CSCI 446: Artificial Intelligence
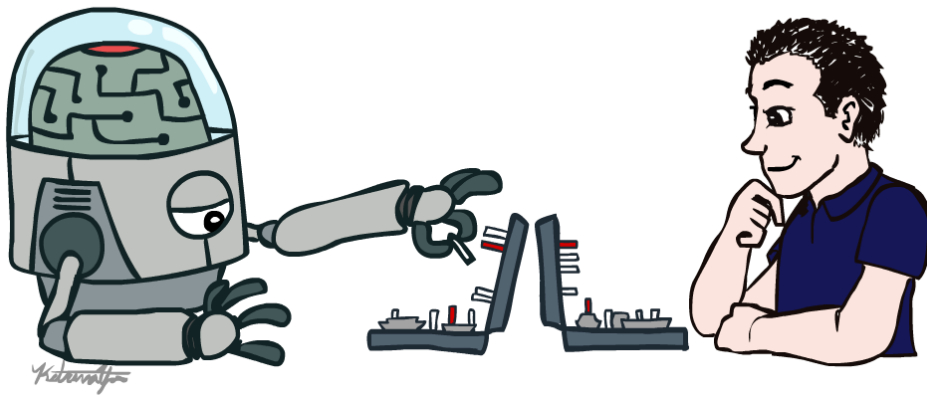
Introduction


Instructor: Michele Van Dyne

Montana Tech

Course Information

- Website:
  - https://katie.mtech.edu/classes/csci446
- Questions?
  - Office Hours: M 2:00-3:00, WF 1:00-2:00 or by appt.
  - Email: mvandyne@mtech.edu
- Optional Textbook:
  - Russell & Norvig, AI: A Modern Approach, 3rd Ed.
    - Warning: Presentation does not necessarily follow the order in the book. Appropriate readings are listed on the class schedule
- Grading:
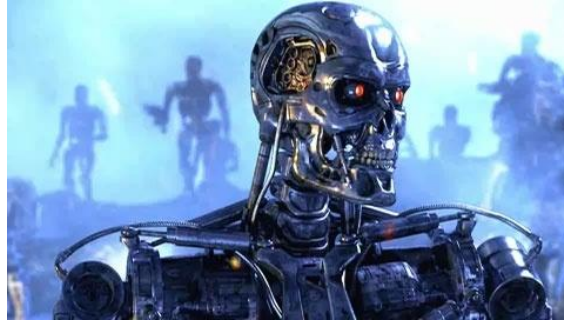 - 12 homework assignments, 5 programming assignments, 3 exams, and a paper and a presentation
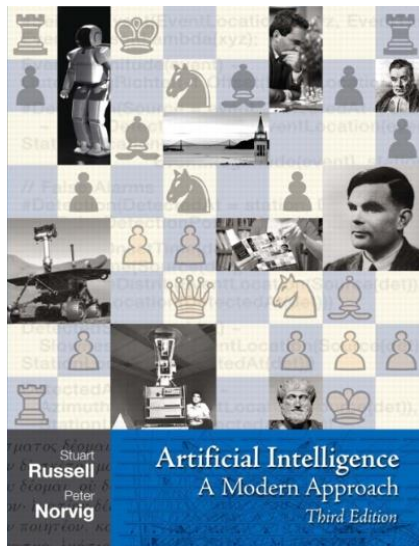
Today

- What is artificial intelligence?

- What can AI do?

- What is this course?
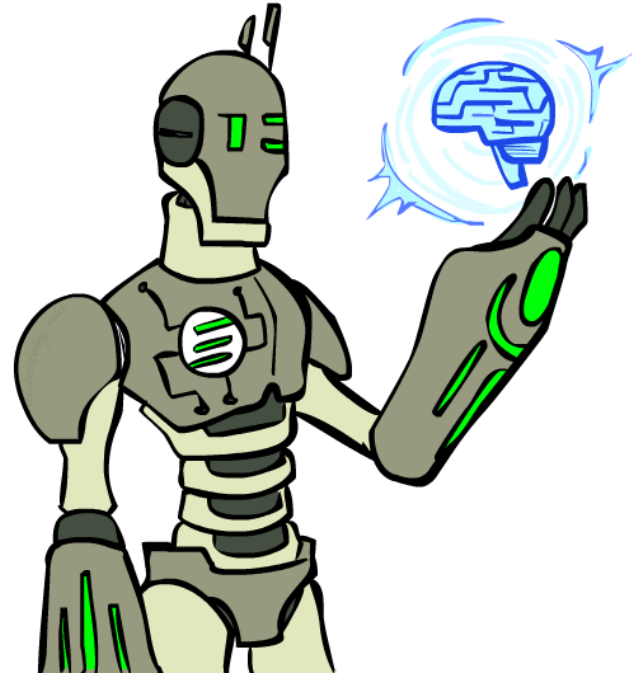
Sci-Fi AI?

