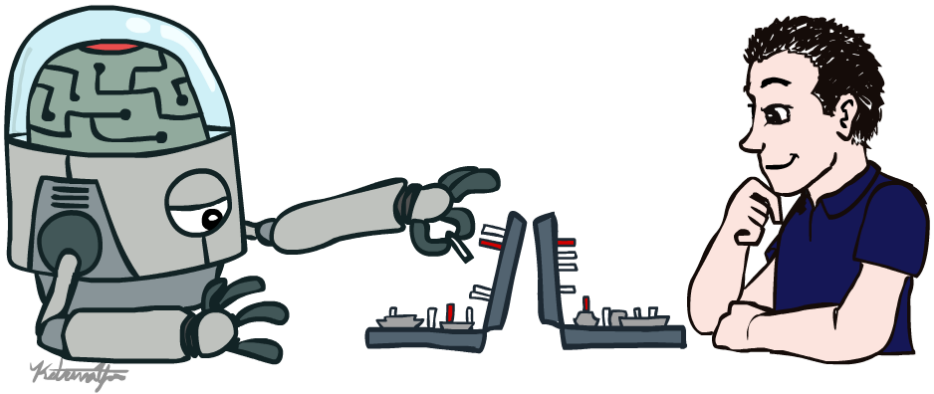
CS 188: Artificial Intelligence

Introduction



Instructors: Josh Hug & Adam Janin

University of California, Berkeley

(slides by Dan Klein, Pieter Abbeel, Anca Dragan, Josh Hug, Adam Janin)

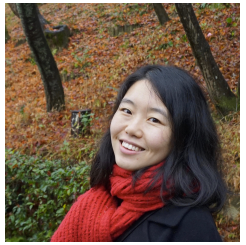
Course Staff

Professors

Josh Hug

Adam Janin

GSIs



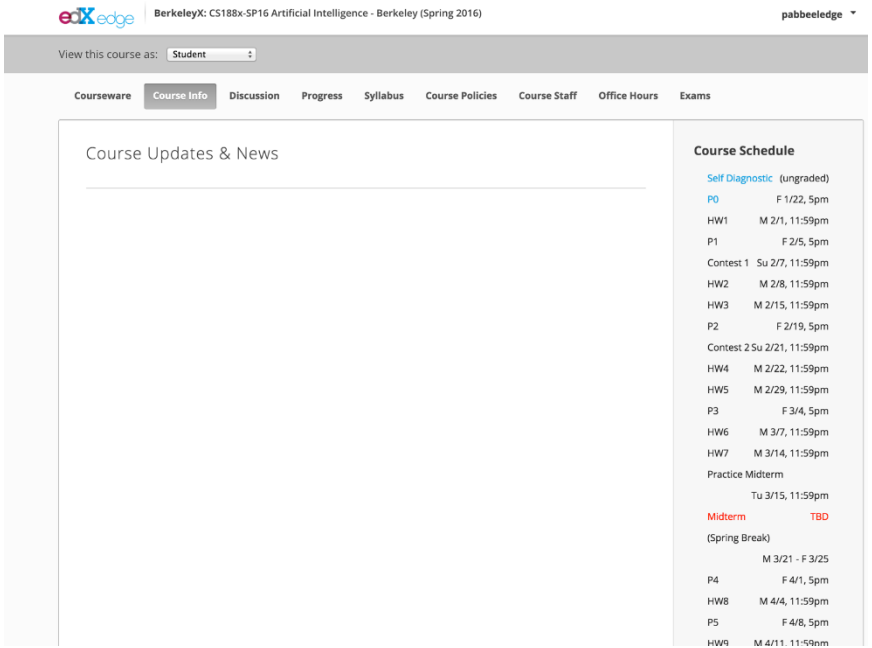
Course Information

- Communication:
  - Website at edge.edx.org
  - Announcements on EdX website
  - Questions? Discussion on piazza
  - Staff email: cs188-staff@lists.berkeley.edu
  - This course is webcast (Fa16 live videos)

  + Fa12 edited videos (1-11)

  + Sp15 edited videos (12-23)
- Course technology:
  - Somewhat new infrastructure
  - Autograded projects, interactive homework
  - Help us make it awesome!

Sign up: see piazza welcome post



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
  - ~10 homework assignments:
    - Online, interactive, solve together, submit alone
  - Two midterms, one final
  - Fixed scale
  - Participation can help on grading boundaries
  - Academic integrity policy
- Contests!

Exam Dates

- Midterm 1: Week of 10/6, evening midterm, time/place TBA
- Midterm 2: Week of 11/8, evening midterm, time/place TBA
- Final Exam: Thursday 12/13, 3-6pm
  - Let Sherdil know ASAP if you cannot make this time.

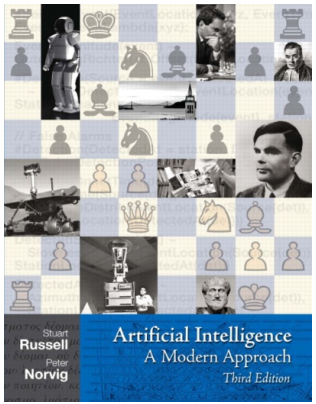
Laptops in Lecture

- 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.
- You are welcome to attend any section of your preference.
  - If the room is full, priority goes to those officially registered for the section.
- 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.
  - See Piazza for possible overflow sections if it feels like we need them next week.
- There will be a recordings available from a previous semester.
- There is no section in the current week (8/24 - 8/26).

