

CS 325: Artificial Intelligence

Tuesday, Thursday 11-12:30

MCS W301

Instructor: Eugene Agichtein (<http://www.mathcs.emory.edu/~eugene/>)

Course homepage: <http://www.mathcs.emory.edu/~eugene/~cs325/>

Introduction to Artificial Intelligence



➤ Logistics

- **What is Artificial Intelligence?**
- Main course topics
- Python and Project 0

Course Staff

- **Instructor: Eugene Agichtein (Ah-Ghi-Sh-teyn)**

Professor at Emory: since 2006. Information Retrieval, Text and Data mining, and Natural Language Processing

<http://www.mathcs.emory.edu/~eugene/>

- **TAs:**

- **Payam Karisani**, CS PhD student
Information retrieval & social media
email: payam.karisani@emory.edu
Office hours: Tuesdays 3-5



- **Rafi Haque**, MD/PhD student
Research: neuroscience, memory, vision
rhaque2@emory.edu
Office hours: Thursdays 4-6

Course Information



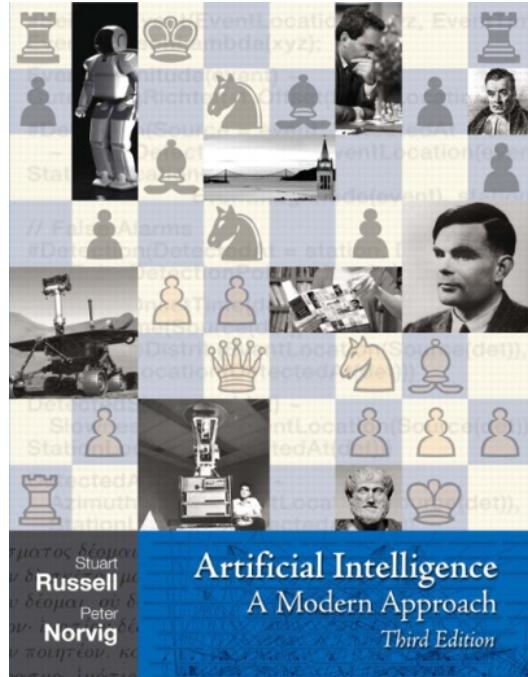
- Course content (lectures, assignments, discussions) on **Piazza**:
<https://piazza.com/emory/spring2017/cs325/>
- Course structure:
 - 6 projects in Python:
 - First 5: done individually, autograded (test cases provided).
 - Last project: done in groups of 2 or 3 (more details TBA).
 - Occasional written homework
 - Exams:
 - Midterm, Final

Expectations



- Prerequisites:
 - CS323 (data structures) or equivalent
 - Object oriented programming (Java or Python)
 - Probability & Stats, basic linear algebra
- Work and grading:
 - 1+5 projects: 50 %
 - Midterm Exam: 20%
 - Final Exam: 27%
 - Participation, in class or Piazza: 3%

Textbook



Russell & Norvig,
AI: A Modern Approach,
3rd Ed.

- Officially required and strongly encouraged, but can get away with just lecture notes and online content.
- N.B.: Good reference book for general AI

Important To Do This Week



- **Register** for the class on Piazza: main resource for content and communication and discussion:
<https://piazza.com/emory/spring2017/cs325/>
- **Get started** on “project” 0 (P0): Python tutorial assigned, due Friday January 20 at 17:00 EST.
- 1-time optional “python clinic” on Wednesday 1/18, time TBA
- **Office hours** start next week, but you can talk to me after class today or Thursday.

Introduction to Artificial Intelligence



✓ Logistics

- **What is Artificial Intelligence?**
- Main course topics
- Python and Project 0

[Slides based on Dan Klein and Pieter Abbeel]

What Is “Intelligence”?



- Thought processes: ← Psychology, Cognitive Science
- Acting Intelligently?
 - What does that mean?
- One definition of “intelligence” is rationality: act in a manner to optimize some utility function (happiness, wealth, fame, etc).

➤ Are people intelligent?

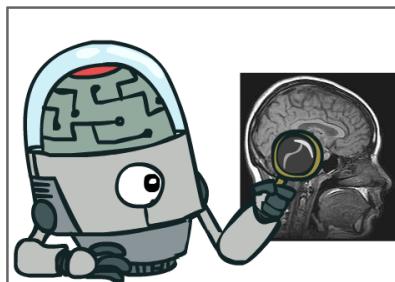
Sci-Fi AI?



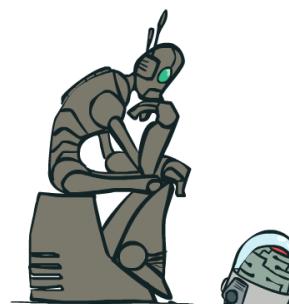
What is AI?

The science of making machines that:

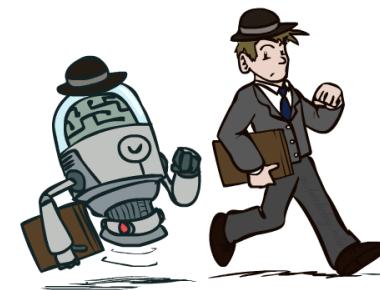
Think like people



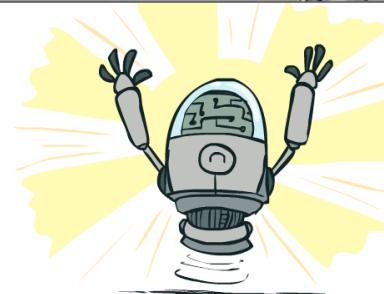
Think rationally



Act like people



Act rationally



Artificial Rationality

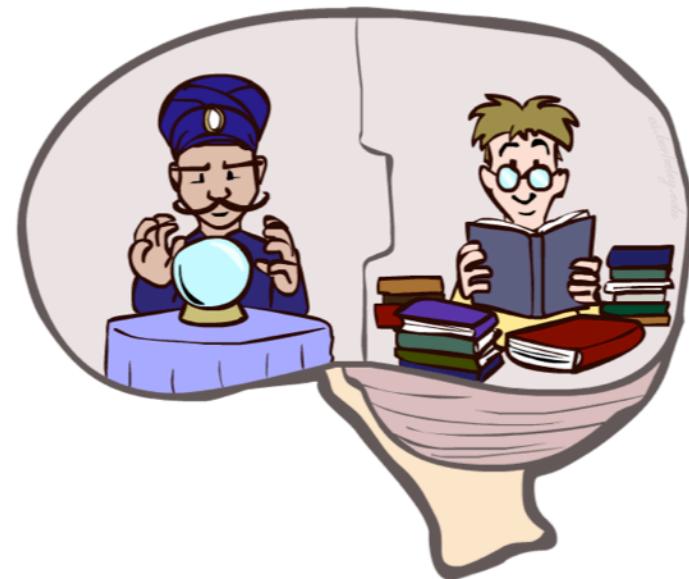


We'll use the term **rational** in a very specific way:

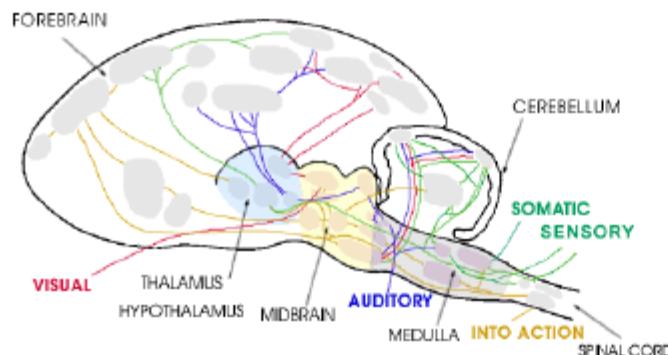
- Rational: maximally achieving pre-defined goals
- Rationality only concerns what decisions are made
(not the thought process behind them)
- Goals are expressed in terms of the **utility** of outcomes
- Definition: rational means **maximizing your expected utility**

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



Can We Build It?



10^{11} neurons
 10^{14} synapses
cycle time: 10^{-3} sec

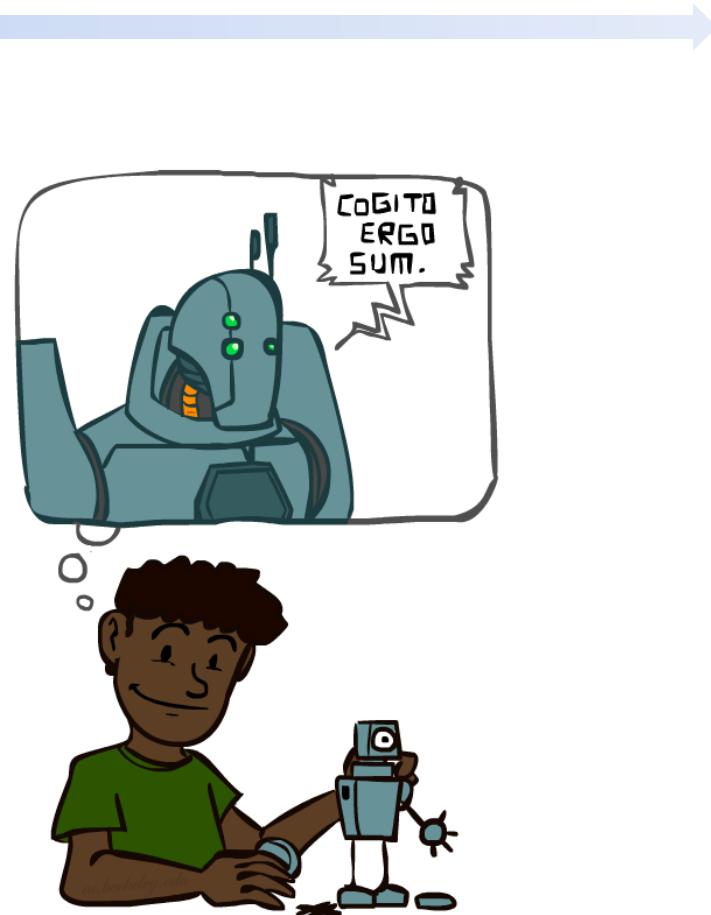
VS.

10^9 transistors
 10^{12} bits of RAM
cycle time: 10^{-9} sec



A (Short) History of AI

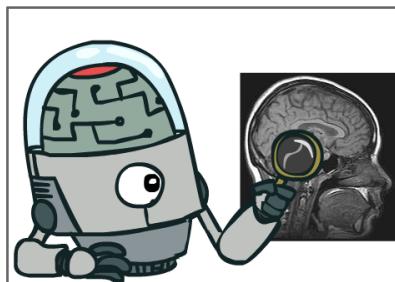
- 1940-1950: Early days
 - 1943: McCulloch & Pitts: Boolean circuit model of brain
 - 1950: Turing's "Computing Machinery and Intelligence"
- 1950–70: Excitement: Look, Ma, no hands!
 - 1950s: Early AI programs, including Samuel's checkers program, Newell & Simon's Logic Theorist, Gelernter's Geometry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



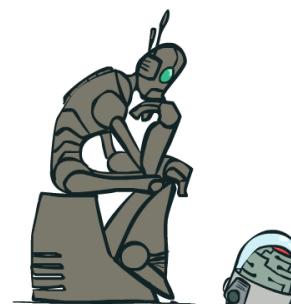
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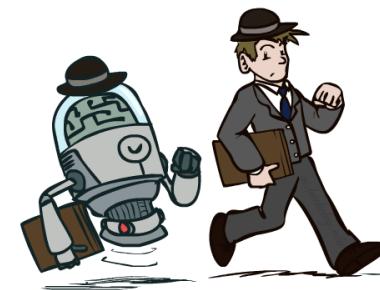
Think like people