News in AI

- IBMs Watson winning at Jeopardy
  - computation + data
- AlphaGo, advances in the game of Go
- Autonomous driving – closer, but not quite there yet
- Healthcare and AI
  - maybe good, but there are ethical questions here
- Elon Musk, Stephen Hawkings
  - concern that AI can ruin civilization, maybe replace us

News in AI

- Neural network for naming paint colors

	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

What is AI?

The science of making machines that:
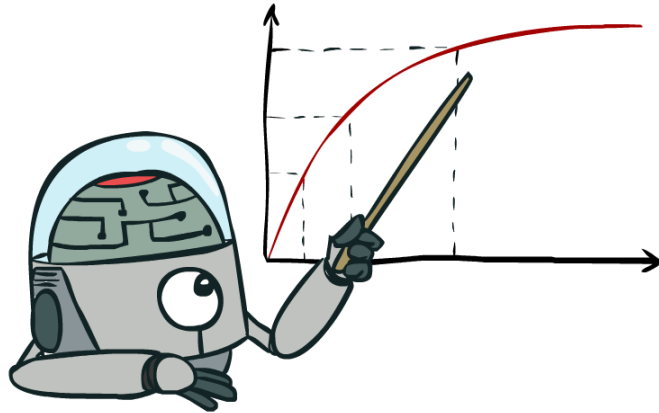
Rational Decisions

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
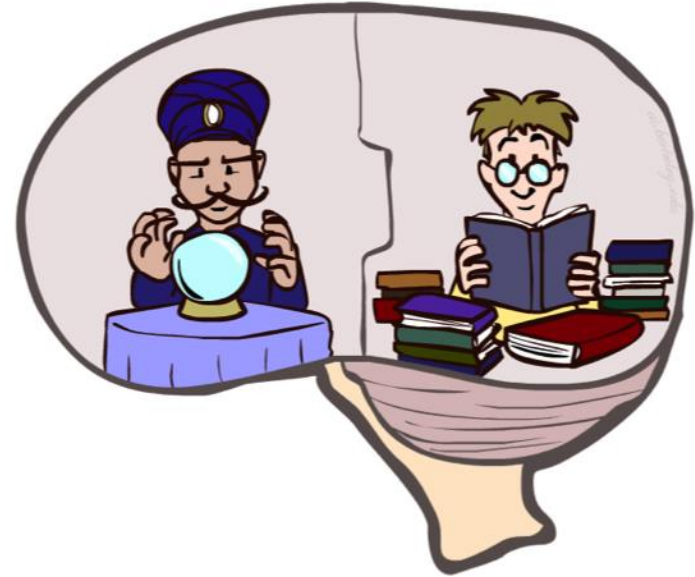
A (Short) History of AI

- **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
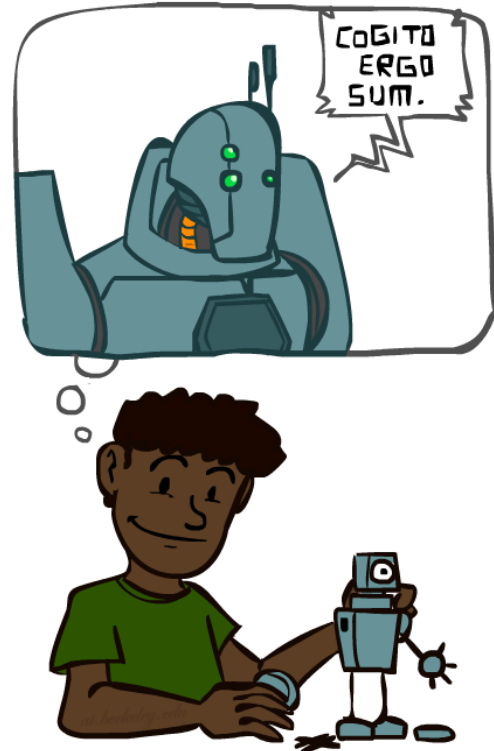
What Can AI Do?