Exam Practice Sessions (Optional Attendance)

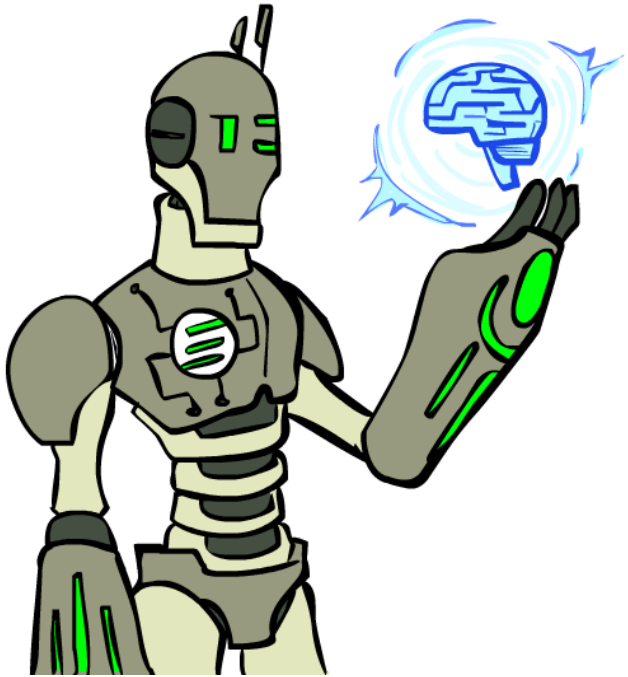
- Starting September 6th, four of the thirteen weekly discussion sections will be dedicated to solving past exam problems. GSIs will be present to guide you through these old exam problems.
- More details next week.
- There will be recordings available from a previous semester.

Important This Week

- Important this week:
  - **Register** for the class on edx: Use **edge.edx.org**
  - **Register** for the class on gradescope: Use entry code **9YJN2M**
  - **Register** for the class on piazza --- our main resource for discussion and communication
  - **P0: Python tutorial** is out (due on Friday 8/31 at 5pm)
  - **One-time (optional) P0 office hours -** Friday and next Tuesday (See Piazza)
  - **Instructional accounts forms:** not needed for CS188, but can obtain online, see 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, see Piazza. Contact Michael-David Sasson (msasson@cs.berkeley.edu) if Piazza post is not sufficient.
  - **Regular Office Hours** start next week, this week there are the P0 office hours and professors will be available after lecture.

Today

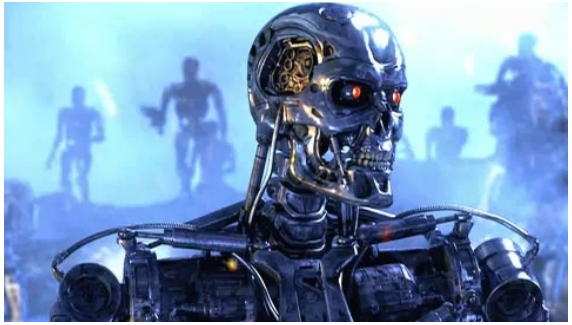
- What is artificial intelligence?
- What can AI do?
- What is this course?



Sci-Fi AI?

1977

1984



1999

2004

2015 (Ex Machina)

AI in the News

theguardian
Winner of the Pulitzer prize

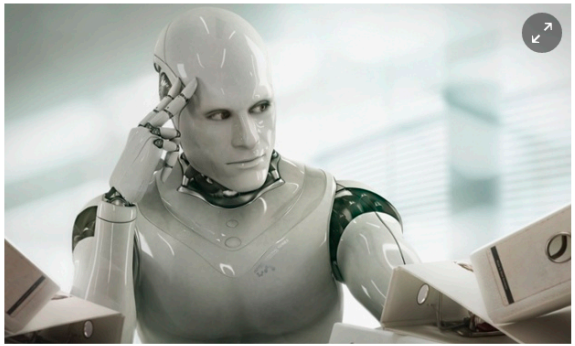
Artificial intelligence (AI)

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



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

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Share
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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 of Orwellian surveillance techniques easier to develop, among other disastrous effects.

Source: NY Times, 12/15/2014

AI in the News

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

(Credit: MoneyTimes) Elon Musk, CEO of US automotive and energy storage company Tesla, presents his outlook on climate change at the Paris-Sorbonne University in Paris on December 2, 2015.

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

AI in the News

Robotics

This Supercomputer Will Try to Find Intelligence on Reddit

Researchers at OpenAI are developing algorithms capable of learning language by reading the Web and controlling robots through practice.

by Will Knight August 15, 2016

Is it possible that the secret to building machine intelligence lies in spending endless hours reading Reddit?

- The OpenAI researchers are feeding message threads from the popular website Reddit to algorithms that build a probabilistic understanding of the conversation. If fed enough examples, the underlying language model will be good enough to hold a conversation itself, the researchers hope.

Nvidia's CEO, Jen-Hsun Huang, delivers the first DGX-1 to Elon Musk's OpenAI.

