CS 07550 - Concepts In Artificial Intelligence

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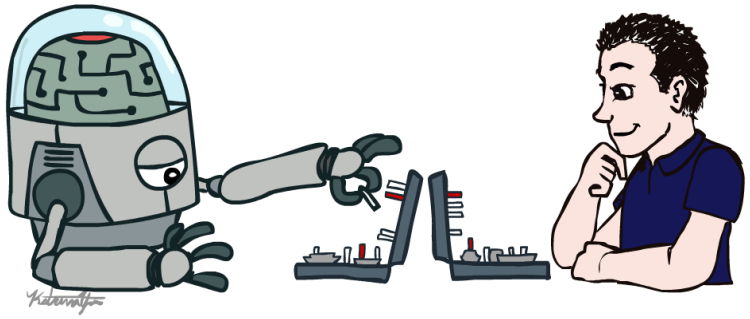
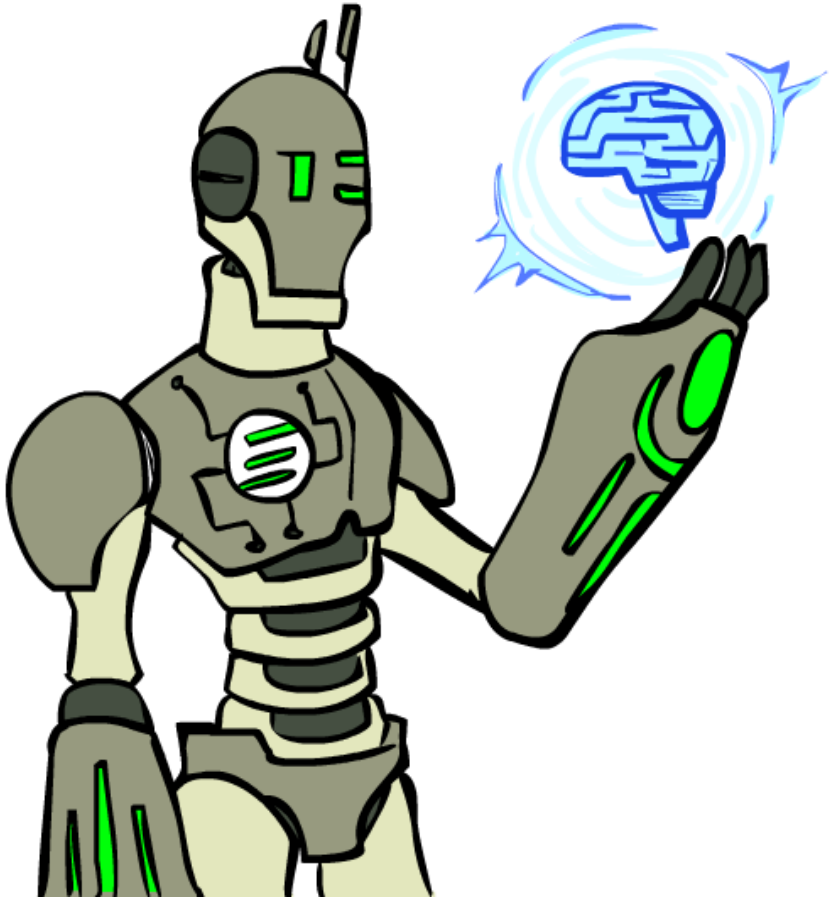


RowanUniversity

Science fiction AI?

Today



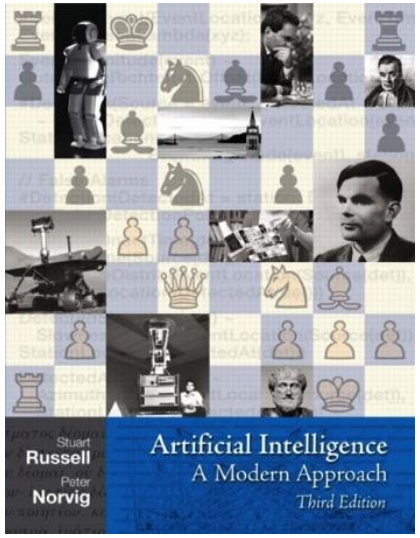
- **What is this course?**
- What is artificial intelligence?
- Where did it come from/What can AI do?
  - What should we and shouldn't we worry about? What can we do about the things we should worry about?

Course Format

Let’s look at our course syllabus

Textbook

- Not required, but for students who want to read more it is recommend
  - Russell & Norvig, AI: A Modern Approach, 4th or 3rd Ed.



  - Warning: The class presentation should not necessarily follow the presentation in the book.