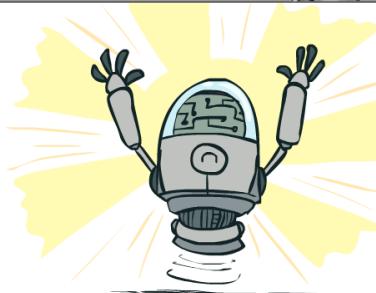
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Act like people



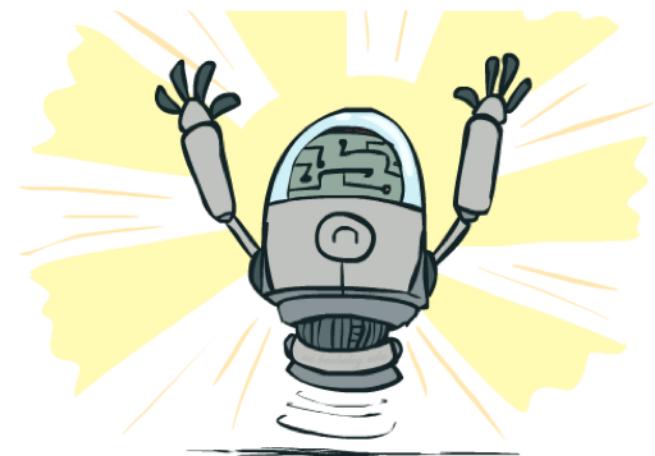
Act rationally



What Can AI Do?

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

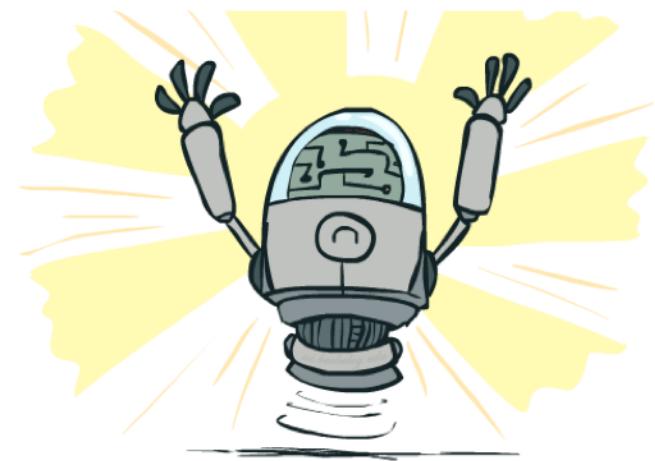
- Play a decent game of table tennis?
- Play a decent game of Jeopardy?
- Drive safely along a curving mountain road?
- Drive safely along Peachtree Street?
- Buy a week's worth of groceries on the web?
- Buy a week's worth of groceries at Publix?
- Discover and prove a new mathematical theorem?
- Converse 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?



What Can AI Do?

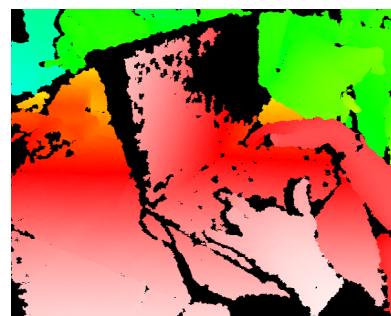
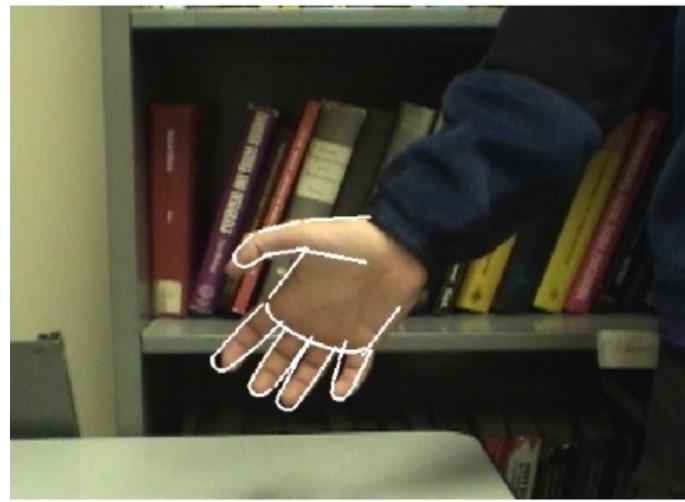
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Vision (Perception)

- Object and face recognition
- Scene segmentation
- Image classification



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

Brownies Anyone?

https://www.youtube.com/watch?v=iqv_WrPfFn0

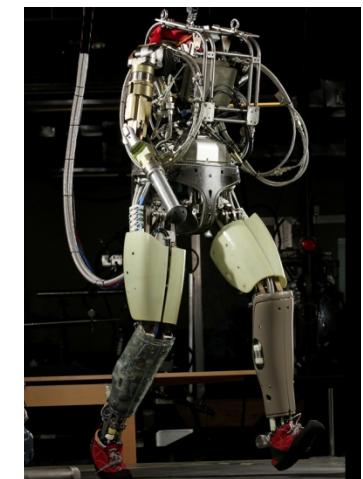
BakeBot: Motion Planning for Cooking

Mario Bollini and Daniela Rus
CSAIL, MIT



Robotics (not focus of class)

