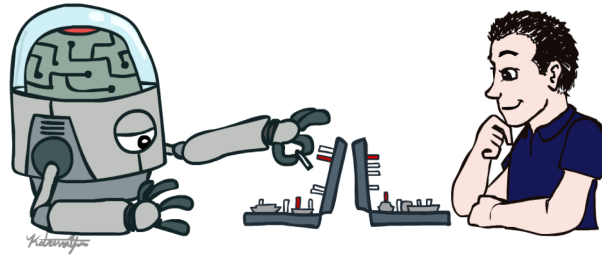


# CS 188: Artificial Intelligence

## Introduction



Pieter Abbeel & Dan Klein  
University of California, Berkeley

## Course Staff

### Professors



Pieter Abbeel

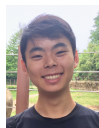


Dan Klein

### GSIs



Aditya Baradwaj  
(Head GSI)



Alex Li



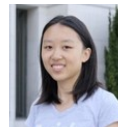
Daniel Ho



David Gaddy



Ignasi Clavera



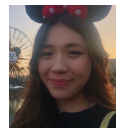
Jasmine Deng



Jonathan Ho



Katie Luo



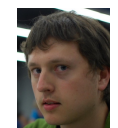
Laura Smith



Mitchell Stern



Nikhil Sharma



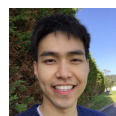
Nikita Kitaev



Noah Golmant



Ronghang Hu



Thanard Kurutach



Wilson Yu

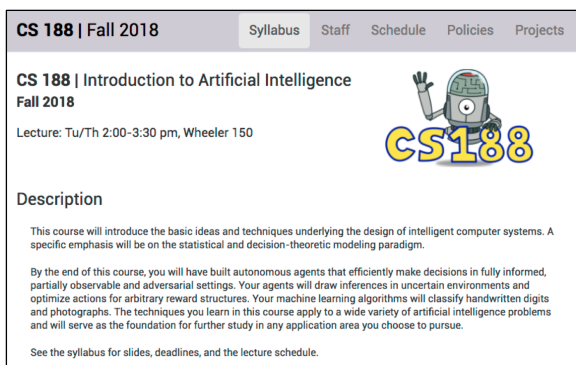


Yi Wu

# Course Information

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<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

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- **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

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- Midterm 1: October 9<sup>th</sup>, 7:30-9:30pm
- Midterm 2: November 15<sup>th</sup>, 7:30-9:30pm
- Final Exam: December 11<sup>th</sup>, 8-11am
  
- There will be no alternate exams

## Discussion Section (Optional Attendance)

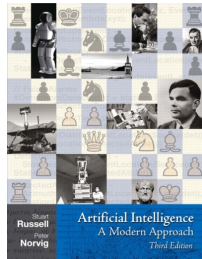
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- Topic: review / warm-up exercises
- Currently, none of you are assigned to sections
- You are welcome to attend any section of your preference
- Piazza survey later this week to help keep sections balanced
  
- From past semesters' experience we 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

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



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

# Laptops in Lecture

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- Laptops can easily distract students behind you  
Please consider sitting towards the back if using your laptop in lecture

# Announcements This Week

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- **Important this week:**

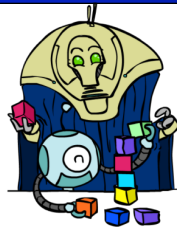
- **Check out website:** <https://inst.eecs.berkeley.edu/~cs188/fa18>
- **Register on Gradescope and Piazza** (check your email for links)
- **HW0: Math self-diagnostic** is online now (due on Monday 8/27 at 11:59pm)
- **P0: Python tutorial** is online now (due on Monday 8/27 at 11:59pm)
- **One-time (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

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Instruction

Grow knowledge, collaborate,  
work until success



Assessment

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

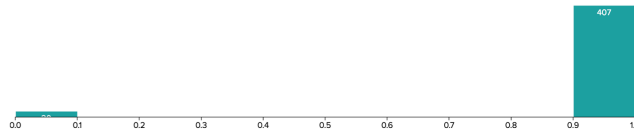
### Our experience: these two goals don't mix