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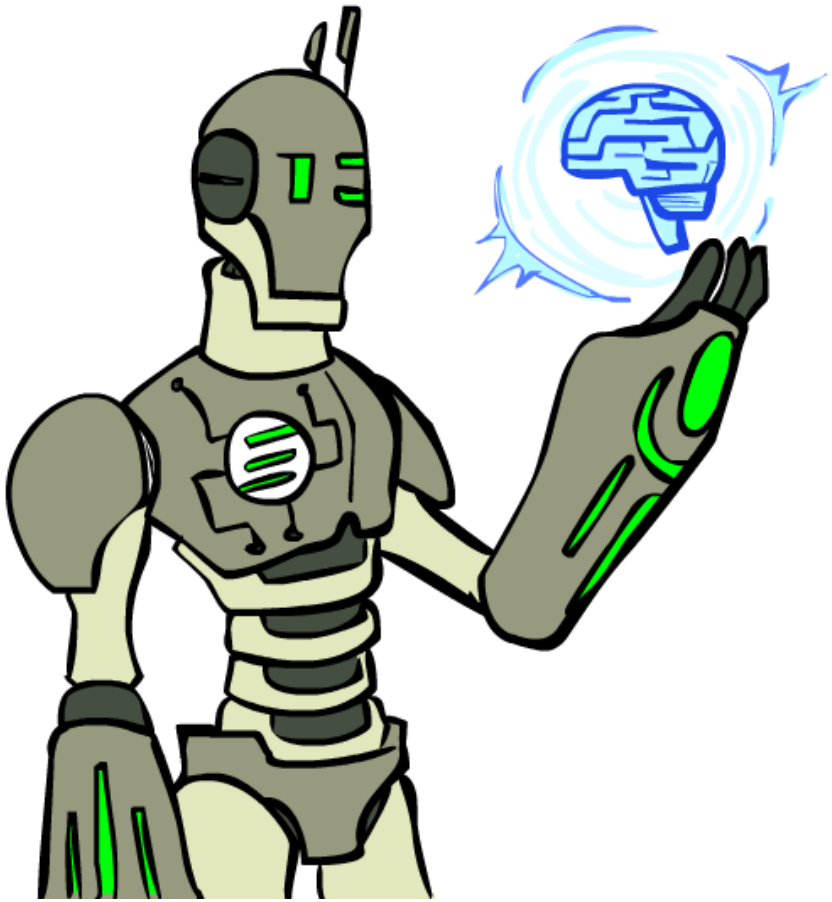
Today



- What is this course?
- **What is artificial intelligence?**
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What is Artificial Intelligence?

The science of making machines that:

Rational Decisions

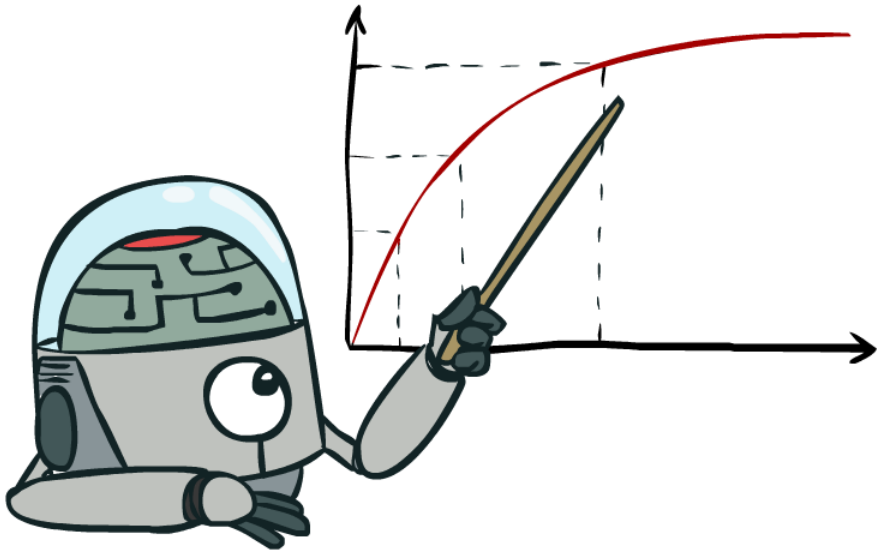
We'll use the term **rational** in a very specific, technical way:

- 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**

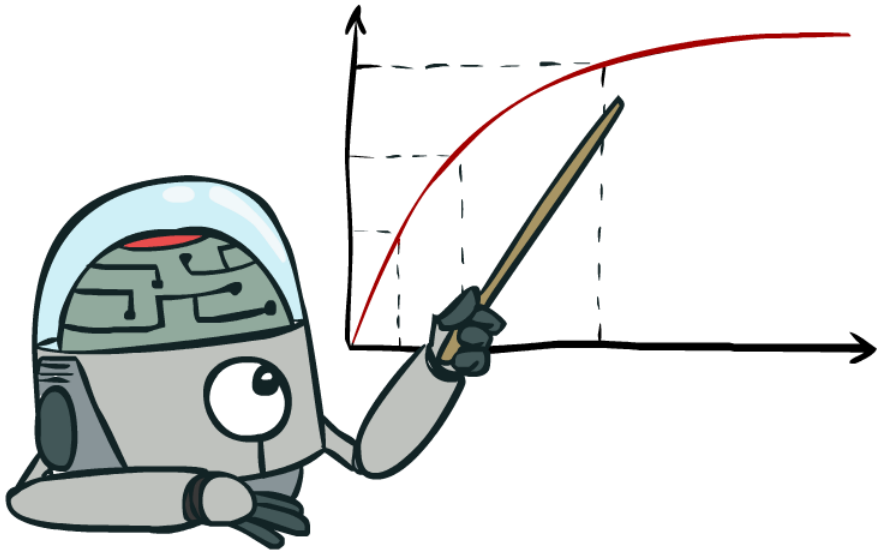
A better title for this course would be:

Computational Rationality

Maximize Your Expected Utility



Maximize Your Expected Utility

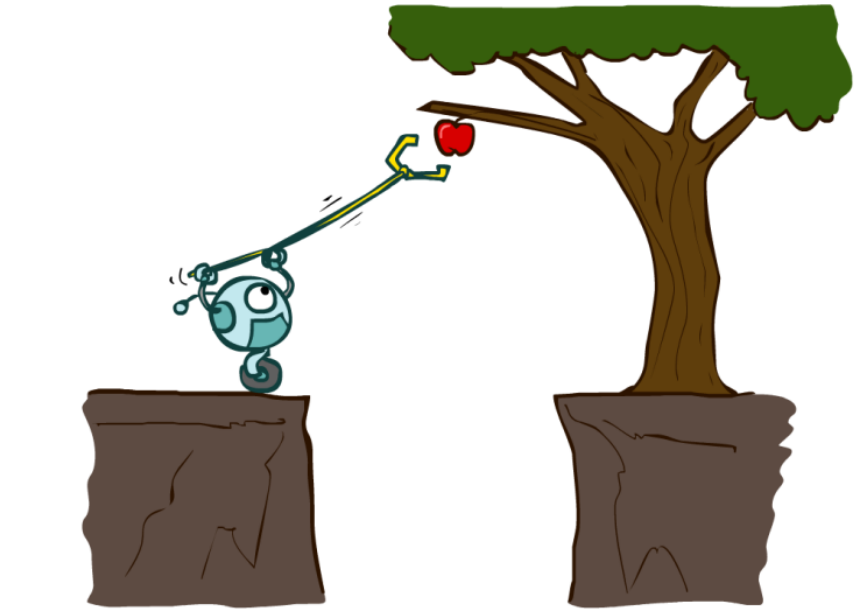


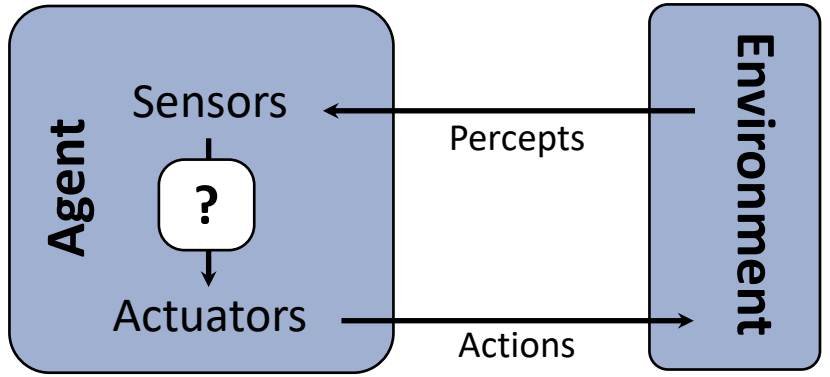
What About the Brain?