Let's take a (rudimentary) look at hardware

Architecture	Num neurons	Num synapses

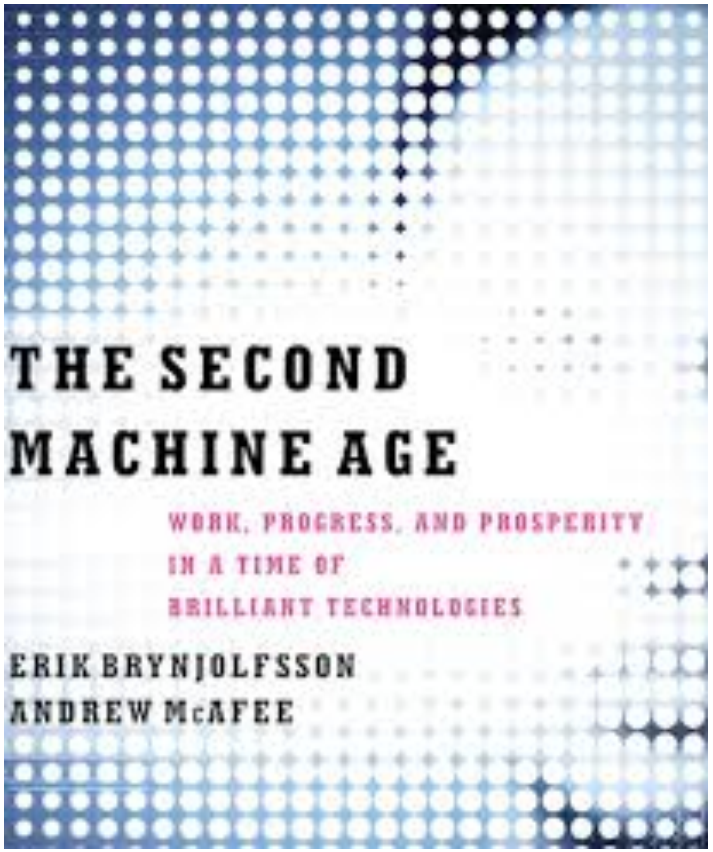
If each synapse is 1 FLOP (i.e., can fire / not fire once per second),

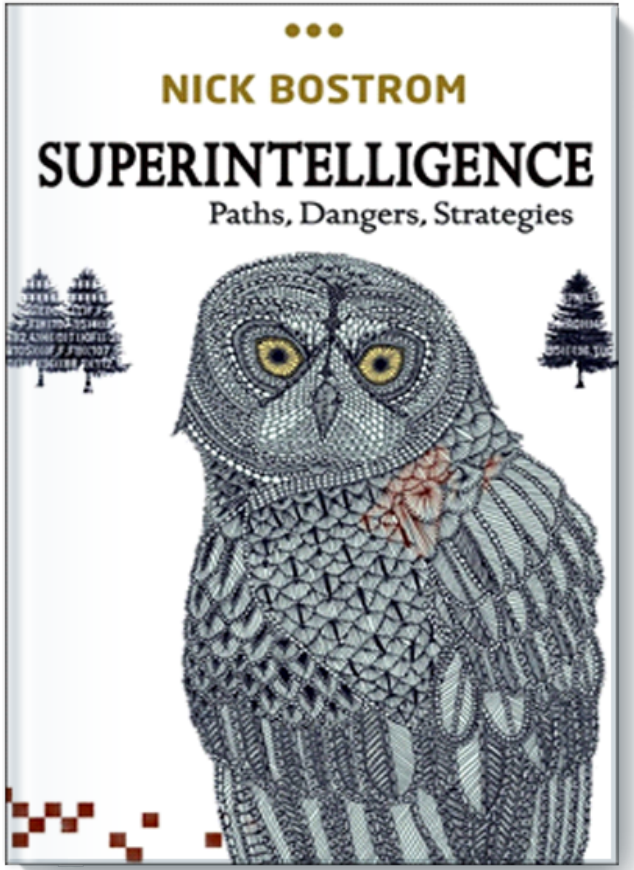
Then human brain requires 10^{15} flops = 1 petaflop.

100,000 current CPUs

costs $5000 / hr on Amazon's EC2.

AI and the World



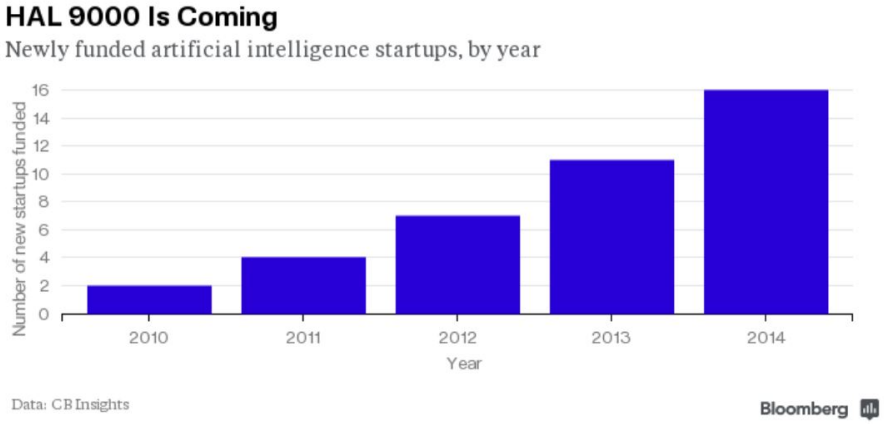


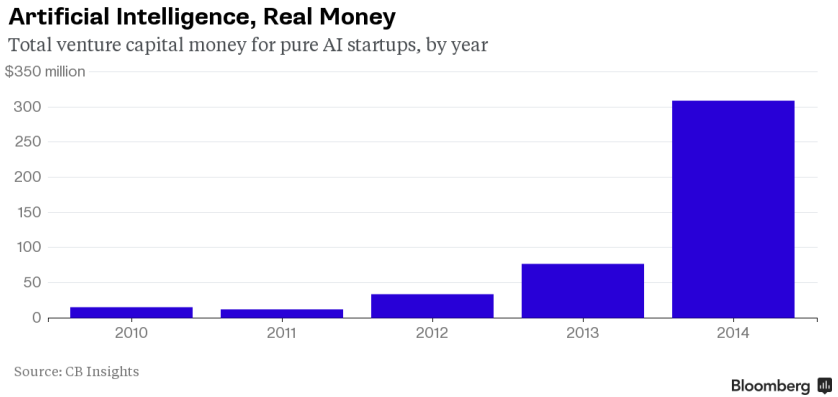
Why Take The Class?