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

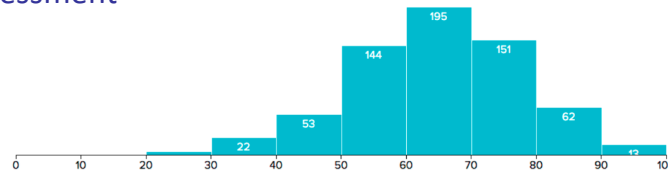
# Some Historical Statistics

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



- Exams: assessment

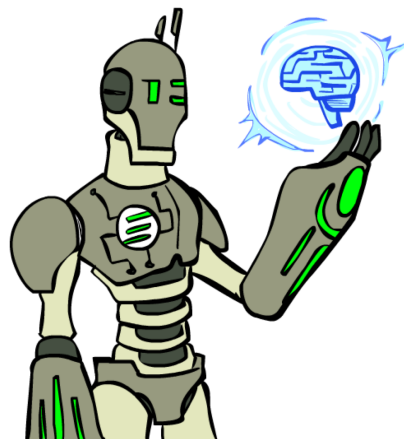


- New this year: written component to homework ( = old exam questions)
- Suggestion: assess yourself by first spending some time working alone

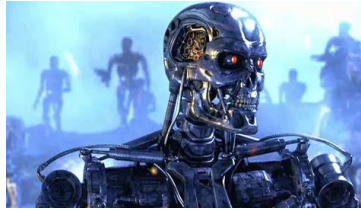
## Today

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



## Sci-Fi AI?



## News AI?



### HEALTH AND SCIENCE

BIOTECH AND PHARMA | HEALTH INSURANCE | HOSPITALS | SCIENCE

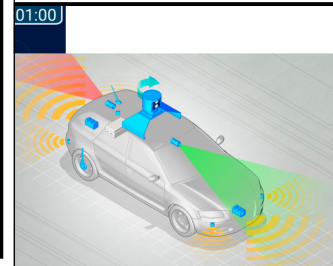
	Clardic Fug	112	113	84
	Snowbonk	201	199	165
	Catbabel	97	93	68
	Bunflow	190	174	155
	Ronching Blue	121	114	125
	Bank Butt	221	196	199
	Caring Tan	171	166	170

**A.I. can transform  
we know it.  
they should slow**

Artificial Intelligence

**Stephen Hawking: 'I fear AI may  
replace humans altogether'**

Musk was speaking to US governors. CREDIT: AP



# What is AI?

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The science of making machines that:

## Rational Decisions

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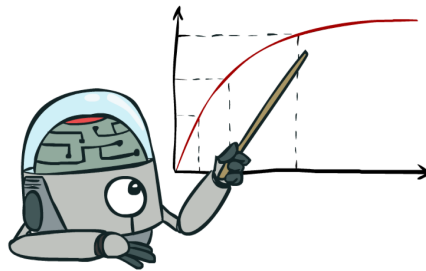
We'll use the term **rational** in a very specific, technical way:

- 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?

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- 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

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- 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

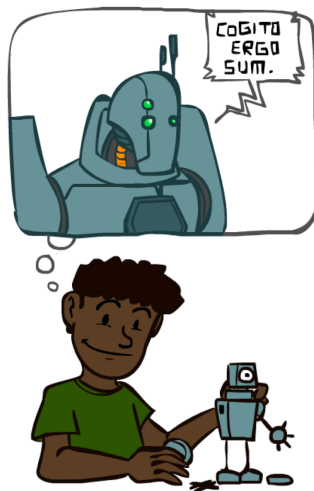
- Throughout: Applications

- Natural language, vision, robotics, games, ...