- 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

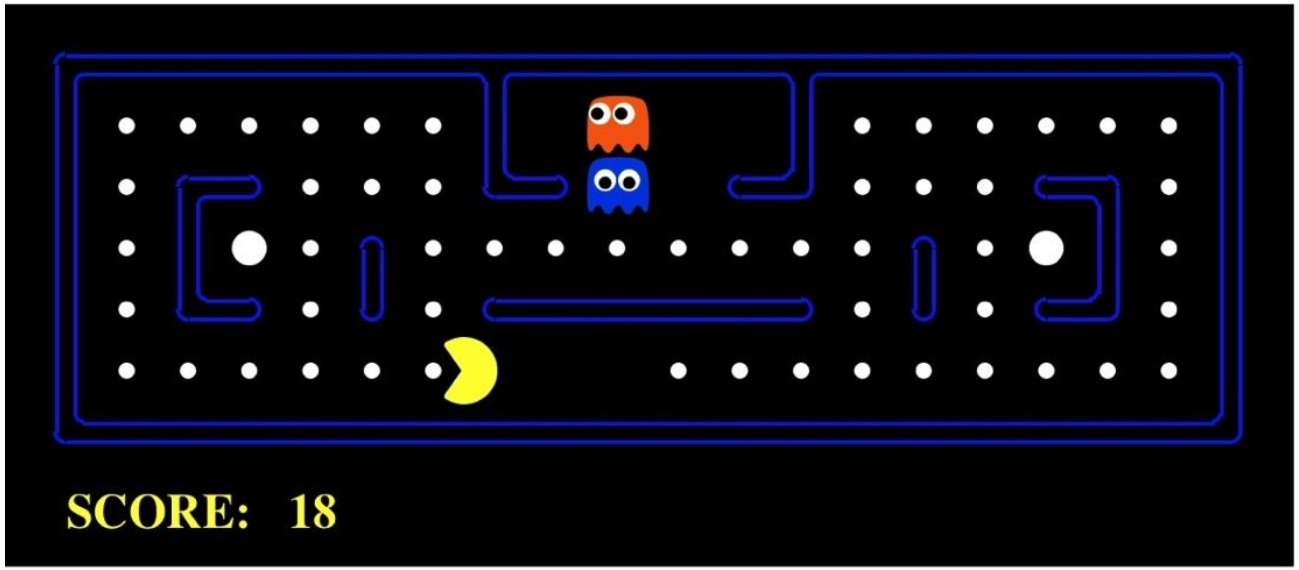
Designing Rational Agents

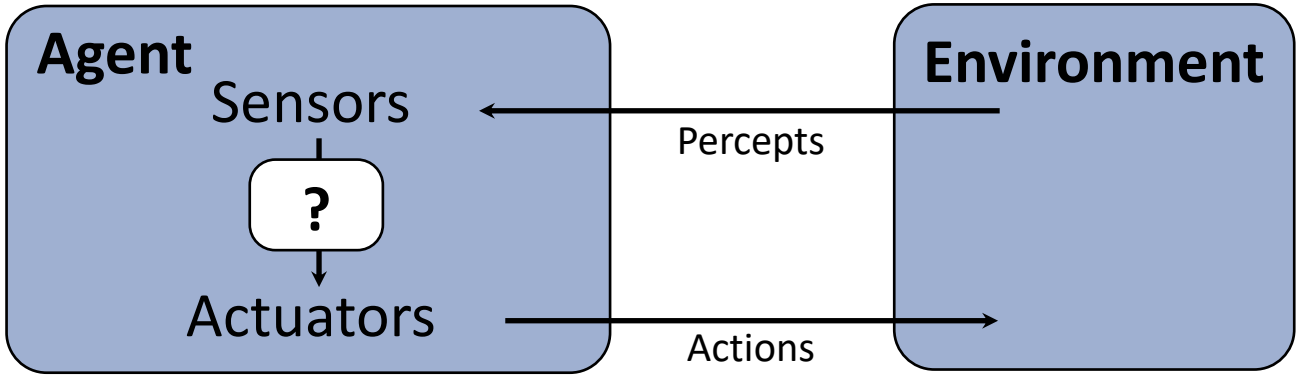
- An **agent** is an entity that *perceives* and *acts*.
- A **rational agent** selects actions that maximize its (expected) **utility**.
- Characteristics of the **percepts, environment,** and **action space** dictate techniques for selecting rational actions
- **This course** is about:
  - General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





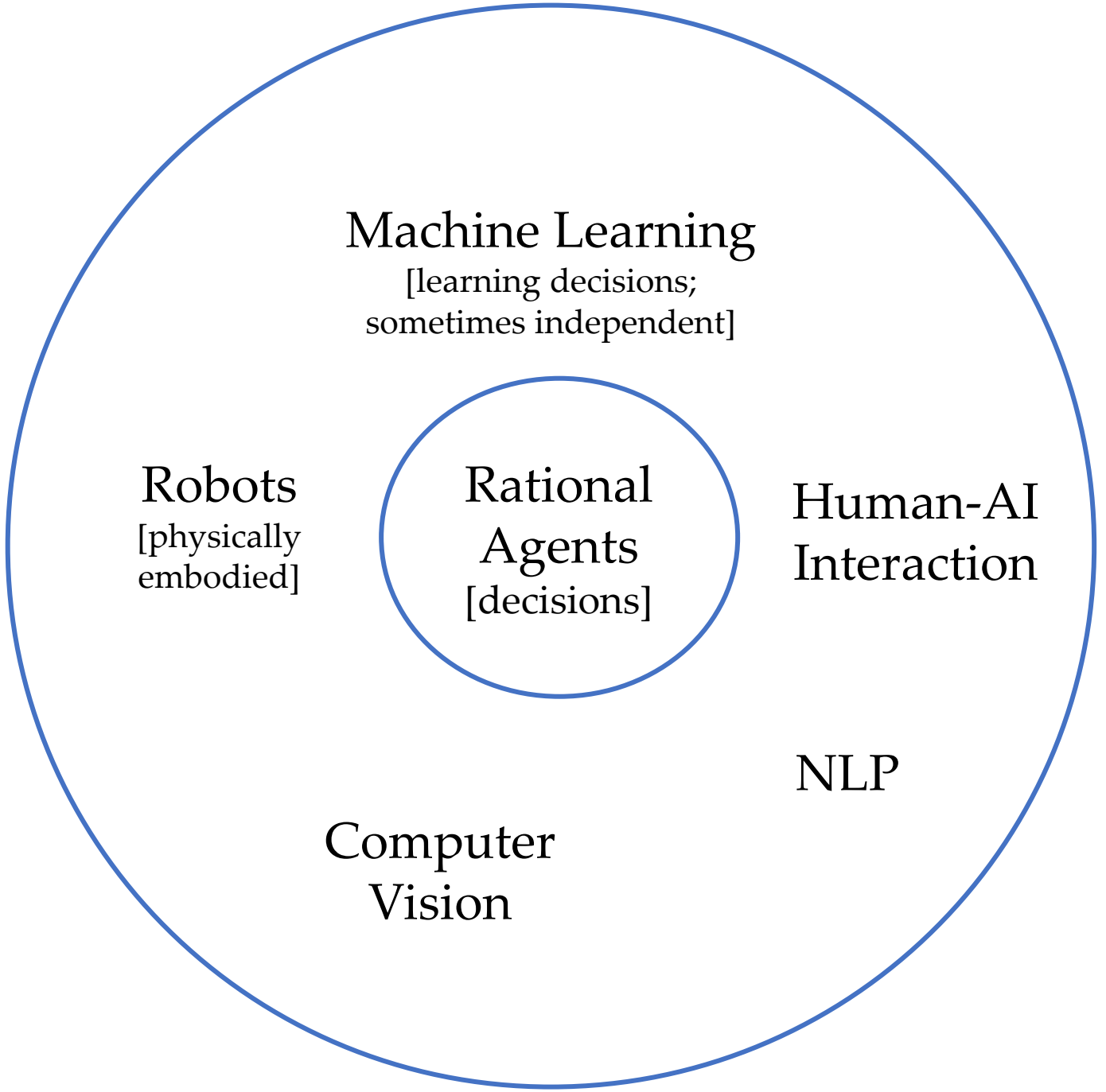
Pac-Man is a registered trademark of Namco-Bandai Games, used here for educational purposes

