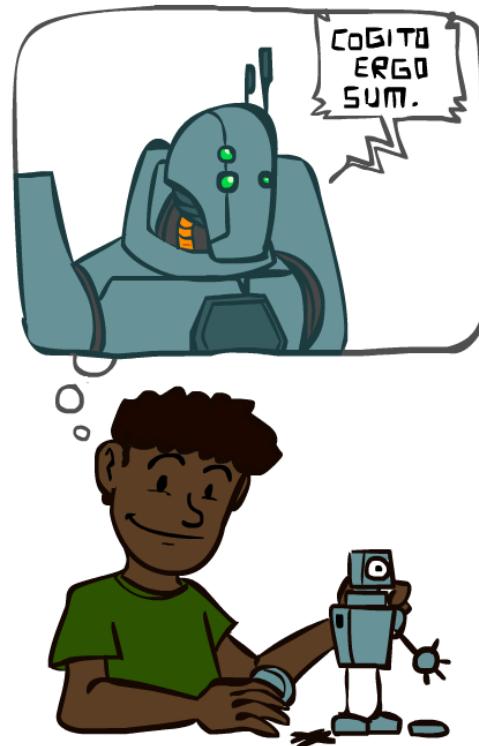


What About the Brain?

- 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



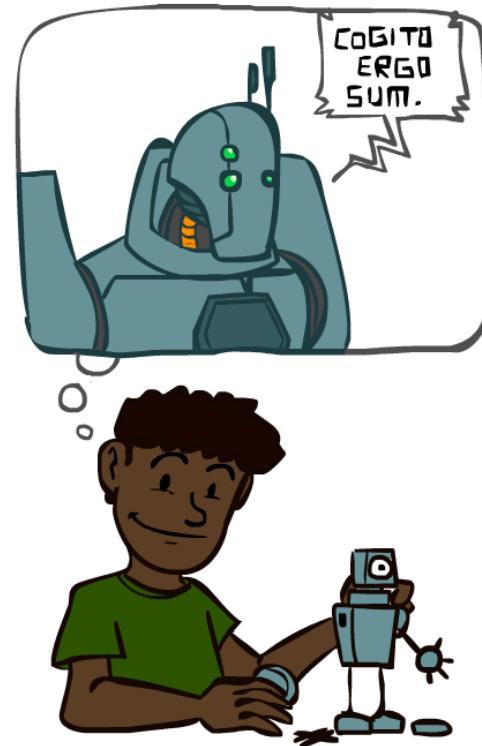
A (Short) History of AI



Demo: HISTORY – MT1950.wmv

A (Short) History of AI

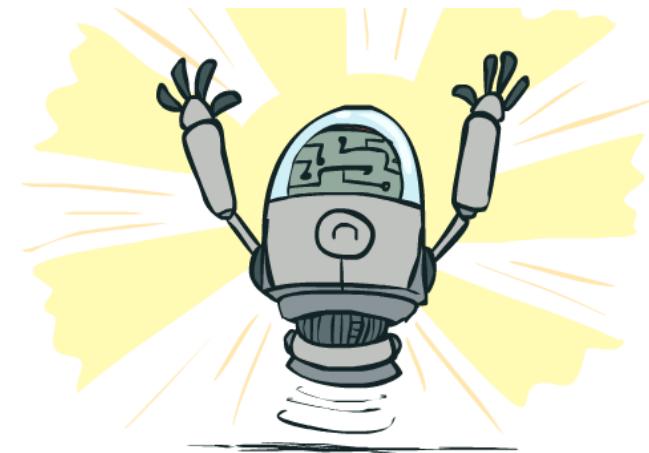
- **1940-1950: Early days**
 - 1943: McCulloch & Pitts: Boolean circuit model of brain
 - 1950: Turing's "Computing Machinery and Intelligence"
- **1950—70: Excitement: Look, Ma, no hands!**
 - 1950s: Early AI programs, including Samuel's checkers program, Newell & Simon's Logic Theorist, Gelernter's 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?