## A (Short) History of AI

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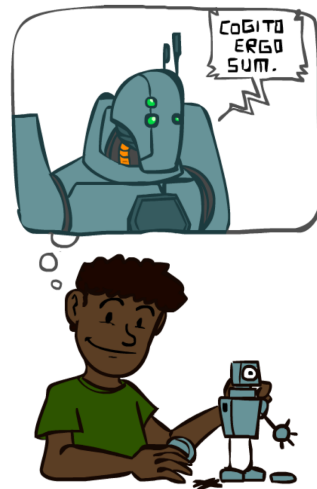




# “the thinking machine”

## A (Short) History of AI

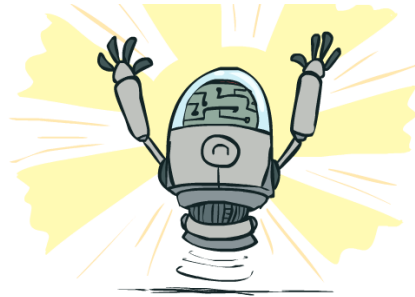
- **1940-1950: Early days**
  - 1943: McCulloch & Pitts: Boolean circuit model of brain
  - 1950: Turing's “Computing Machinery and Intelligence”
- **1950—70: Excitement: Look, Ma, no hands!**
  - 1950s: Early AI programs, including Samuel's checkers program, Newell & Simon's Logic Theorist, Gelernter's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



**Janelle Shane**  
@JanelleCShane

Follow

Tried retraining the neural net on just "what do you get when you cross a X with a X?" jokes. Results did not improve. And for some reason, bungees are its favorite thing.

What do you get when you cross a dog and a vampire? A bungee

What do you get when you cross a gorilla and a bull? A spider.

What do you get when you cross a cow with a rhino? A bungee with a dog.

What do you get when you cross a mountain and a bungee and a cow? A cow with a rhinocero.

What do you get when you cross a street and a bungee with a cow? A bungee and a pig with a cow.

What do you get when you cross a street and a cow? A bungee with a bungee and a rhino.

What do you get when you cross a pig with a cow with a party? Because the engineers with a dog.


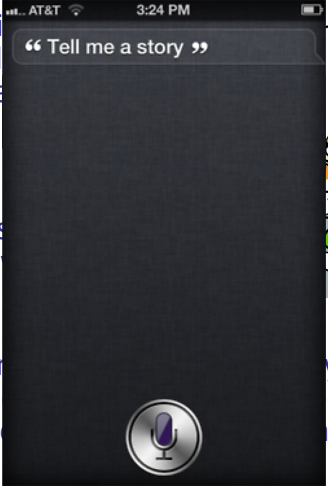
What do you get when you cross a weee and a rooster? I don't know that wouldn't deer.

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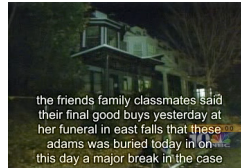


[Shank, Tale-Spin System, 1984]

# Natural Language

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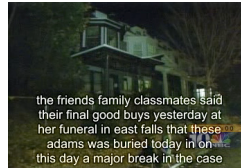
- Speech technologies (e.g. Siri)
  - Automatic speech recognition (ASR)
  - Text-to-speech synthesis (TTS)
  - Dialog systems



# Natural Language

- Speech technologies

- Automatic speech recognition (ASR)
- Text-to-speech synthesis (TTS)
- Dialog systems



- Language processing technologies

- Question answering
- Machine translation



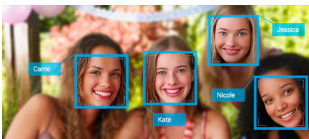
- Web search
- Text classification, spam filtering, etc...

## Vision (Perception)

PIXELS -> INFO/DECISION

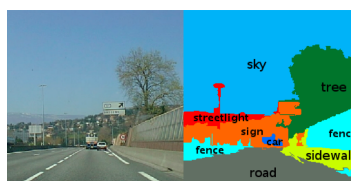
E.g.:

