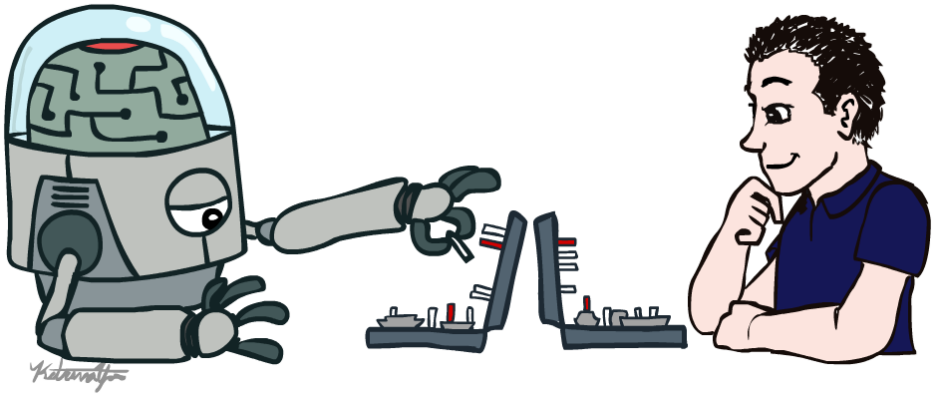
CS 5522: Artificial Intelligence II

Introduction



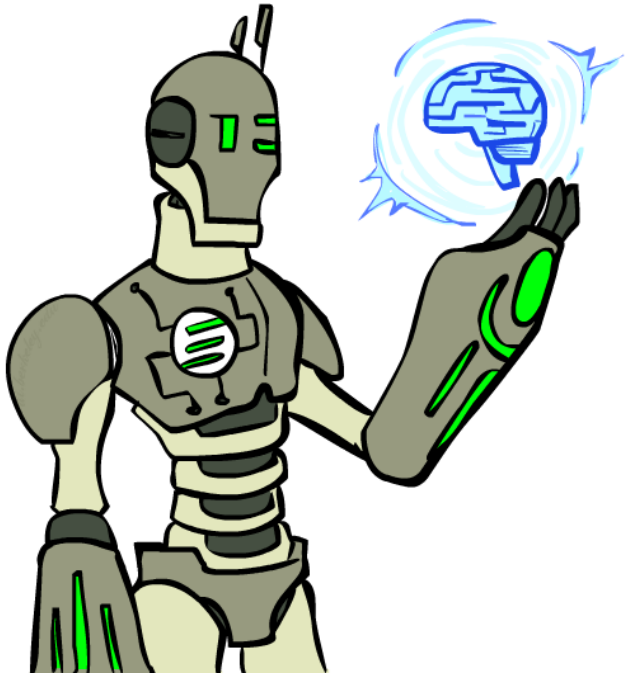
Instructor: Alan Ritter

Ohio State University

[These slides were adapted from CS188 Intro to AI at UC Berkeley. All materials available at http://ai.berkeley.edu.]

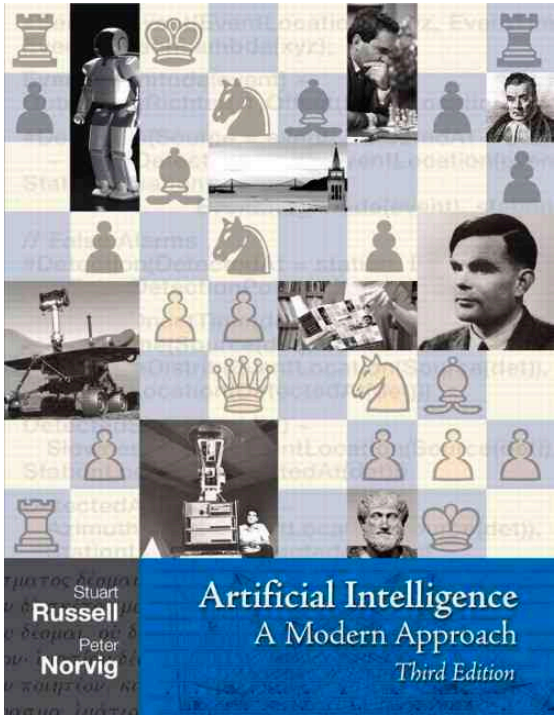
Today

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



Textbook

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



Course Webpage

Grading

Grading will be based on:

Participation (5%)

You will receive credit for asking and answering questions related to the homework on Piazza and engaging in class discussion.