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 down Park St. as the bars are closing?
- ✔ Buy a week's worth of groceries on the web?
- ✘ Buy a week's worth of groceries at Henessey 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?
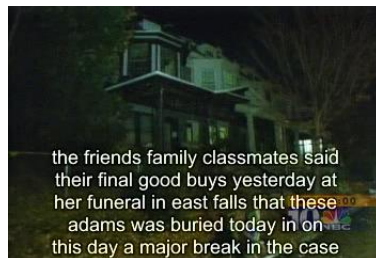- ✘ Write an intentionally funny story?
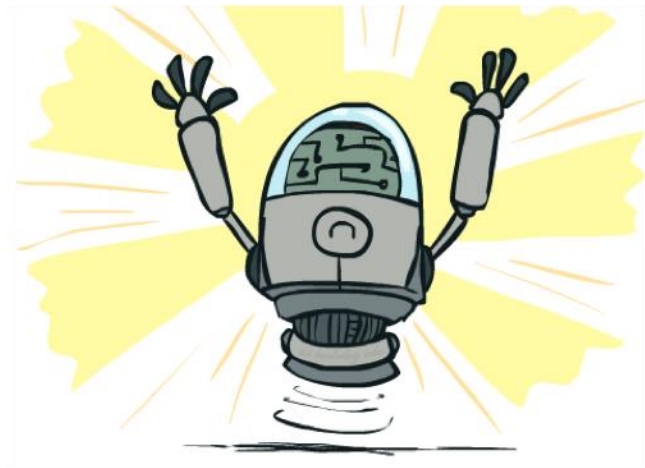
Unintentionally Funny Stories

- One day Joe Bear was hun[gry]... [an]d [asked] Irving Bird where some ho[ney was...He said to him] there was a beehive in the [oak tree...Joe walked] to the oak tree. He ate the b[ees. The End.]

- Henry Squirrel was thirsty. [He walked over to the] river bank where his good [friend Bill Bird was sitting]. Henry slipped and fell in th[e river. He was drown]ed. The End.

- Once upon a time there w[as a dishonest fox and] a vain crow. One day the crow was sitting in his tree[, holding a piece of che]ese in his mouth. He noticed that he was holding the pie[ce of cheese. He beca]me hungry, and swallowed the cheese. The fox walke[d away. Th]e End.
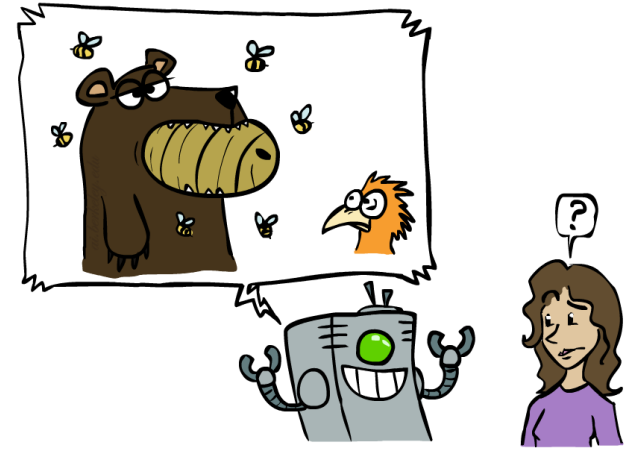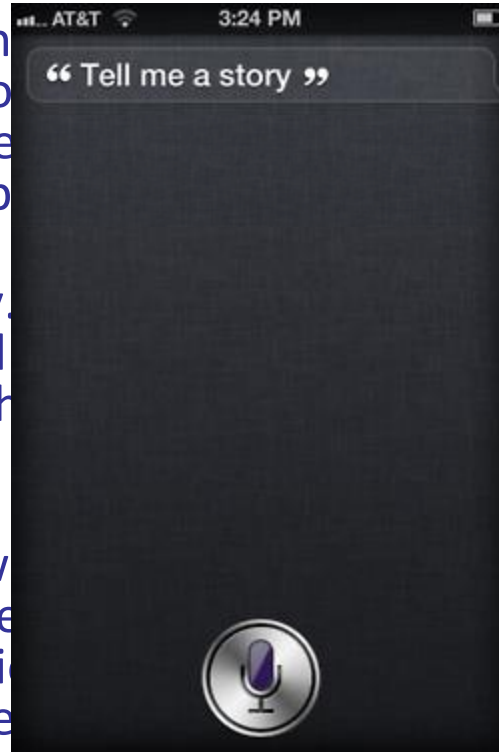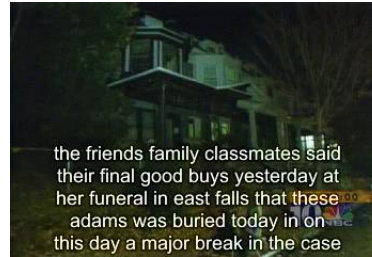
[Shank, Tale-Spin System, 1984]