### Face detection and recognition



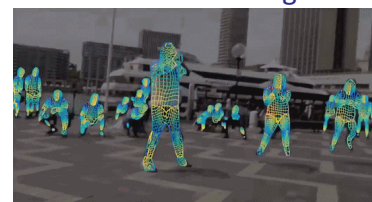
Source: TechCrunch

### Semantic Scene Segmentation

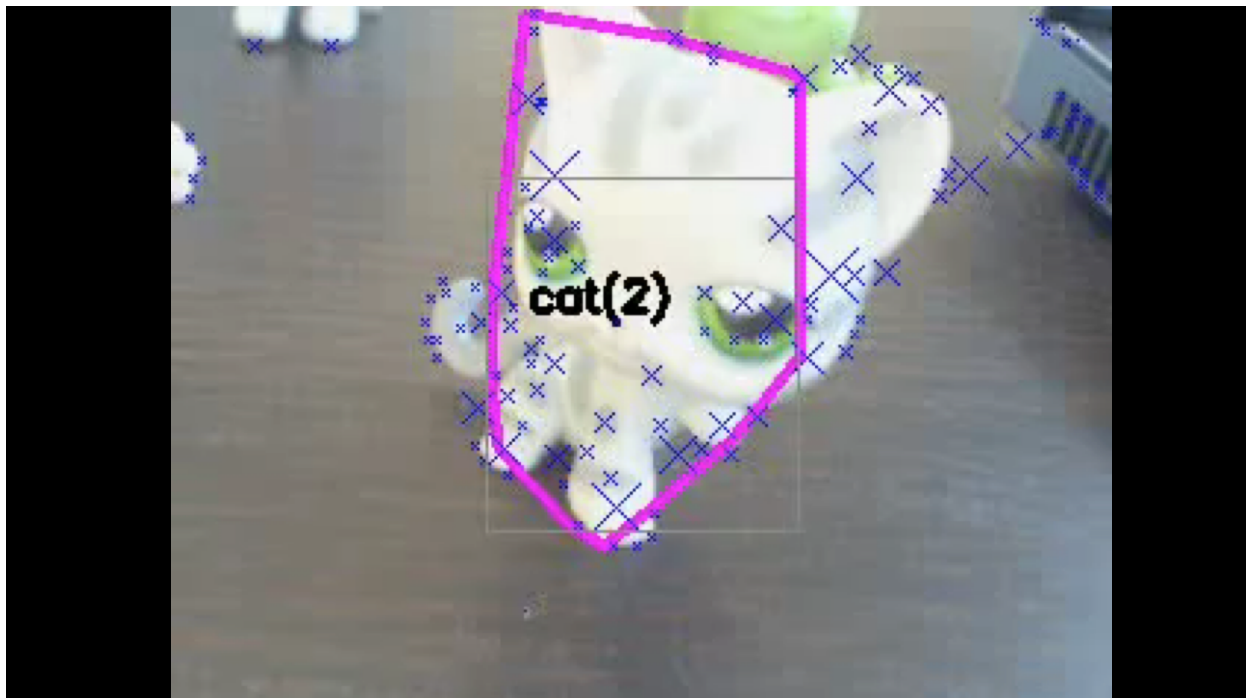


[Caesar et al, ECCV 2017]

### 3-D Understanding



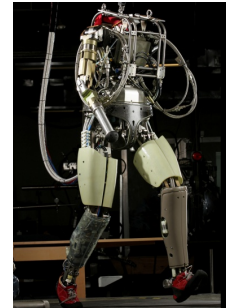
[DensePose]