- 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 ;)

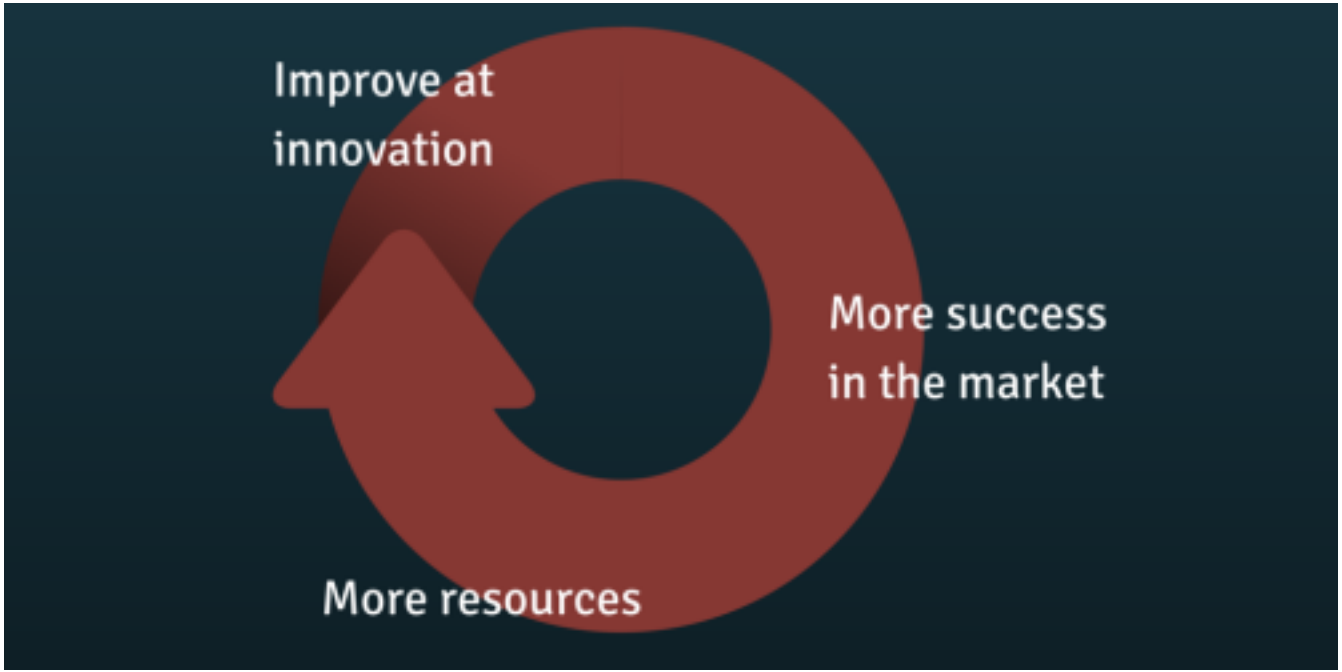
- My 2016 answer:
  - I am still hoping because you really want to learn about AI…
  - … but a lot of jobs have started to emerge

Industry Activity

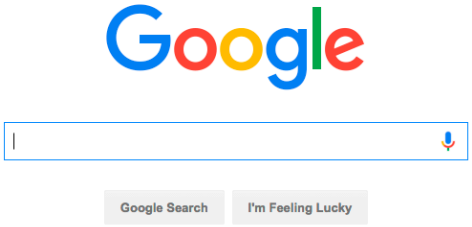


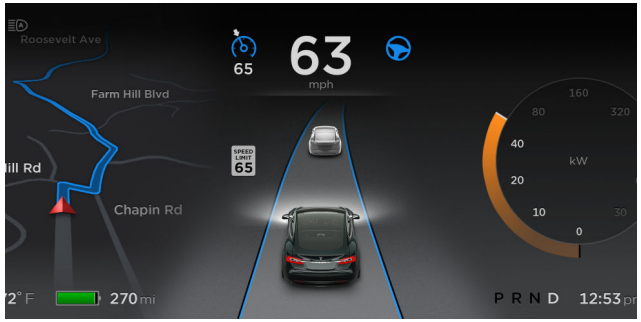


Cycle of Innovation / AI



Examples





Tesla Autopilot

What is AI?