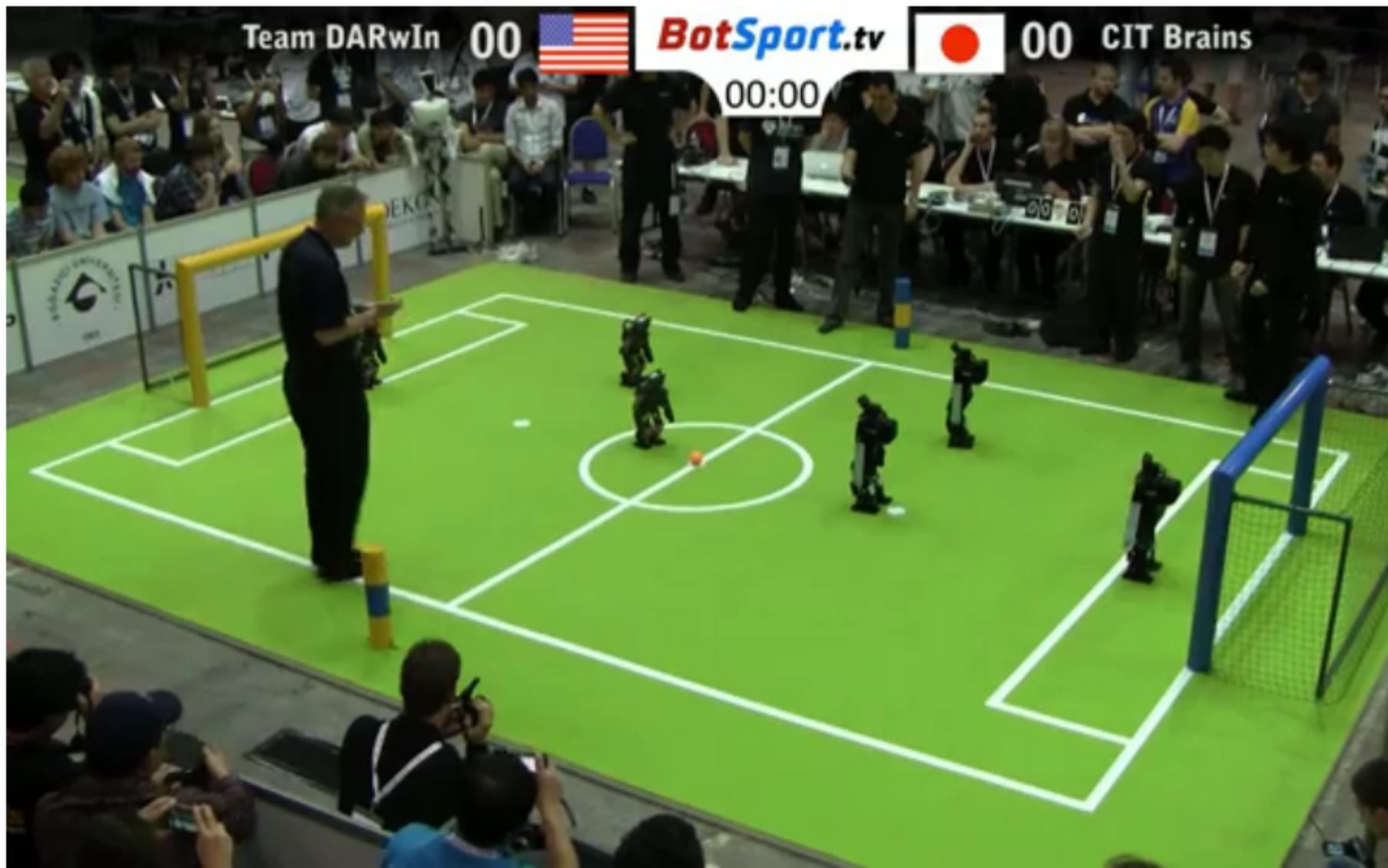
- Robotics
 - Part mech. eng.
 - Part AI
 - Reality much harder than simulations!
- Technologies
 - Vehicles
 - Rescue
 - Soccer!
 - Lots of automation...
- In this class:
 - We ignore mechanical aspects
 - Methods for planning
 - Methods for control



Images from UC Berkeley, Boston Dynamics, RoboCup, Google

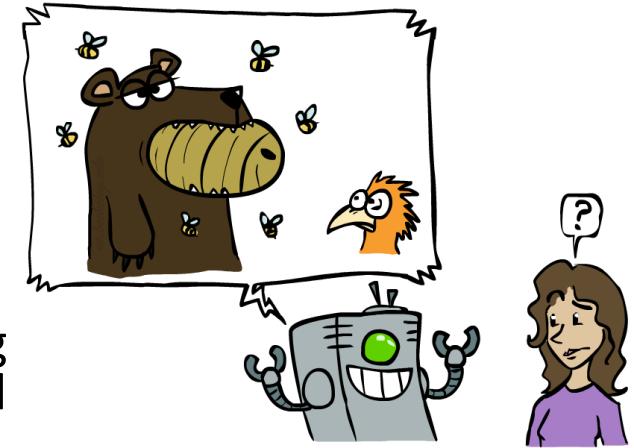
<https://www.youtube.com/watch?v=KfNRXTS55nY>

Robocup



Unintentionally Funny Stories

- One day Joe Bear was hunting for food. He saw Irving Bird where some honey bees were flying around. He noticed that there was a beehive in the tree. He ate the honey and the bees stung him. The End.
 - Henry Squirrel was thirsty. He was walking along the river bank where his good friend, Mr. Fox, lived. Henry slipped and fell in the water. He was very wet and cold. The End.
 - Once upon a time there was a crow who lived in a tree. A mouse was sitting in his tree. The mouse noticed that he was holding a piece of cheese. The mouse swallowed the cheese. The crow was very angry. The End.

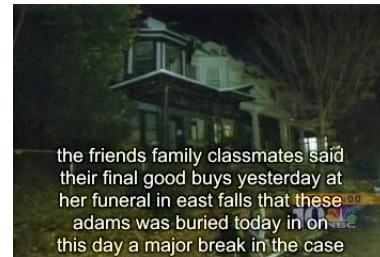


a vain crow. One day the
eese in his mouth. He
He became hungry, and
the crow. The End.