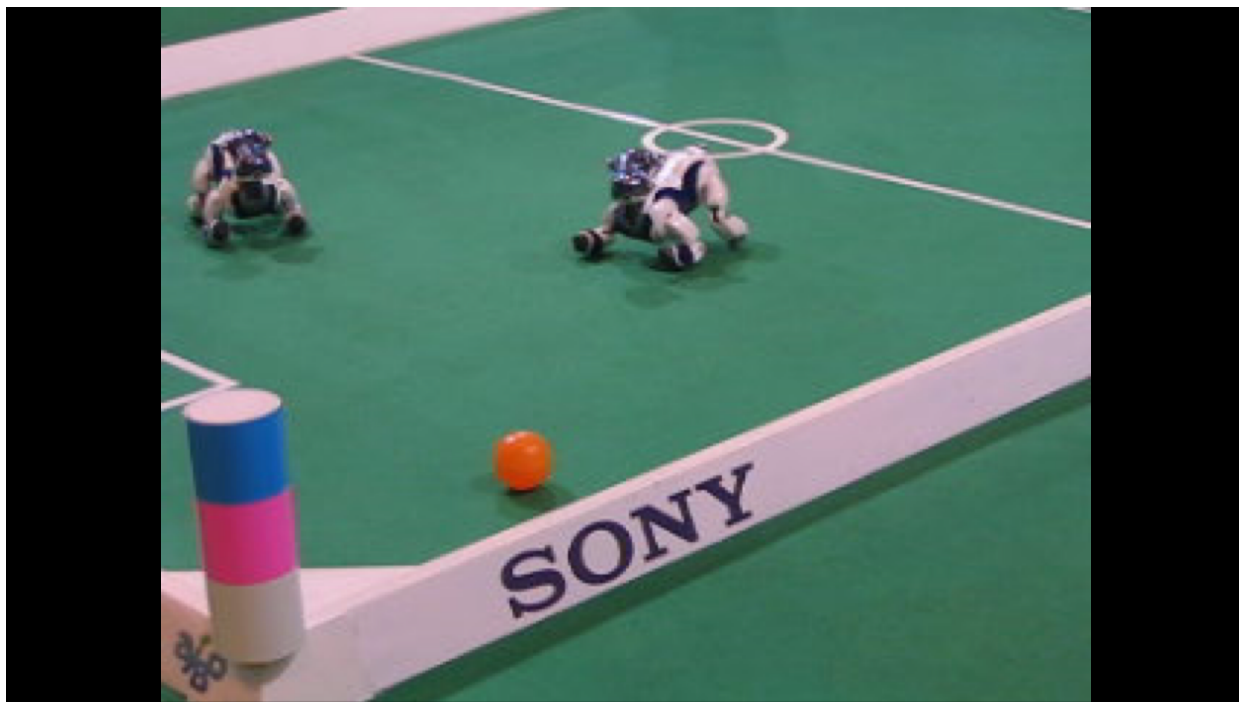
# Robotics

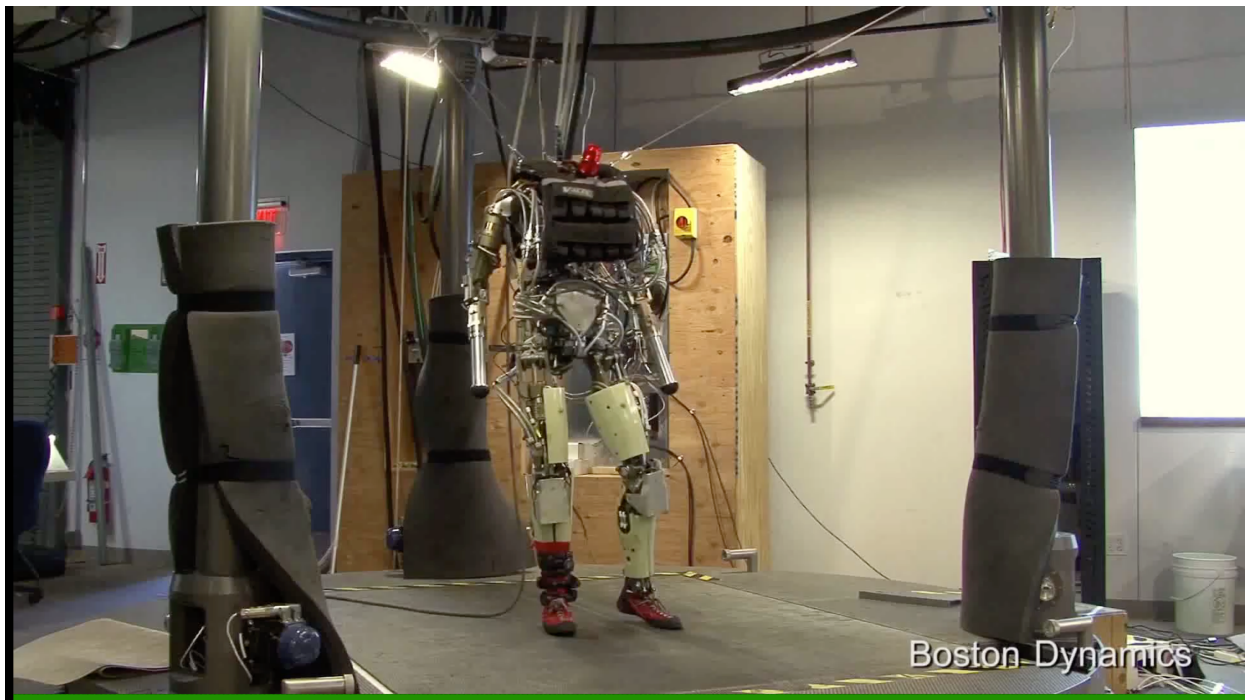
- Robotics
  - Part mech. eng.
  - Part AI
  - Reality much harder than simulations!
- Technologies
  - Vehicles
  - Rescue
  - Soccer!
  - Lots of automation...
- In this class:
  - We ignore mechanical aspects
  - Methods for planning
  - Methods for control