Homeworks (55%)

The homeworks will include both written and programming assignments. Homework should be submitted to the Dropbox folder in Carmen by 11:59pm on the day it is due (unless otherwise instructed). Each student will have 3 flexible days to turn in late homework throughout the semester. As an example, you could turn in the first homework 2 days late and the second homework 1 day late without any penalty. After that you will loose 20% for each day the homework is late. Please email your homework to the instructor in case there are any technical issues with submission.

Midterm (20%)

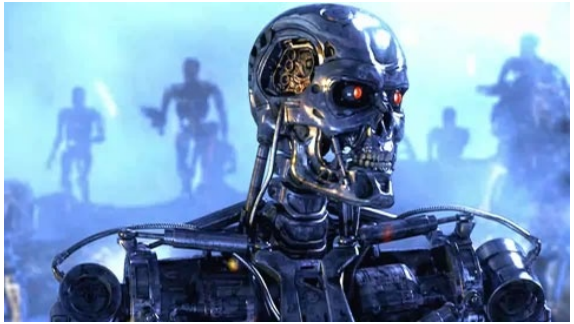
Final Exam (20%)

Prerequisites

- Probability
- Calculus
- Linear Algebra
- Python

- Lots of Math and Programming!

Sci-Fi AI?



What is AI?

The science of making machines that:

Rational Decisions

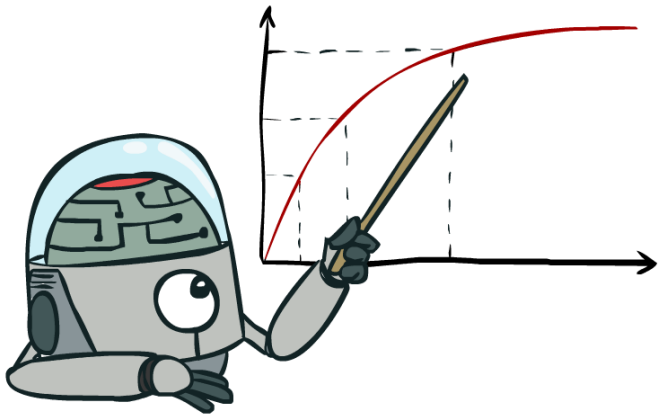
We'll use the term **rational** in a very specific, technical way:

- 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

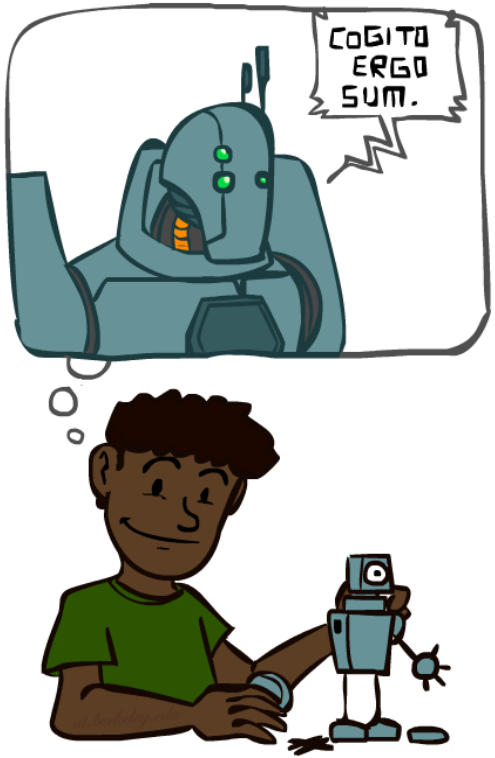
Maximize Your Expected Utility



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

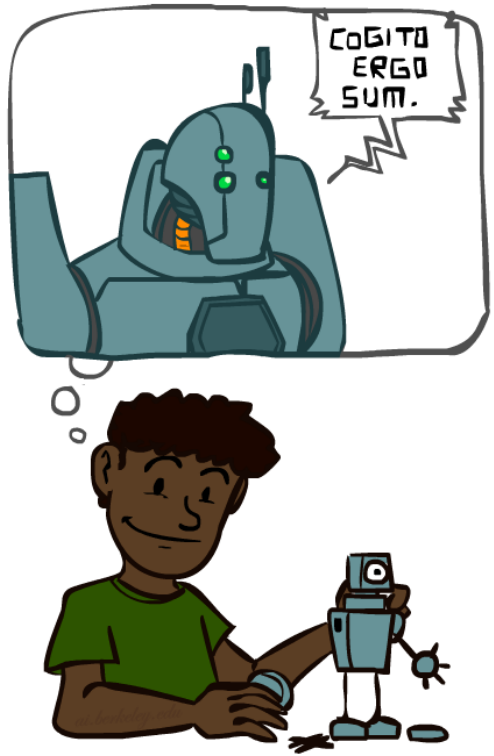
A (Short) History of AI



https://www.youtube.com/watch?v=aygSMgK3BEM

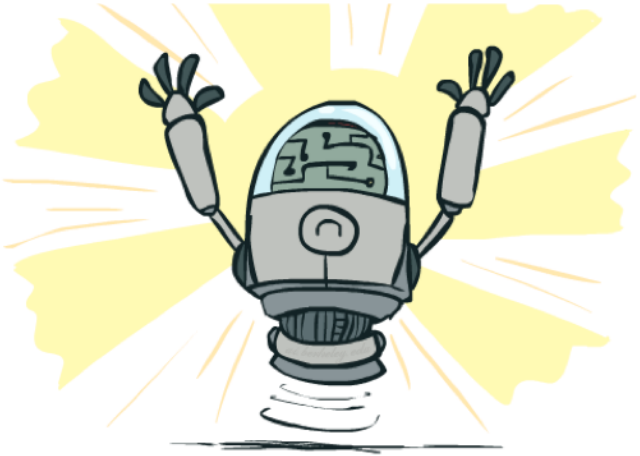
A (Short) History of AI

- 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?



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 across campus during the Michigan Game?
- ✓ Buy a week's worth of groceries on the web?
- ✗ Buy a week's worth of groceries at North Market?
- ? 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?

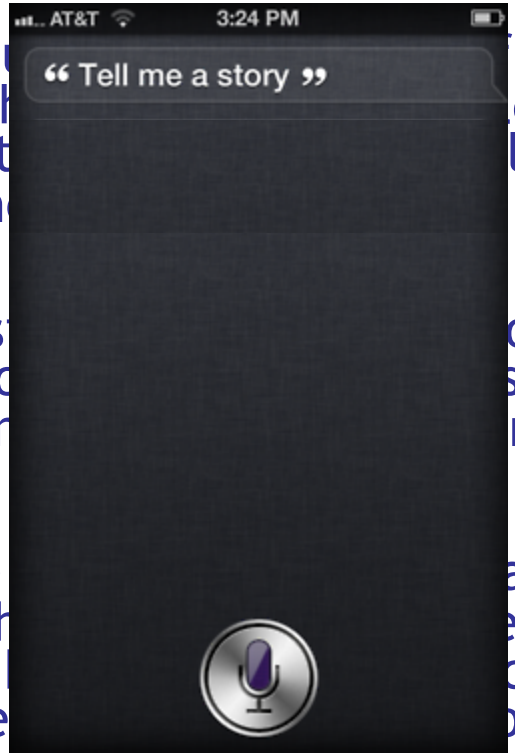


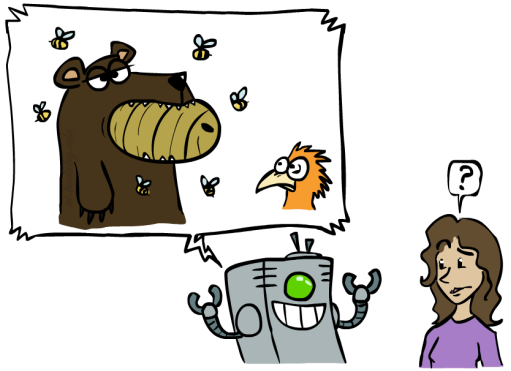
Unintentionally Funny Stories

- One day Joe Bear was hu riend Irving Bird where some h d him there was a beehive in t lked to the oak tree. He ate th

- Henry Squirrel was thirs o the river bank where his goo s sitting. Henry slipped and fell in rowned. The End.

- Once upon a time there and a vain crow. One day the crow was sitting in h ece of cheese in his mouth. He noticed that he was cheese. He became hungry, and swallowed the chee over to the crow. The End.