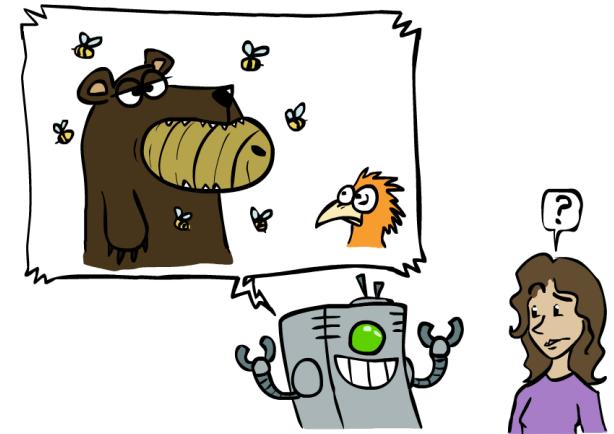
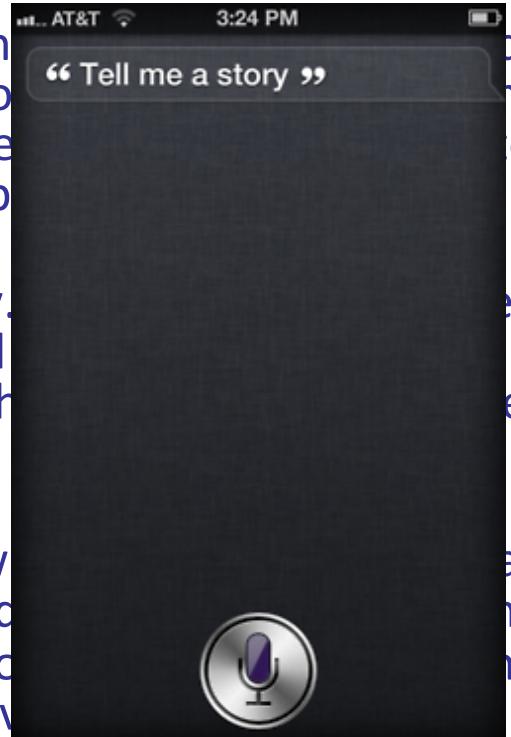
Quiz: Which of the following can be done at present?

- ✓ 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

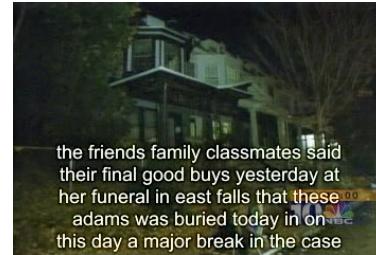
- One day Joe Bear was hungry. Irving Bird where some honey. There was a beehive in the tree. He ate the bees.
- Henry Squirrel was thirsty. He was at the river bank where his good friend Henry was swimming. Henry slipped and fell in the water. The End.
- Once upon a time there was a fox. The fox was sitting in his tree, holding a piece of cheese. He noticed that he was holding the piece of cheese. The fox walked over to a vain crow. One day the crow had a piece of cheese in his mouth. He noticed that he was hungry, and swallowed the cheese. The fox walked over to the crow and said.



[Shank, Tale-Spin System, 1984]

Natural Language

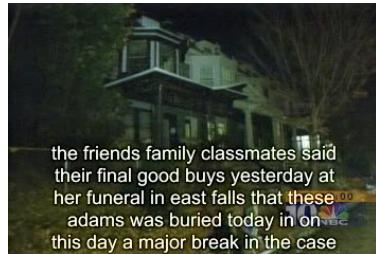
- Speech technologies (e.g. Siri)
 - Automatic speech recognition (ASR)
 - Text-to-speech synthesis (TTS)
 - Dialog systems