The science of making machines that:

Rational Decisions

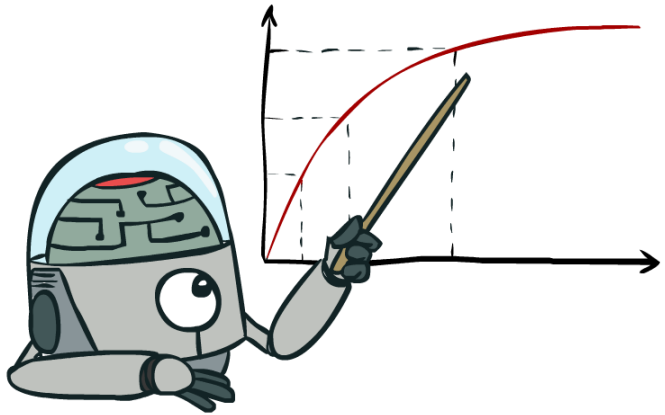
We'll use the term **rational** in a very specific, technical way:

- 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

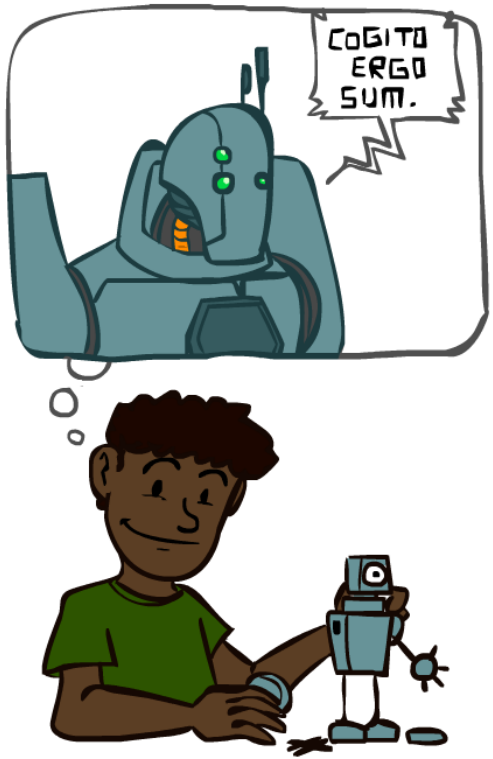
Maximize Your Expected Utility



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

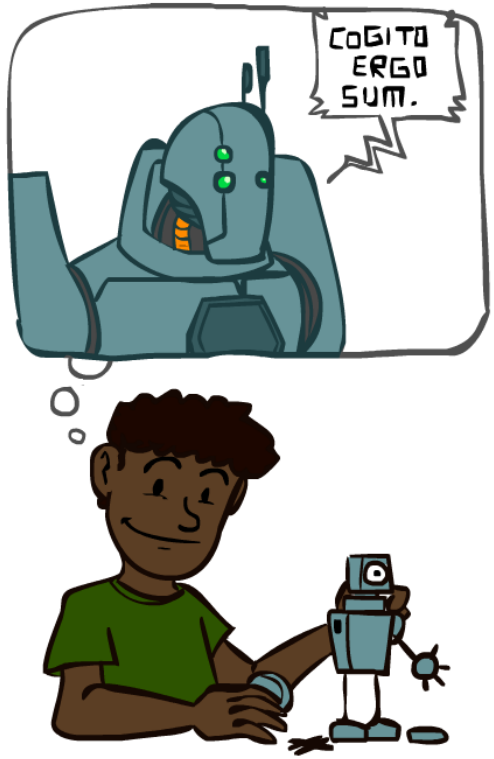


Demo: HISTORY – MT1950.wmv

Thinking Machines

A (Short) History of AI

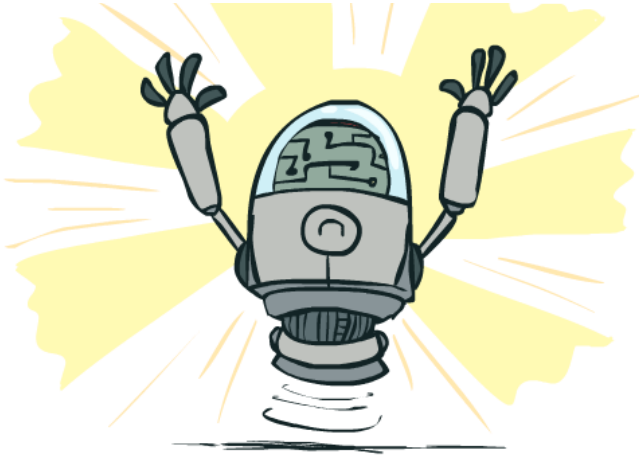
- 1940-1950: Early days
  - 1943: McCulloch & Pitts: Boolean circuit model of brain
  - 1950: Turing's "Computing Machinery and Intelligence"
- 1950—70: Excitement: Look, Ma, no hands!
  - 1950s: Early AI programs, including Samuel's checkers program, Newell & Simon's Logic Theorist, Gelernter's Geometry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