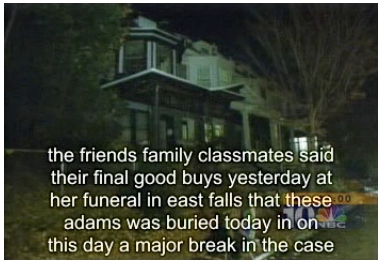




[Shank, Tale-Spin System, 1984]

Natural Language

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

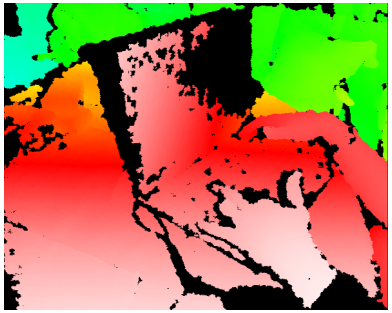


- Language processing technologies
  - Question answering
  - Machine translation

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

Vision (Perception)

- Object and face recognition
- Scene segmentation
- Image classification



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

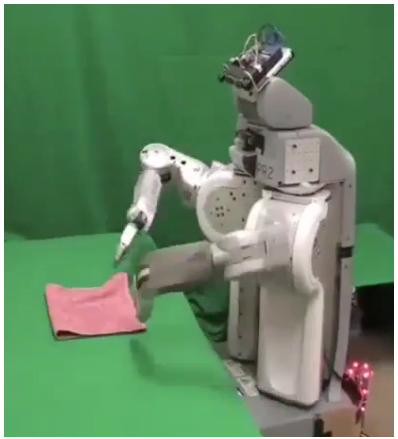
Demo1: VISION – lec_1_t2_video.flv

Demo2: VISION – lec_1_obj_rec_0.mpg

Robotics

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

- 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!)

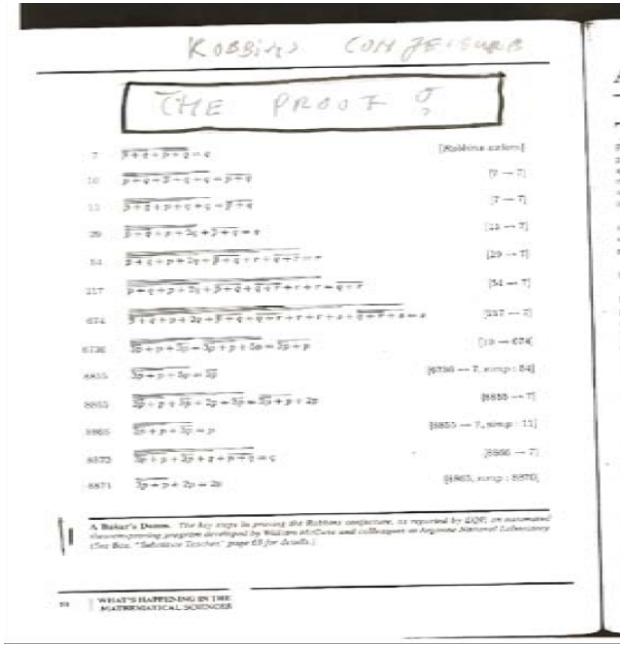
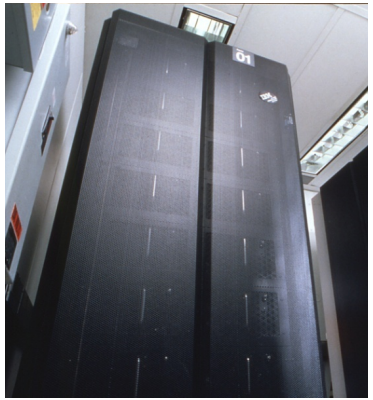


Image from Bart Selman

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



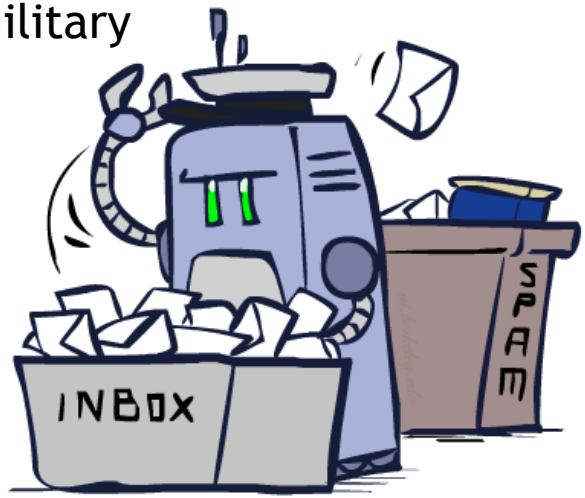
- Open question:
  - How does human cognition deal with the search space explosion of chess?
  - Or: how can humans compete with computers at all??