Natural Language

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

the friends family classmates said
their final good buys yesterday at
her funeral in east falls that these
adams was buried today in on
this day a major break in the case

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- 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'illégalité".
Les faits Le dalaï-lama dénonce l'"enfer" imposé au Tibet depuis sa fuite, en 1959
Vidéo Anniversaire de la rébellion tibétaine : la Chine sous garde

"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."
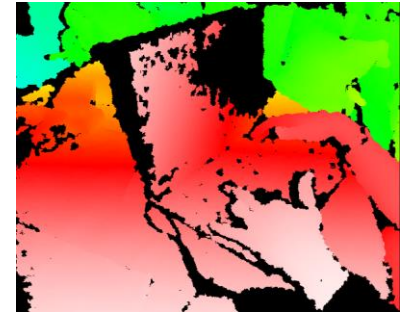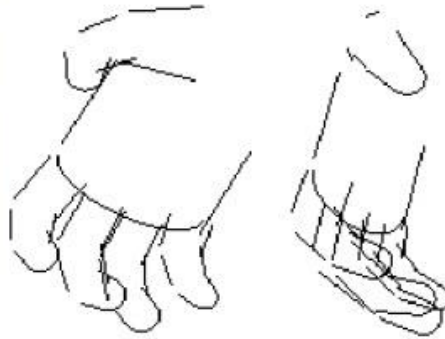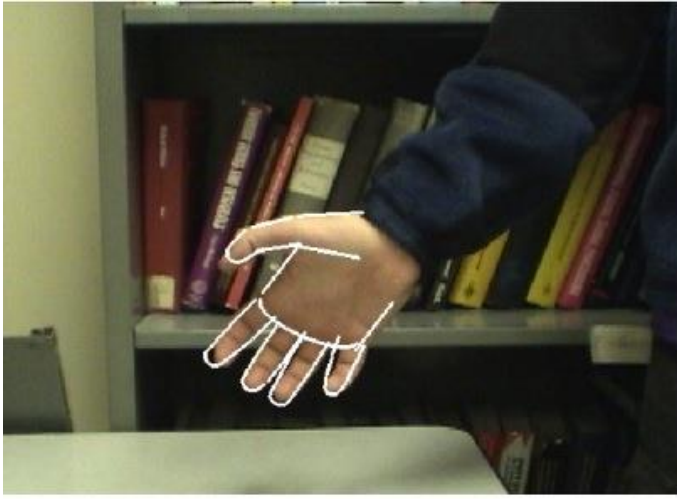Facts The Dalai Lama denounces the "hell" imposed since he fled Tibet in 1959
Video Anniversary of the Tibetan rebellion: China on guard

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

$77,147

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

Vision (Perception)

PIXELS -> INFO/DECISION

E.g.:

Face detection and recognition

Source: TechCrunch

Semantic Scene Segmentation

[Caesar et al, ECCV 2017]

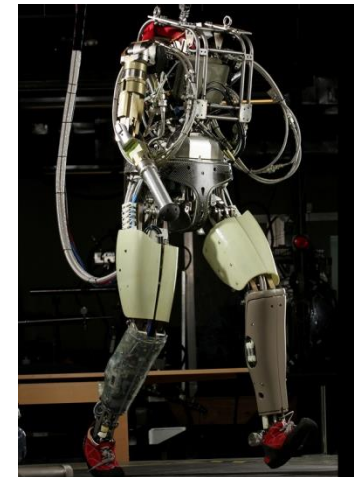**3-D Understanding**

[DensePose]

Robotics

- Robotics
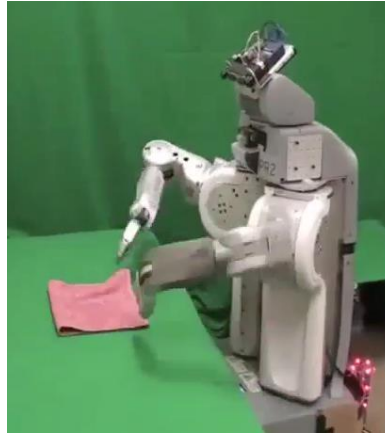 - Part mech. eng.
  - Part AI
  - Reality much harder than simulations!