[Shank, Tale-Spin System, 1984]

Natural Language

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



Simultaneous, with original voice pitch (French \leftrightarrow English demo:)

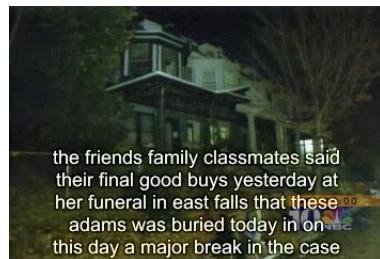
<https://www.youtube.com/watch?v=NhxCg2PA3ZI>

Chinese \leftrightarrow English demo:

<https://www.youtube.com/watch?v=mWTySUGXR2k>

Natural Language Applications

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

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

Vidéo Anniversaire de la rébellion tibétaine : le China sur ses gardes

"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...

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

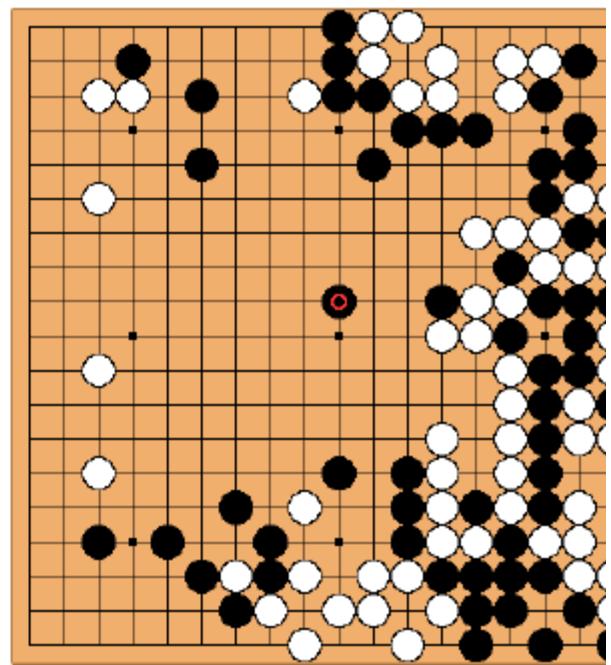
“I could feel --- I could smell --- a new kind of intelligence across the table.”
- 1997: Deep Blue Beats Kasparov

“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 page

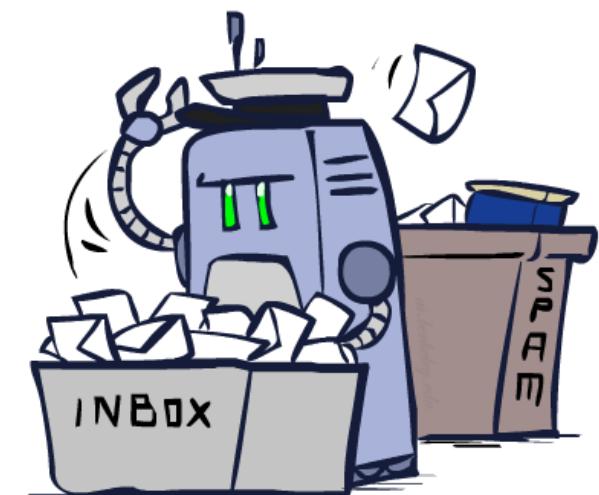
Other Games?



<https://www.youtube.com/watch?v=Y2wQQ-xSE4s>

Decision Making

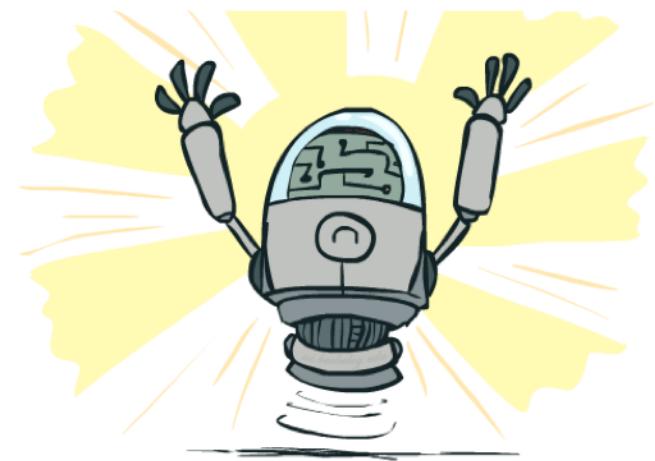
- Applied AI involves many kinds of automation
 - Scheduling, e.g. airline routing, military
 - Route planning, e.g. Google maps
 - Medical diagnosis
 - Web search engines
 - Spam classifiers
 - Automated help desks
 - Fraud detection
 - Product recommendations
 - ... Lots more!



What Can't AI Do?