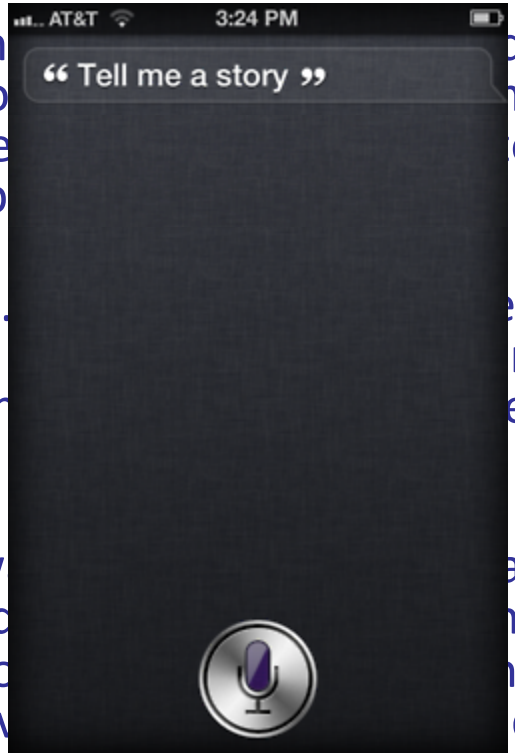
AI in Action

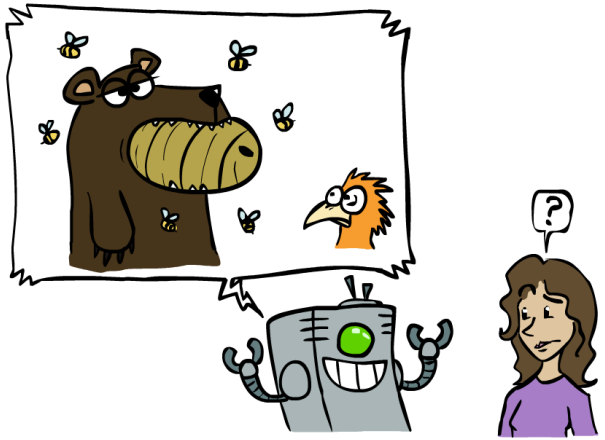
Unintentionally Funny Stories

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

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

- Once upon a time there w a vain crow. One day the crow was sitting in his tree, hold his mouth. He noticed that he was holding the piece c hungry, and swallowed the cheese. The fox walked ov d.

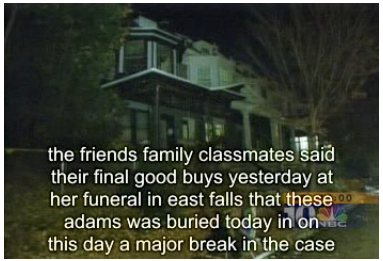




[Shank, Tale-Spin System, 1984]

Natural Language

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

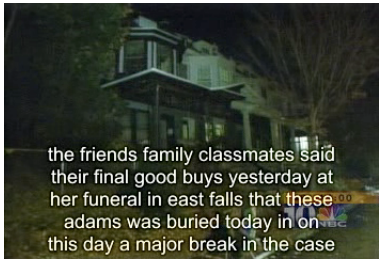


Demo: NLP – ASR tvsample.wmv

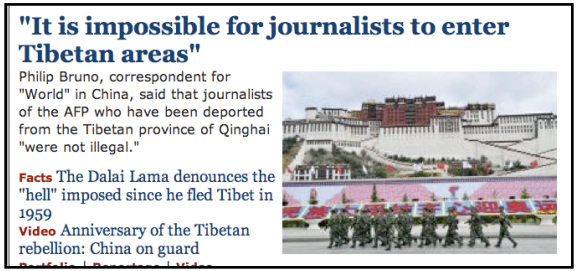
Real Time Transcription

Natural Language

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



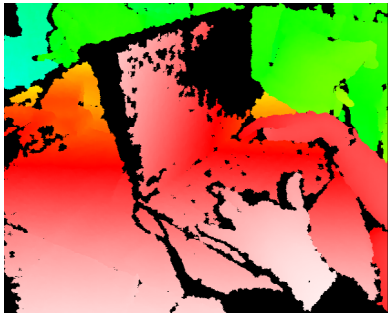
- Language processing technologies
  - Question answering
  - Machine translation



  - 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

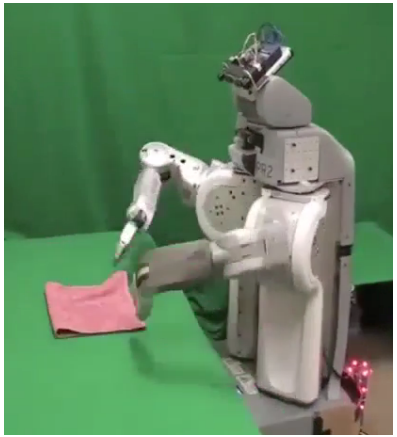
Computer Vision (1991)

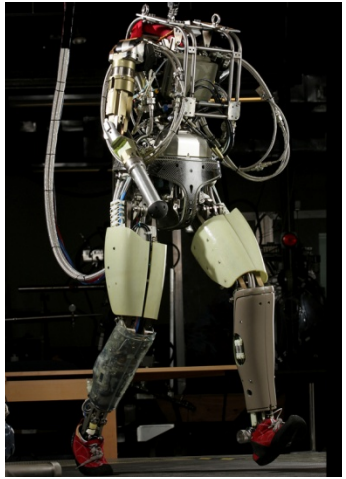
Computer Vision (Modern)