Demo1: pacman-l1.mp4

Acting humanly

- **An intelligent computer/system would need the following capabilities:**
  - **Natural language processing** to communicate successfully in a human language.
  - **Knowledge representation** to store what it knows or hears.
  - **Automated reasoning** to answer questions and to draw new conclusions.
  - **Machine learning** to adapt to new circumstances and to detect and extrapolate patterns.
  - **Computer vision** and speech recognition to perceive the world.
  - **Robotics** to manipulate objects and move about.

AI


Machine Learning
[learning decisions;
sometimes independent]
Robots
[physically
embodied]
Rational
Agents
[decisions]
Human-AI
Interaction
NLP
Computer
Vision

A (Short) History of AI

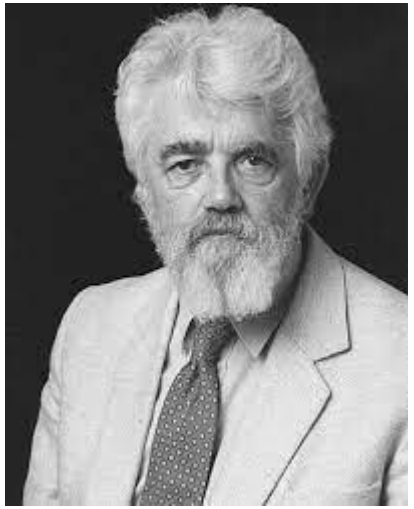
- Alan Turing was a brilliant British mathematician who took a leading role in breaking Nazi ciphers during WWII.
- He proposed **Turing test** in 1950, originally called the **imitation game**.
- The Turing Test is a method of inquiry in artificial intelligence (AI) for determining whether or not a computer is capable of thinking like a human being.
- The ACM A.M. **Turing Award**, often referred to as the "Nobel Prize of Computing".
- Turing Award is given for contributions "of lasting and major technical importance to the computer field".

Alan Turing (1912 – 1954)

Movie: The Imitation Game

A (Short) History of AI

- 1940-1950: Early days
  - 1943: McCulloch & Pitts: Boolean circuit model of brain
  - 1950: Turing's "Computing Machinery and Intelligence"
- 1950-80: back-propagation
  - 1980: Connectionist models – Mc Carthy
  - 1986: Neural network – Geoff Hinton
    - High computation cost
    - Lack of data
- 1970—90: Probabilistic reasoning
  - 1988: Pearl's Bayesian networks
- 2001—: Big data
  - IBM Watson system
- 2011—: Deep learing
  - Convolutiona neural network (CNN)
  - 2012: ImageNet competition (classifying images into one of a thousand categories)
  - 2013: Deep model (Geoff Hinton)
    - Hardware: CPU, GPU, TPU
  - Where are we now?