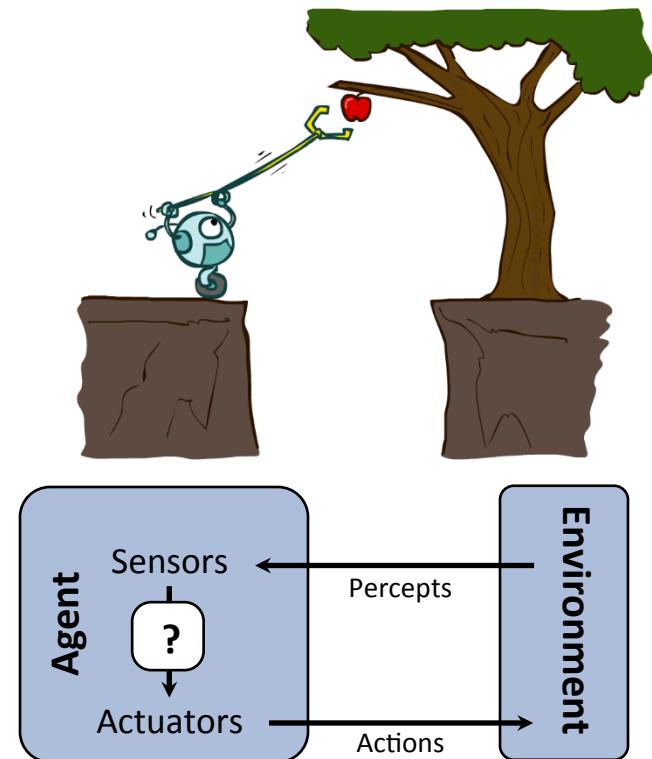
~~What Can AI Do?~~

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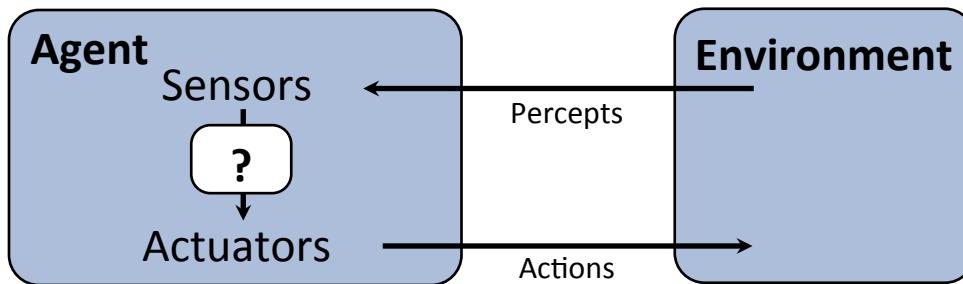
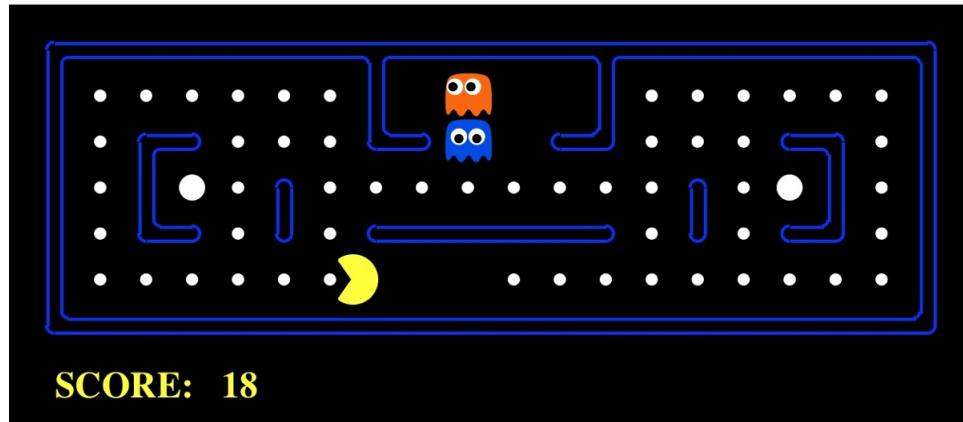


Designing Rational Agents

- 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
 - Final project: applying multiple techniques to solve a realistic problem in NLP or IR



Pac-Man as an Agent



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

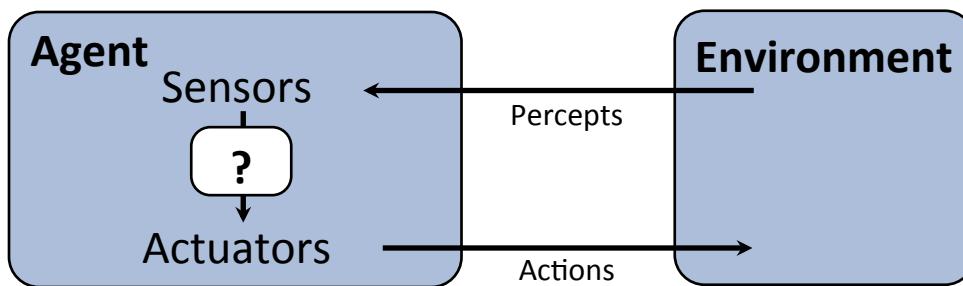
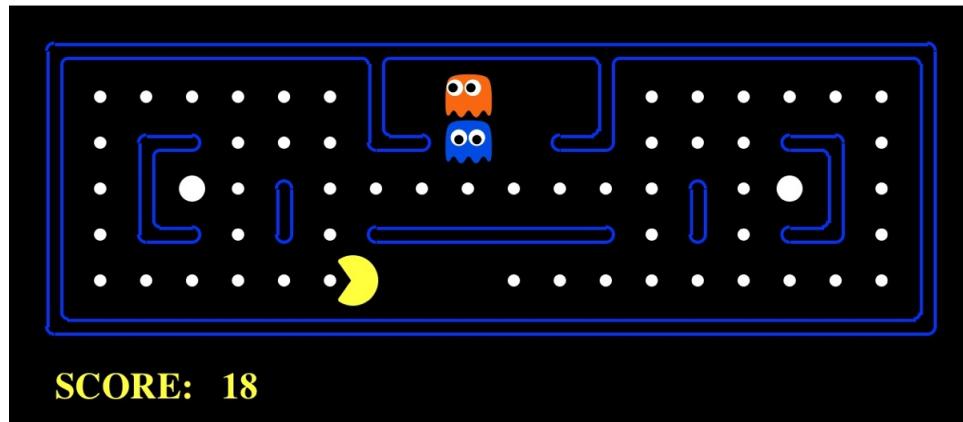
<https://www.google.com/logos/2010/pacman10-i.html>