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

Google car

Laundry

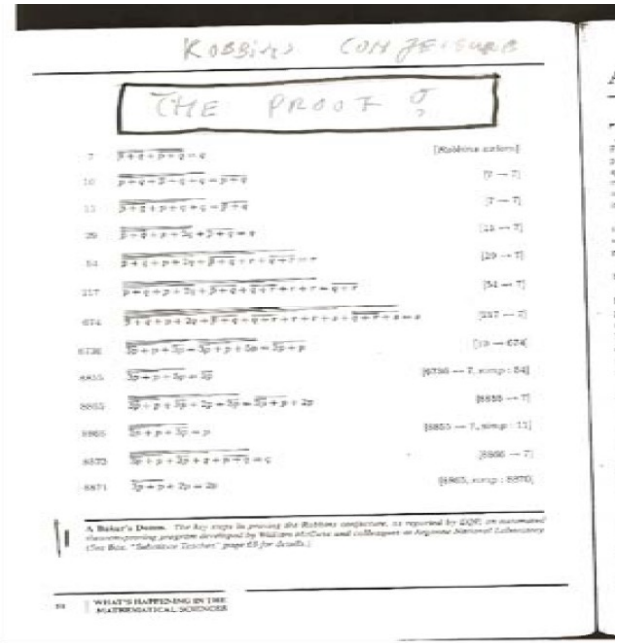
Soccer

Soccer2

Petman

Logic

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

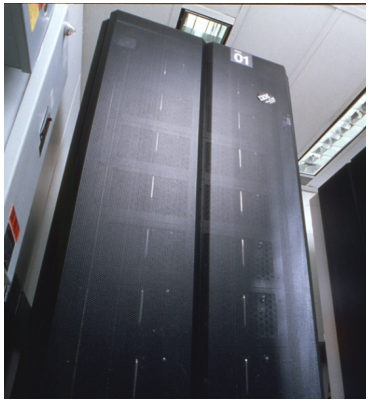


1996

Image from Bart Selman

Game Playing (Link)

- 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



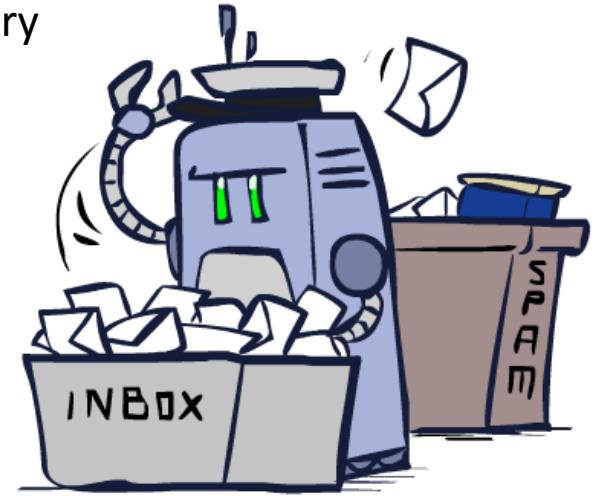
- Open question:
  - How does human cognition deal with the search space explosion of chess?
  - Or: how can humans compete with computers at all??

- 1996: Kasparov Beats Deep Blue
  “I could feel --- I could smell --- a new kind of intelligence across the table.”
- 2009: Pocket Fritz (on a mobile phone) reaches grandmaster.
  “a[n] HTC Touch HD mobile phone won a category 6 tournament with a performance rating of 2898” (Link above)
- Mar 2016: AlphaGo unexpectedly defeats world champion Lee Sedol 4-1.
  “robots will never understand the beauty of the game the same way that we humans do.” (Sedol)

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

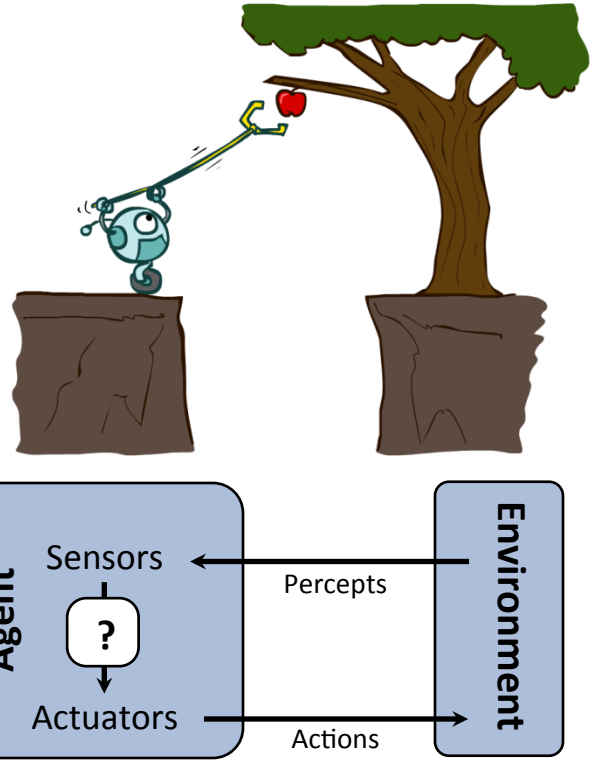
Decision Making

- 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!