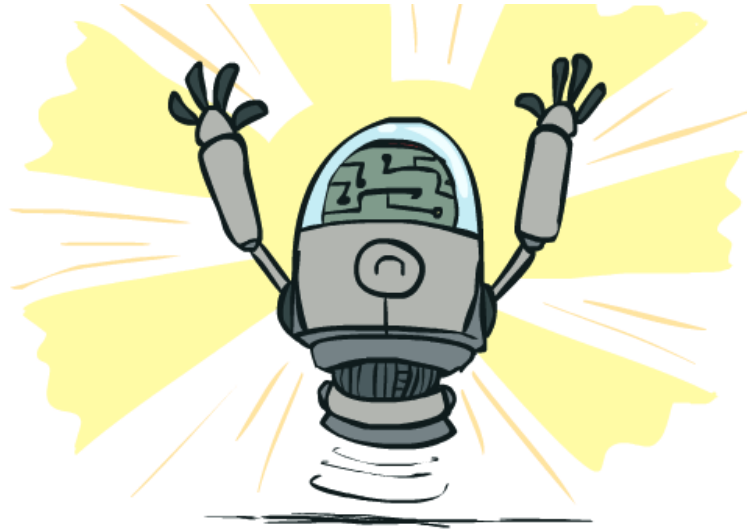
John McCarthy

Geoff Hinton
received Turing award in 2018

What Can AI Do?

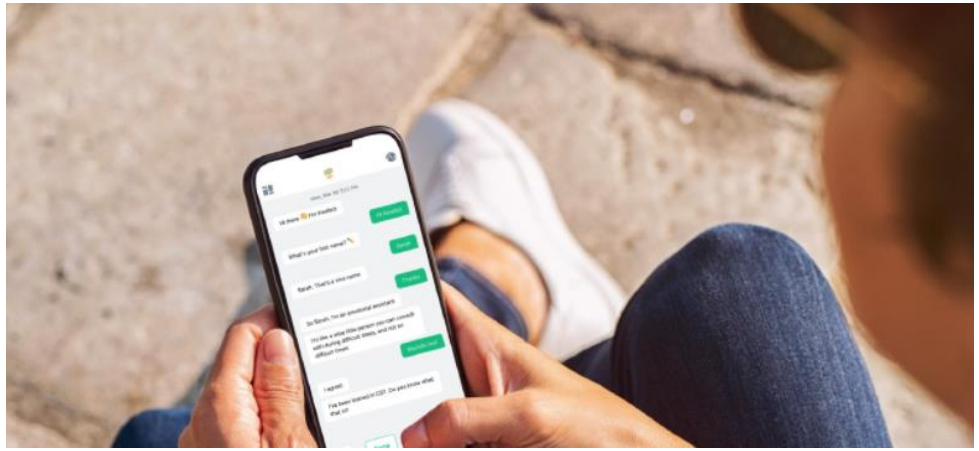
Quiz: Which of the following can be done at present?

- ✓ Play a decent game of Jeopardy?
- ✓ Win against any human at chess?
- ✗ Play a decent game of tennis?
- ✓ Grab a particular cup and put it on a shelf?
- ✗ Unload any dishwasher in any home?
- ? Drive safely along the highway?
- ✓ Buy a week's worth of groceries on the web?
- ✗ Discover and prove a new mathematical theorem?
- ? Perform a surgical operation?
- ✓ Translate spoken Chinese into spoken English in real time?
- ✗ Write an intentionally funny story?



Natural Language

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



Woebot for adult mental health

- Language processing technologies
  - Question answering
  - Machine translation

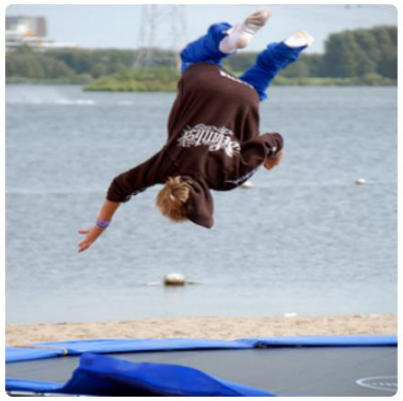
  - Web search
  - Text classification, spam filtering, etc…

Computer Vision

"man in black shirt is playing guitar."

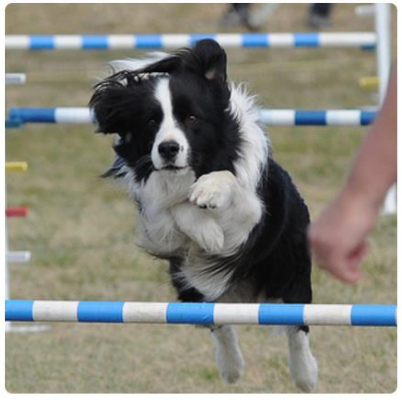
"construction worker in orange safety vest is working on road."

"two young girls are playing with lego toy."



"boy is doing backflip on wakeboard."

"girl in pink dress is jumping in air."