Course Topics



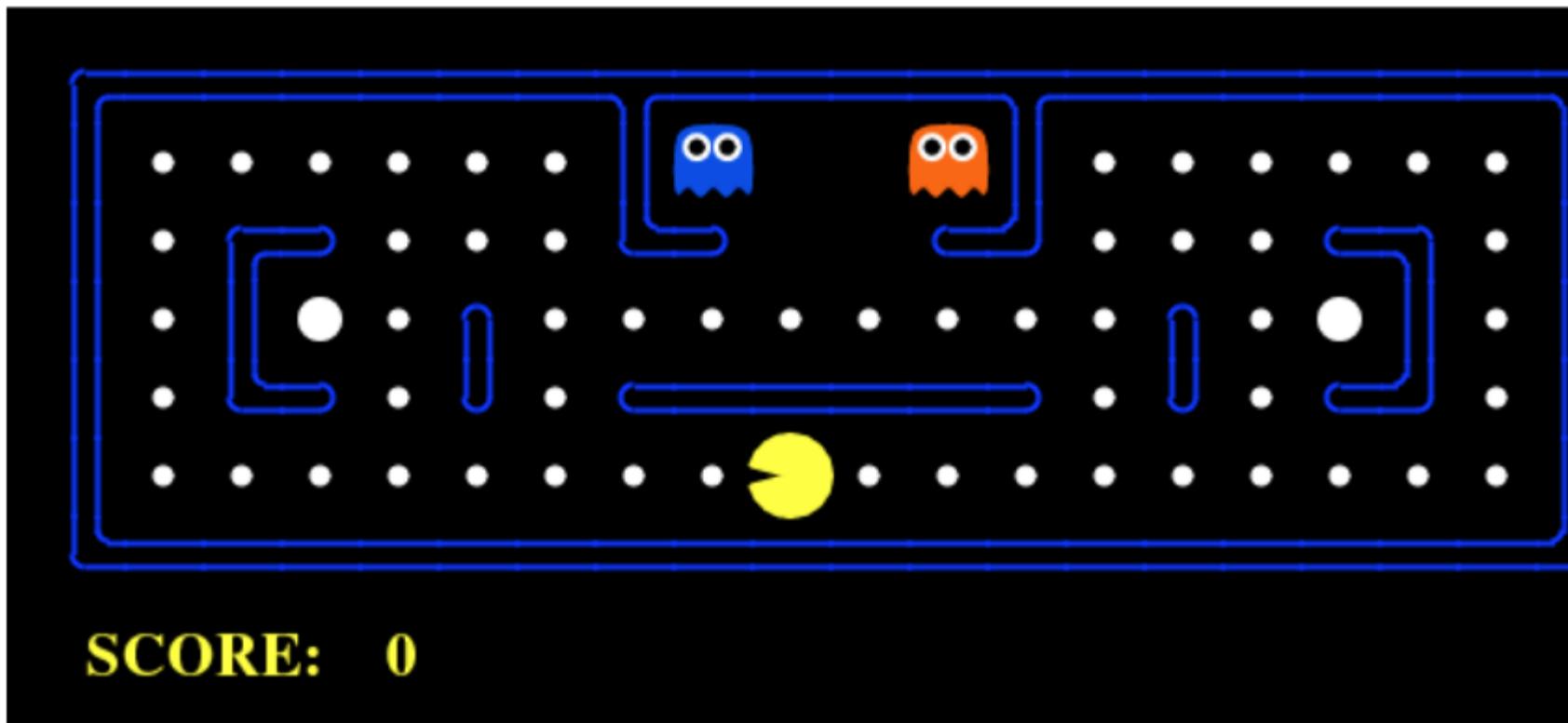
- Part 1: Making Decisions:
 - Search/planning, optimization
 - Adversarial and uncertain search, games
- Part 2: Reasoning under uncertainty:
 - Probabilistic reasoning, inference, decision making
- Part 3: Learning:
 - (Supervised), Reinforcement learning

Pac-Man as an Agent



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Assignments: Pac-man



Originally developed at UC Berkeley:

<http://www-inst.eecs.berkeley.edu/~cs188/pacman/pacman.html>

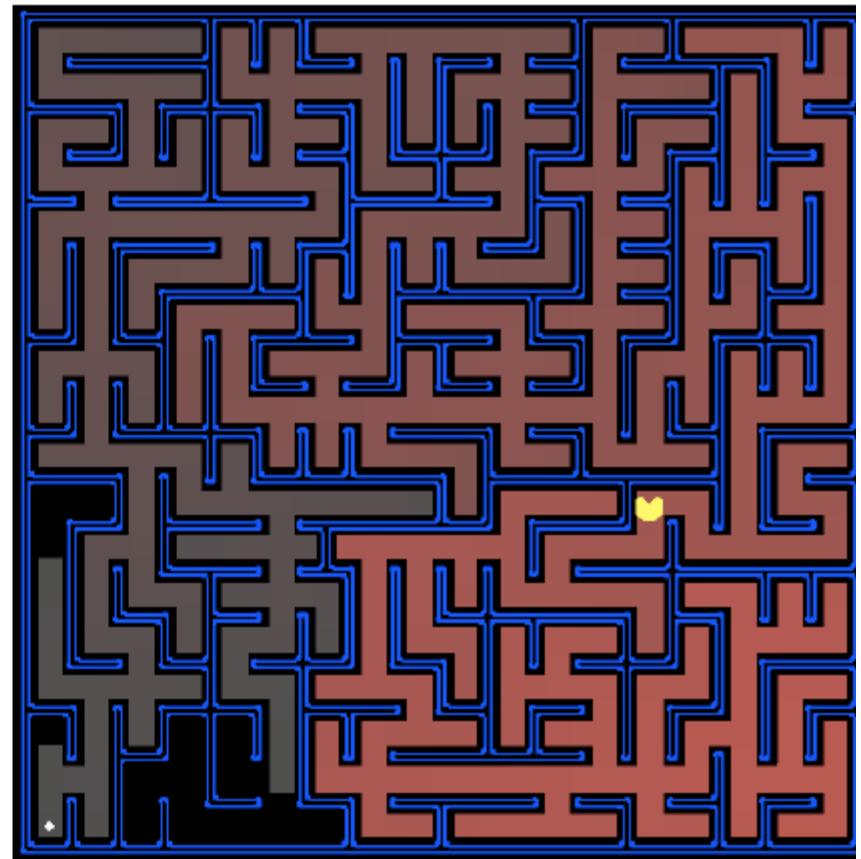
Project 1: Search

Goal:

- Help Pac-man find his way through the maze

Techniques:

- Search: breadth-first, depth-first, etc.
- Heuristic Search: Best-first, A*, etc.