Demo: NLP – ASR tvsample.wmv

Natural Language

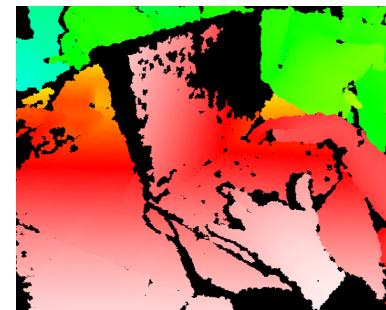
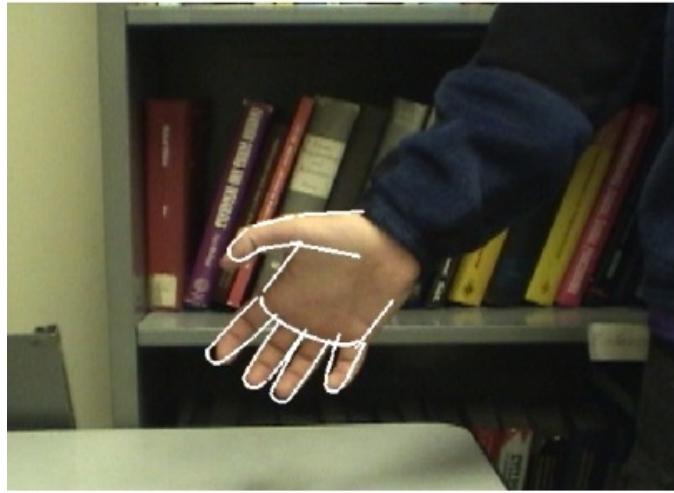
- Speech technologies (e.g. Siri)
 - Automatic speech recognition (ASR)
 - Text-to-speech synthesis (TTS)
 - Dialog systems
- Language processing technologies
 - Question answering
 - Machine translation



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

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 4: ROBOTICS – laundry.avi
Demo 2: ROBOTICS – soccer2.avi Demo 5: ROBOTICS – petman.avi
Demo 3: ROBOTICS – gcar.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!)