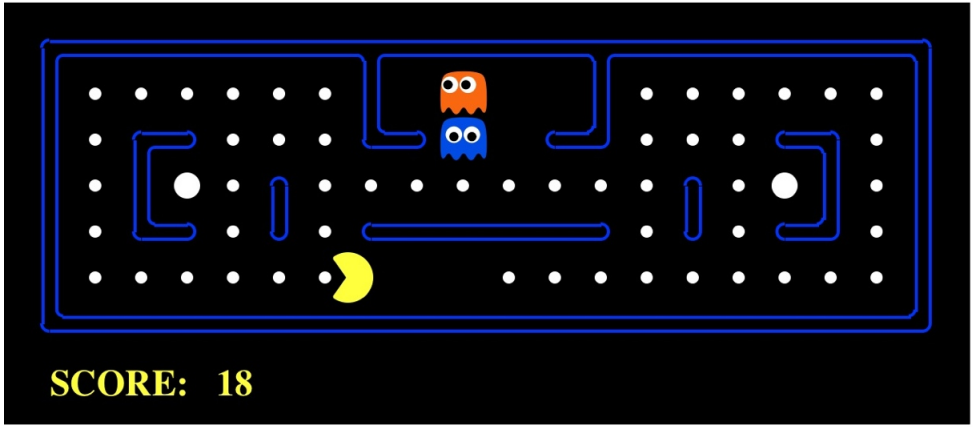


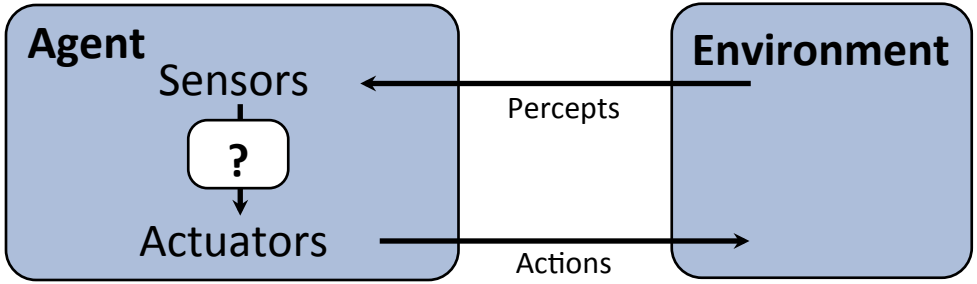
Designing Rational Agents

- 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

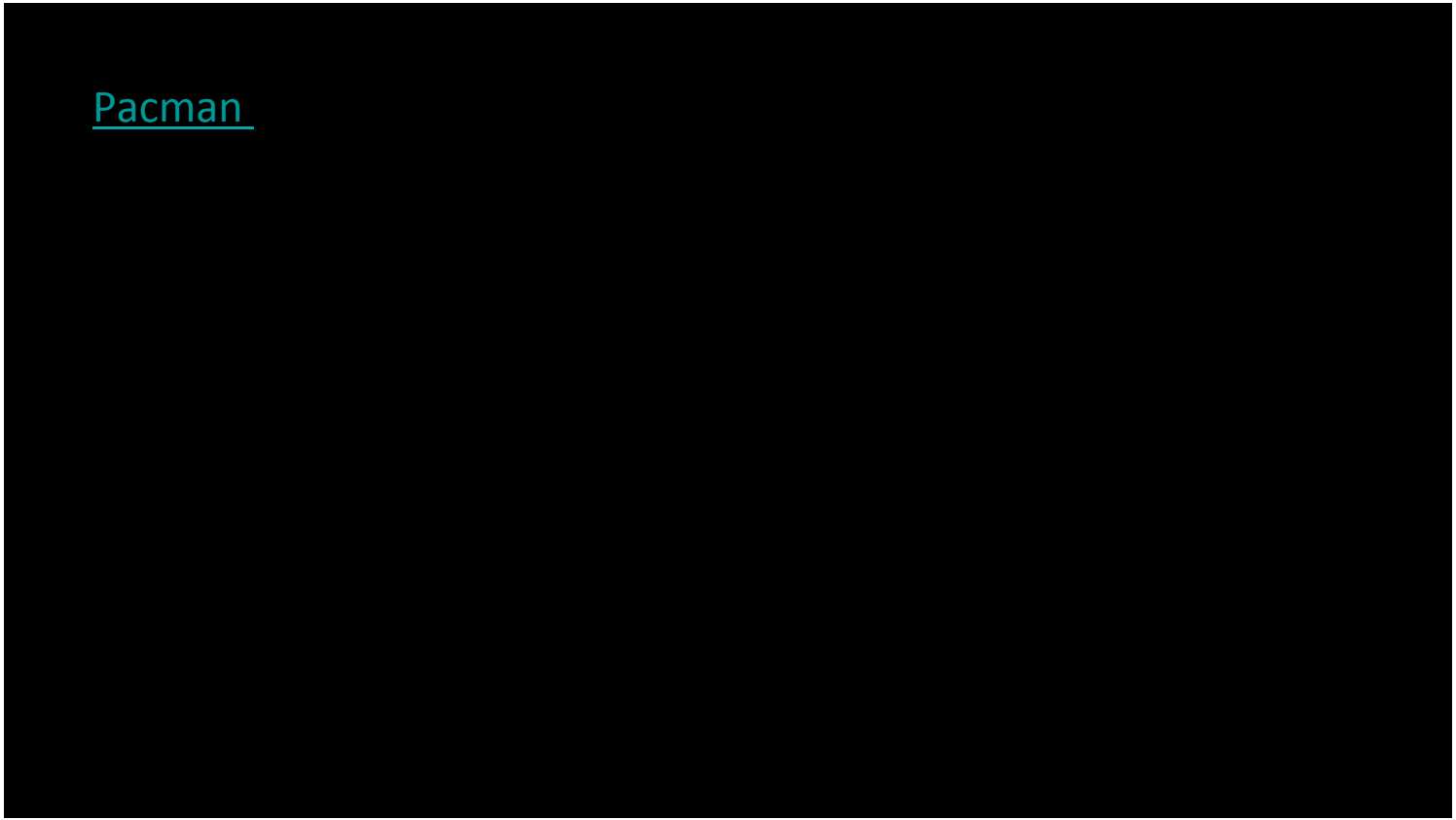




Pac-Man is a registered trademark of Namco-Bandai Games, used here for educational purposes

Demo1: pacman-l1.mp4

Pacman Demo



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, …