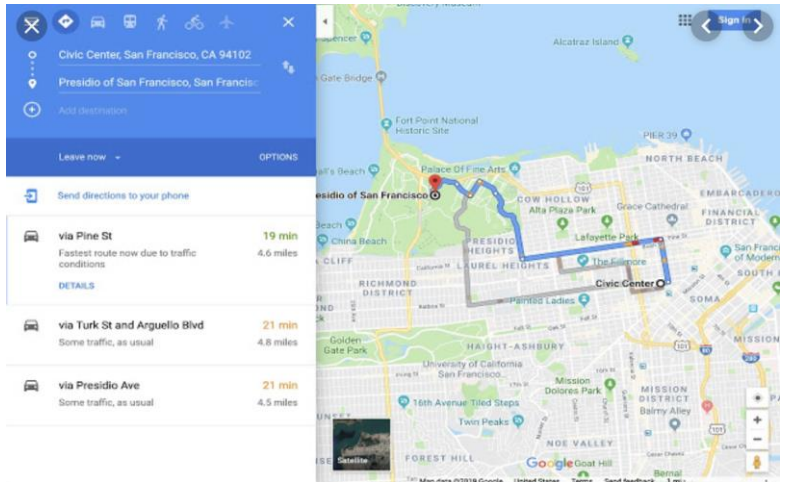


"black and white dog jumps over bar."

"young girl in pink shirt is swinging on swing."

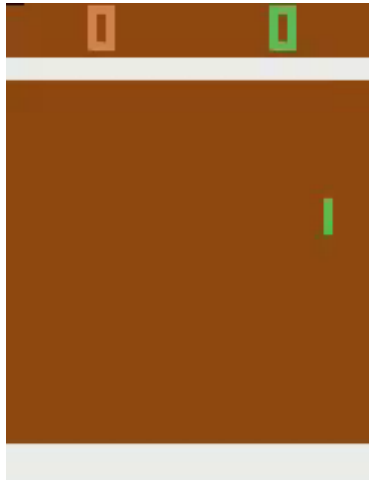
"man in blue wetsuit is surfing on wave."