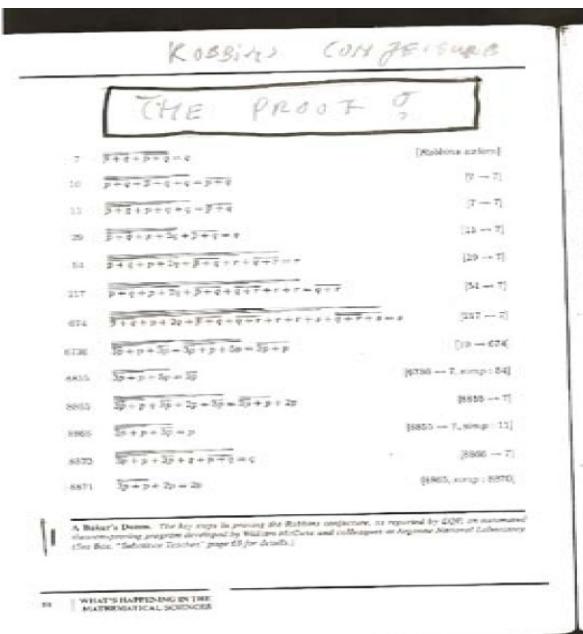


Image from Bart Selman

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!**

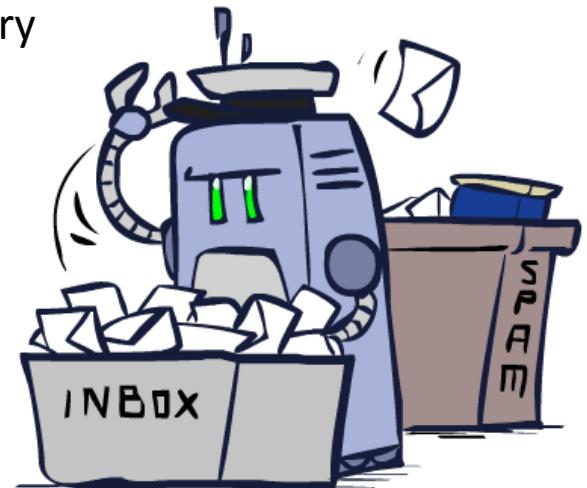


Text from Bart Selman, image from IBM's Deep Blue pages

Decision Making

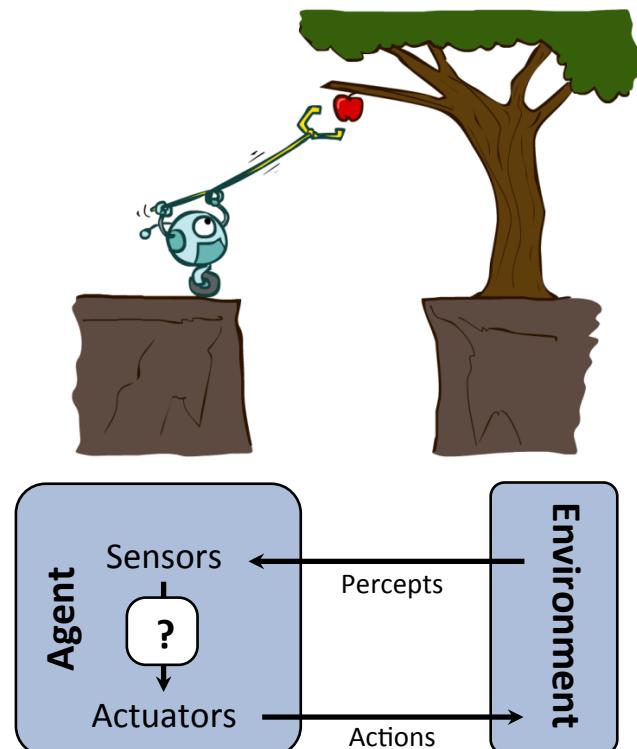
- Applied AI involves many kinds of automation

- 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!

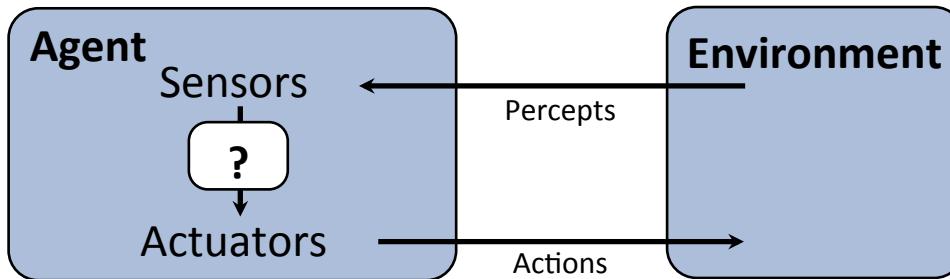
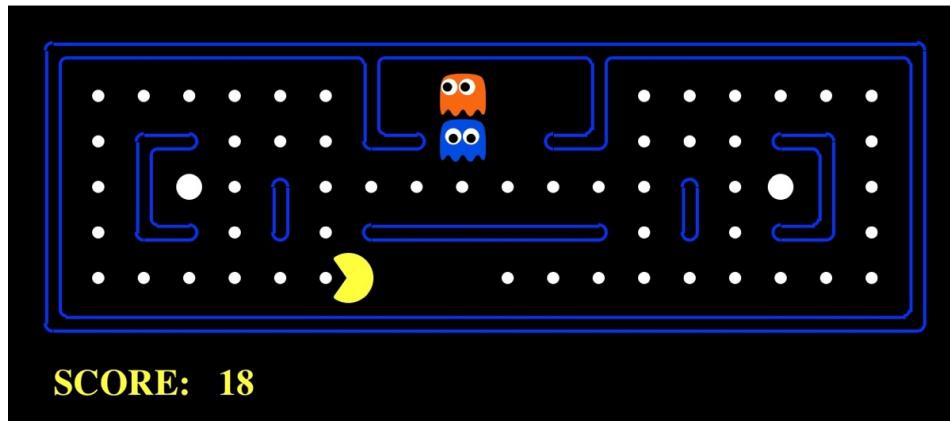


Designing Rational Agents

- 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

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, ...