- Technologies
  - Vehicles
  - Rescue
  - Soccer!
  - Lots of automation…

- In this class:
  - We ignore mechanical aspects
  - Methods for planning
  - Methods for control

Images from UC Berkeley, Boston Dynamics, RoboCup, Google

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!

New Intelligence Scent

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
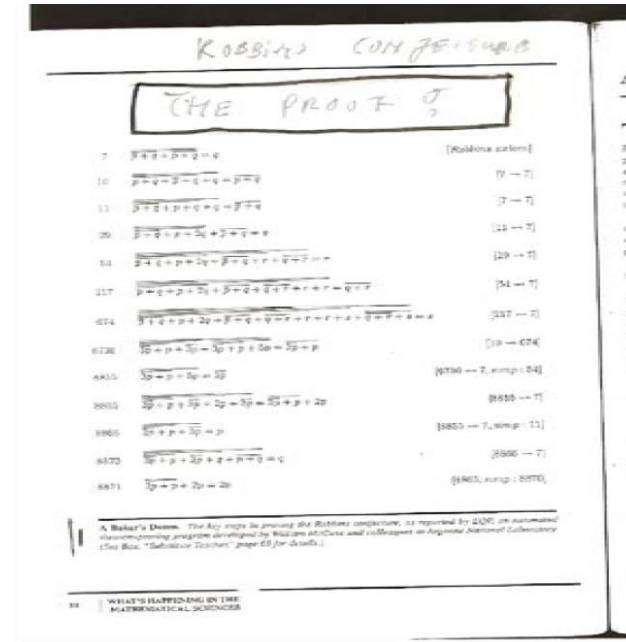
AI is starting to be everywhere...

- **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!
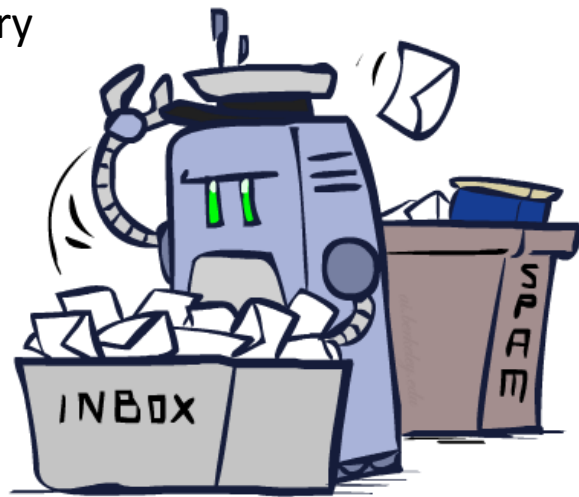
Designing Rational Agents