- 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

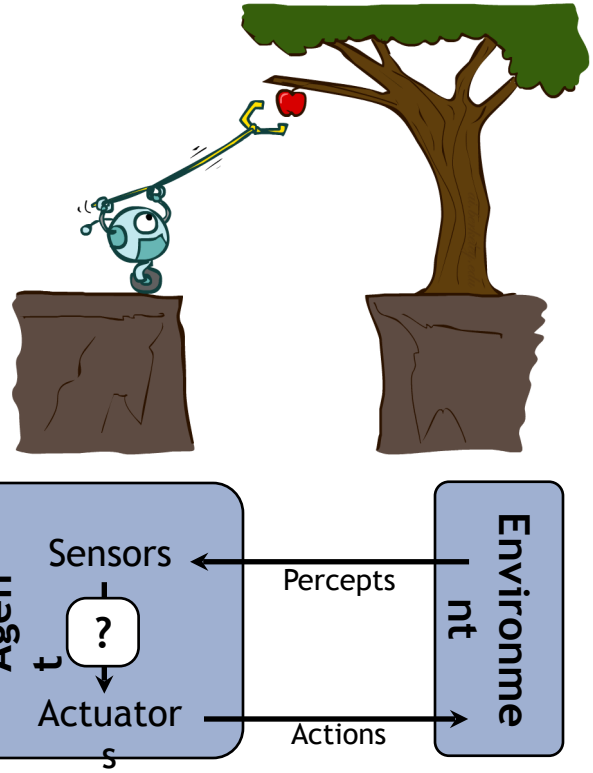
Decision Making

- 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!

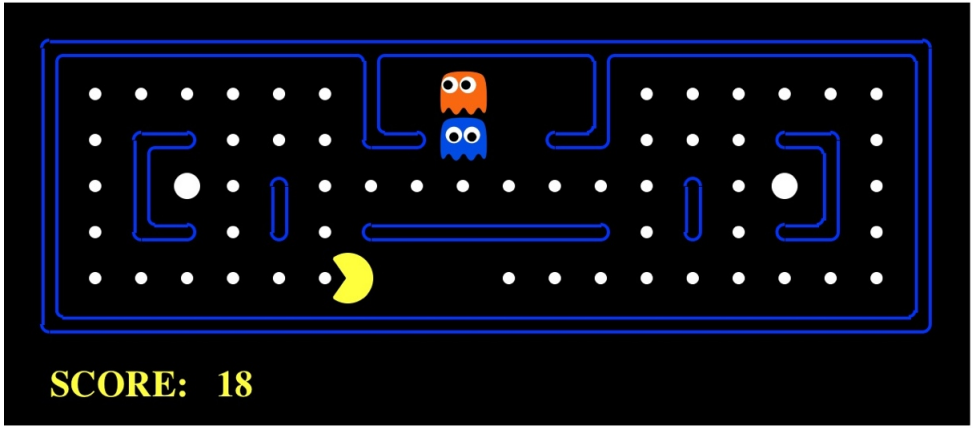


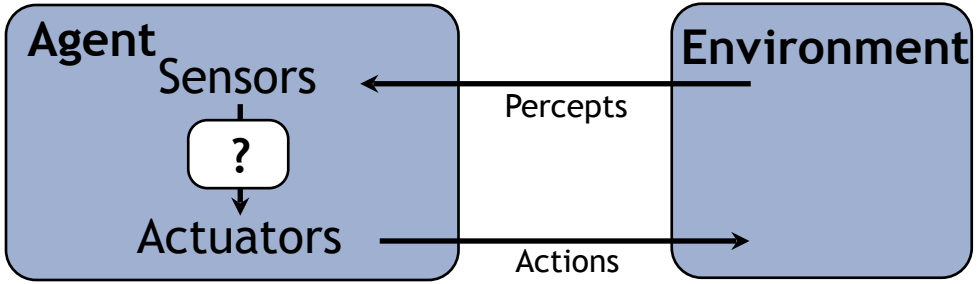
Designing Rational Agents

- 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

- Search
- Adversarial Search (minimax, alpha beta, expectimax)
- Markov Decision Processes
- Reinforcement Learning
- Constraint Satisfaction
- Uncertianty, Bayesian Networks, HMMs
- Supervised Machine Learning
- Applications: Natural Language Processing, Computer Vision

To Do

- Homework #1
  - Math Review + Python Tutorial
  - Due in 1 Week
  - Hand in paper copy at the beginning of class