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!)

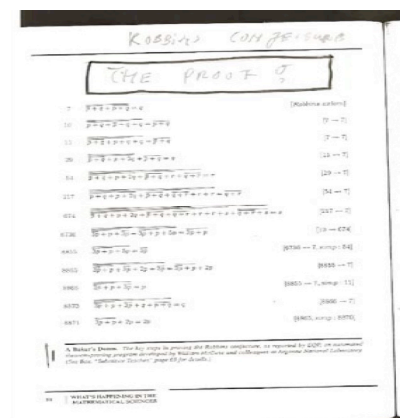


Image from Bart Selman

# AI is starting to be everywhere...

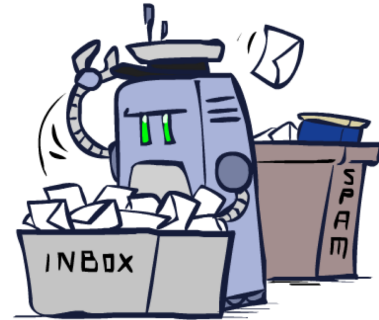
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## ■ Applied AI automates all kinds of things

- 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

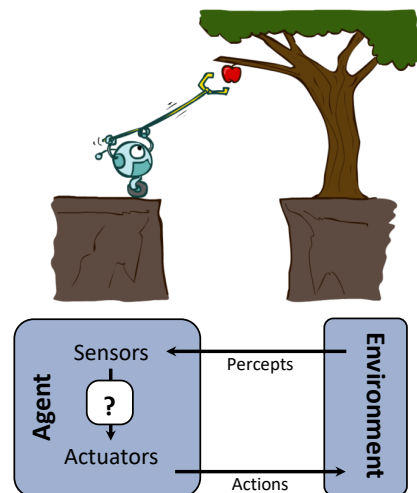
■ ... Lots more!



## Designing Rational Agents

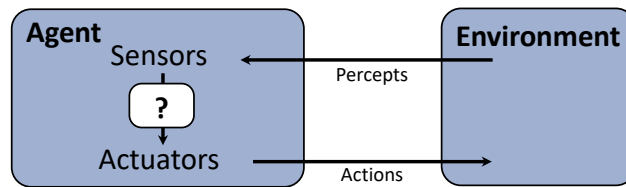
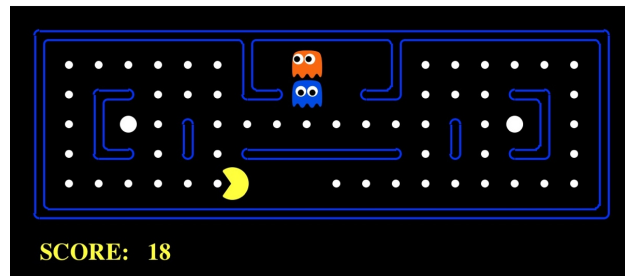
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- An **agent** is an entity that *perceives* and *acts*.
- A **rational agent** selects actions that maximize its (expected) **utility**.
- Characteristics of the **percepts**, **environment**, and **action space** dictate techniques for selecting 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

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