- 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

Demo1: pacman-l1.mp4 or L1D2
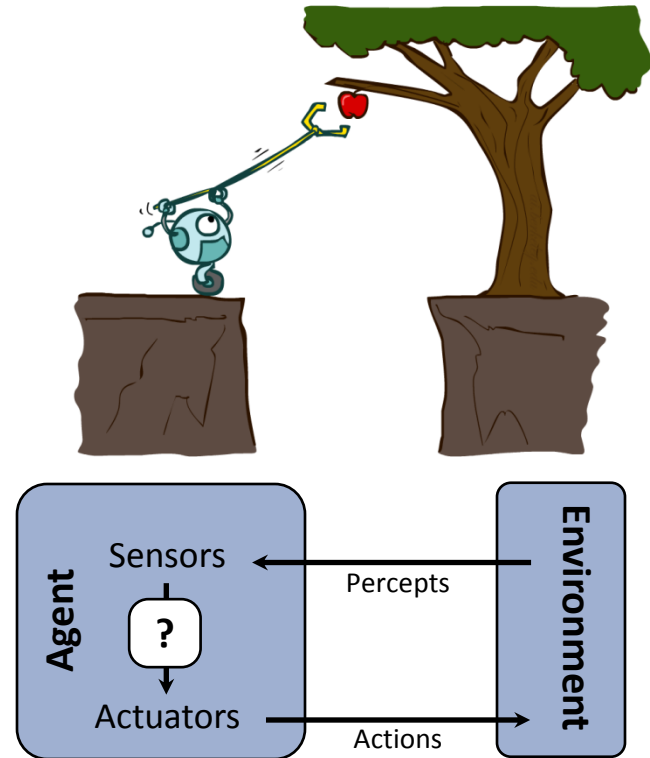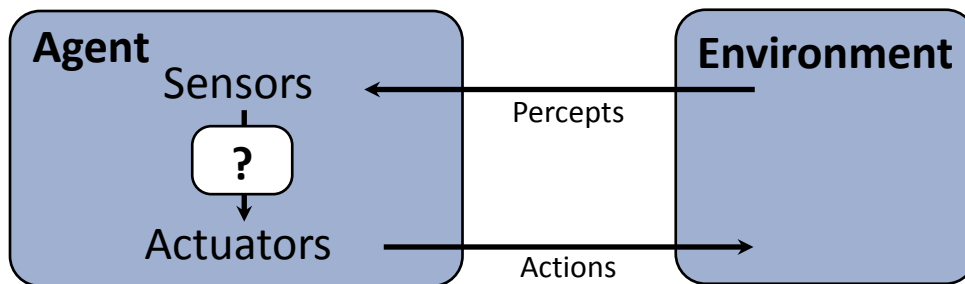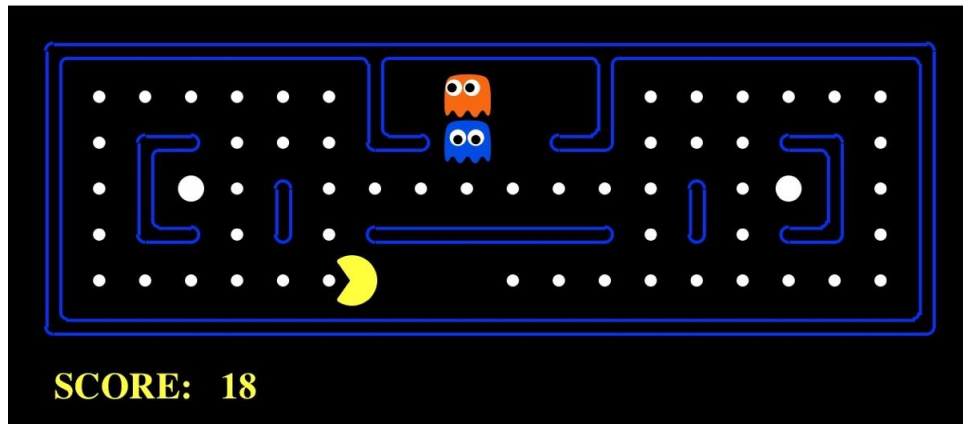
Course Topics

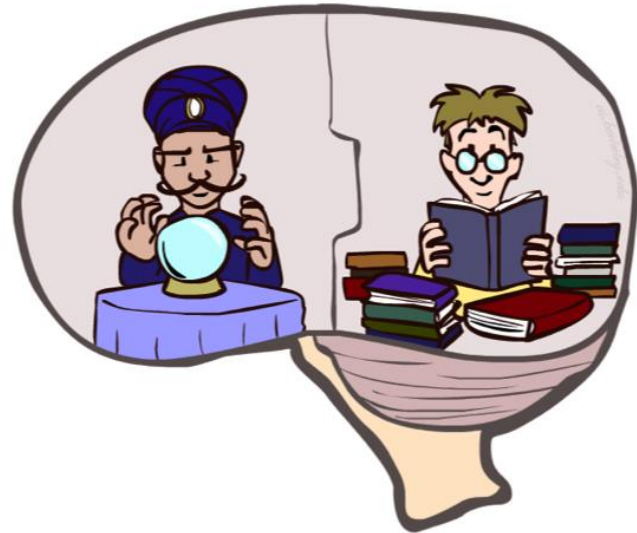- **Part I: Intelligence from Computation**
  - Fast search / planning
  - Constraint satisfaction
  - Adversarial and uncertain search

- **Part II: Intelligence from Data**
  - Bayes' nets
  - Decision theory
  - Machine learning
  - Logic

- **Throughout: Applications**
  - Natural language, vision, robotics, games, …

Summary

- What is artificial intelligence?

- What can AI do?

- What is this course?