Tools for Predictions & Decisions

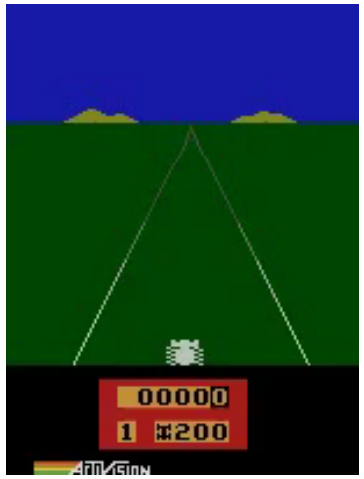


Game Agents

- Reinforcement learning

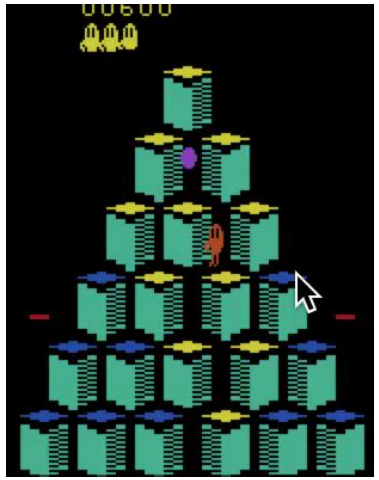


Pong



Enduro

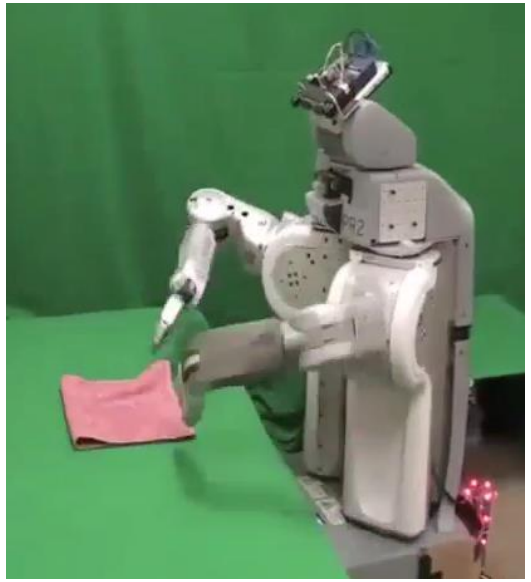
Beamrider

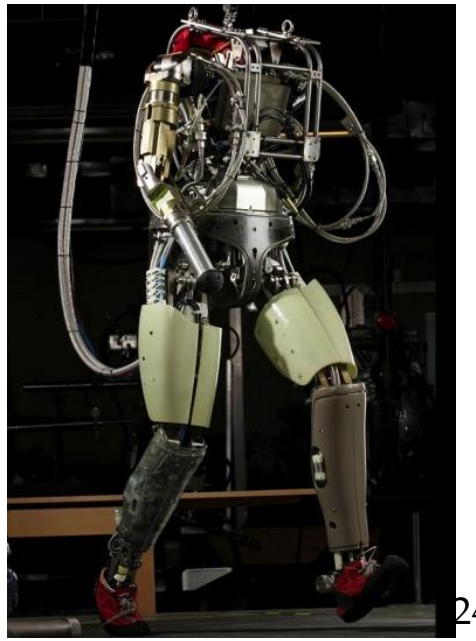


Q*bert

Robotics

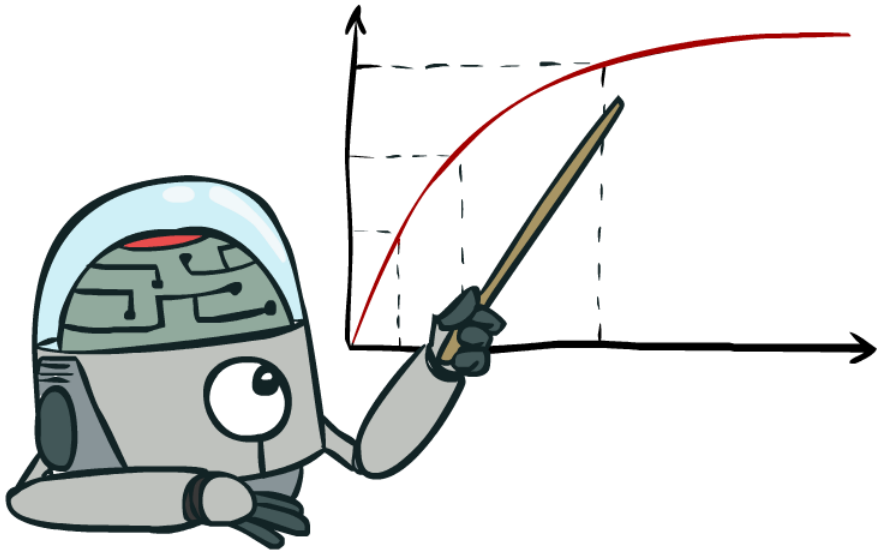
- Robotics
  - Part mech. eng.
  - Part AI
  - Reality much harder than simulations!
- Technologies
  - Vehicles
  - Rescue
  - Help in the home
  - Lots of automation…
- In this class:
  - We ignore mechanical aspects
  - Methods for planning
  - Methods for control





Images from UC Berkeley, Boston Dynamics, RoboCup, Google

Maximize Your Expected Utility

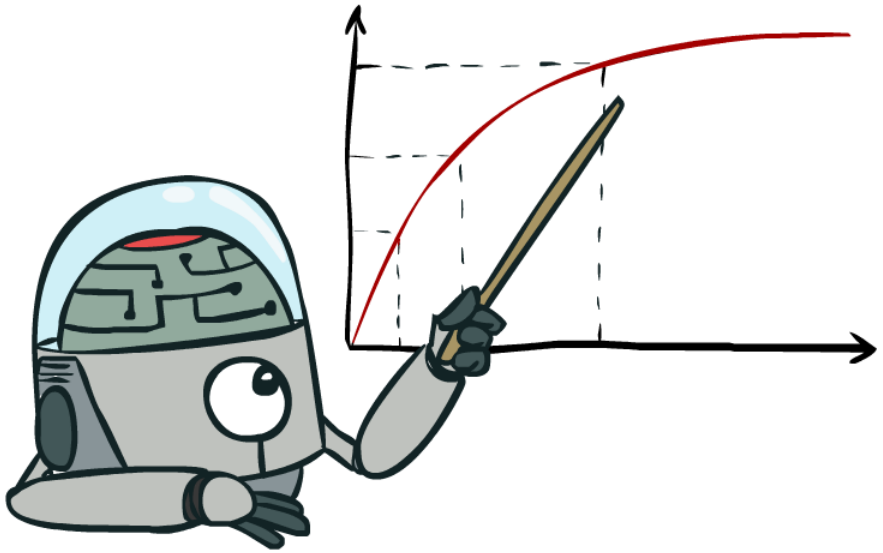


Utility?

Clear utility function

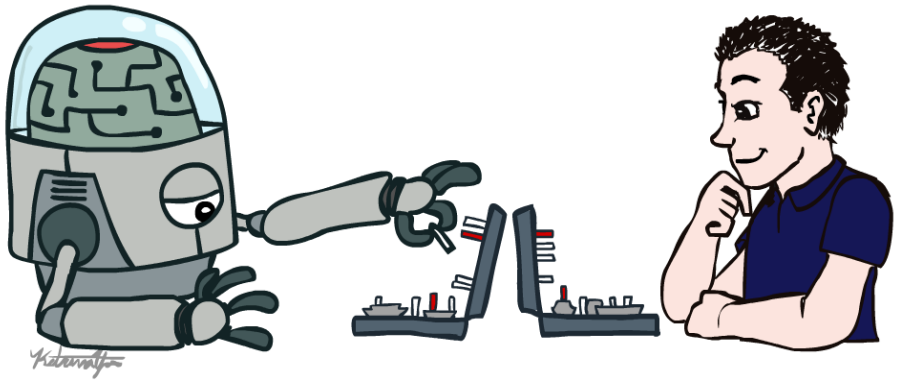
Not so clear utility function

Maximize Your Expected Utility



Next class?

- Intelligent Agent
- Uninformed search



Thanks!