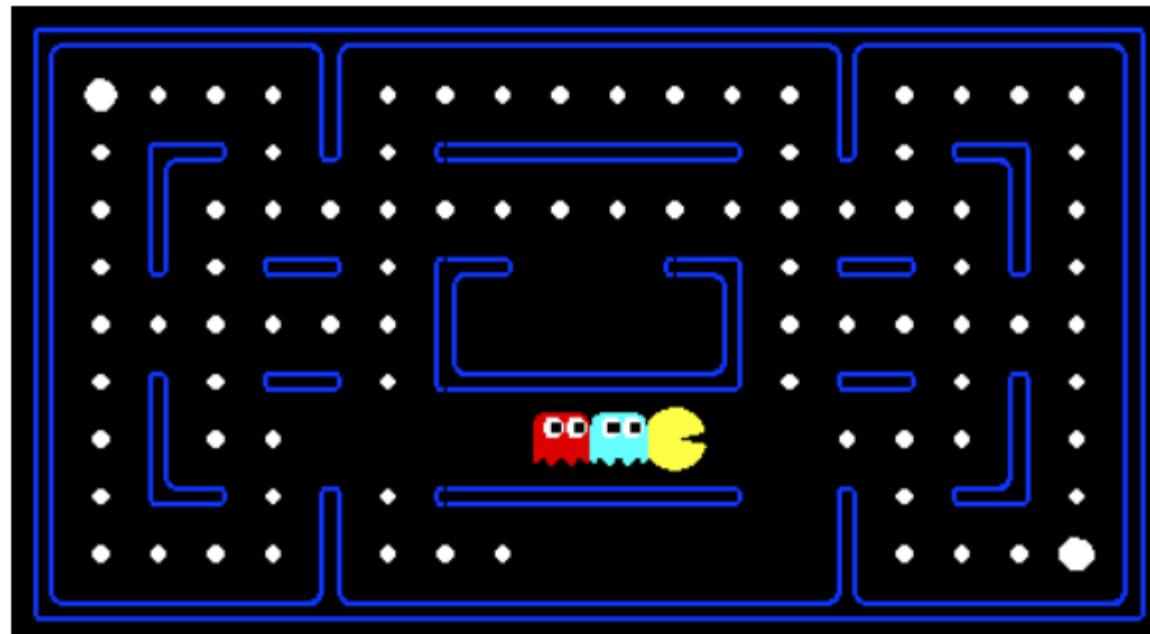
Project 2: Adversarial search (games)

Goal:

- Play Pac-man!

Techniques:

- Adversarial Search: minimax, alpha-beta, expectimax, etc.



Project 3: Uncertainty

Goal:

- Help Pac-man hunt down the ghosts

Techniques:

- Probabilistic models:
HMMs, Bayes Nets
- Inference: State estimation and particle filtering



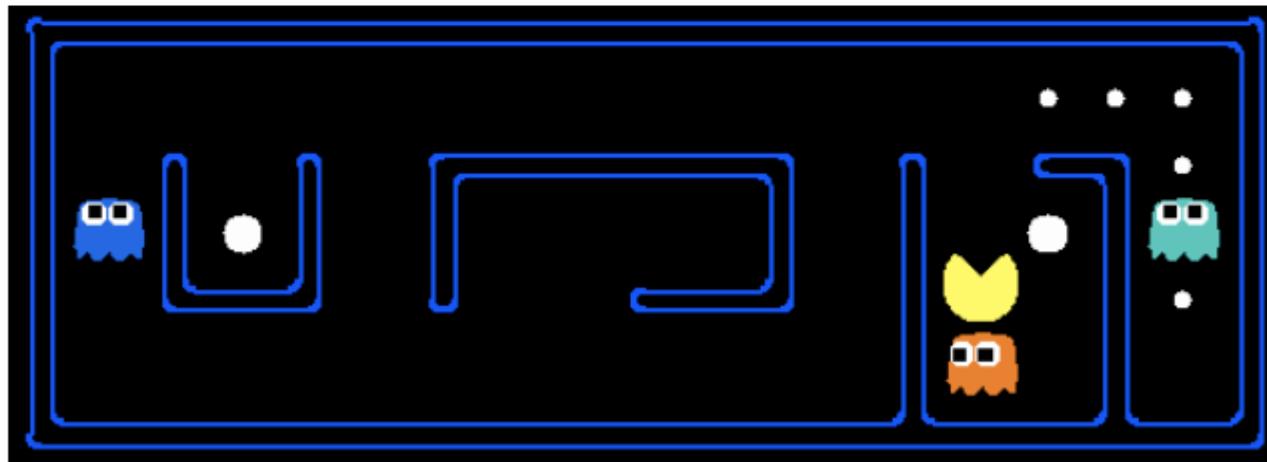
Project 4: Planning and Learning

Goal:

- Help Pac-man learn about the world

Techniques:

- Planning: MDPs, Value Iteration
- Learning: Reinforcement Learn



Project 5: More Learning



- Details TBA, two possibilities
- 1: more reinforcement learning (openAI gym)
- 2: supervised learning (image or text classification)

Python Programming Language



- The projects in this course will be in Python:
<https://www.python.org/>
- Java + good parts of interpretable languages
- Used for Web, GUI, Scientific computing, ML, etc.
- Fast, modular, and clean (unlike Perl)
- Available for all common platforms
- Editing: PyCharm (my favorite). Or text editor.
 - Pacman projects tested with Python 2.7 (not later)
- Learning resources:
 - <https://docs.python.org/2/tutorial/>
 - <http://www.learnpython.org/>

Project 0: Python tutorial



- Temporary location:
- <http://www.mathcs.emory.edu/~eugene/cs325/p0/>
- Purpose: gets you up and running with Python. You will gain more experience as the class progresses.
- Grading: out of 3 points (a freebie!)
- **Due: Friday 1/20 by 17:00 U.S Eastern time**
- What it is: hands-on tutorial with 3 exercises.

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