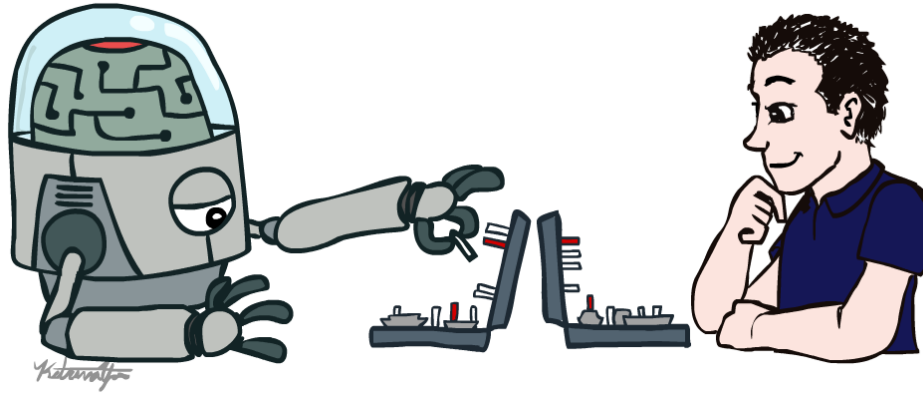
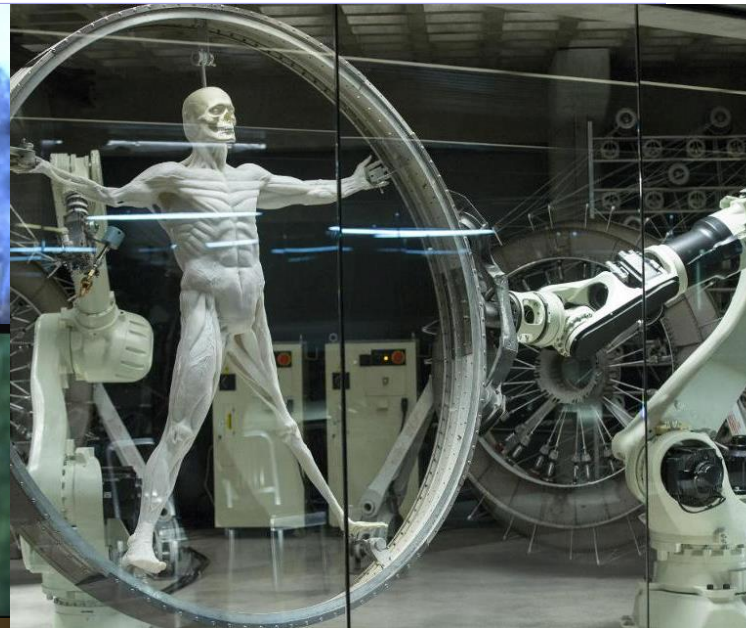
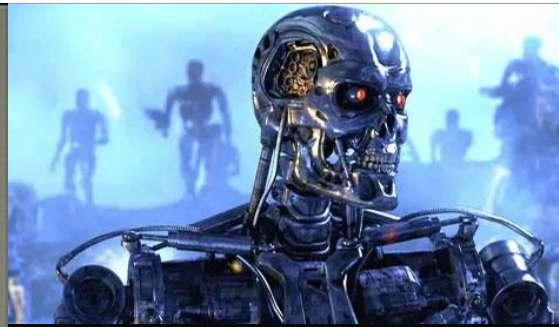


# Artificial Intelligence

## Introduction



# Sci-Fi AI?









TUG  
CAUTION  
MAY CONTAIN  
CHEMOTHERAPY DRUG

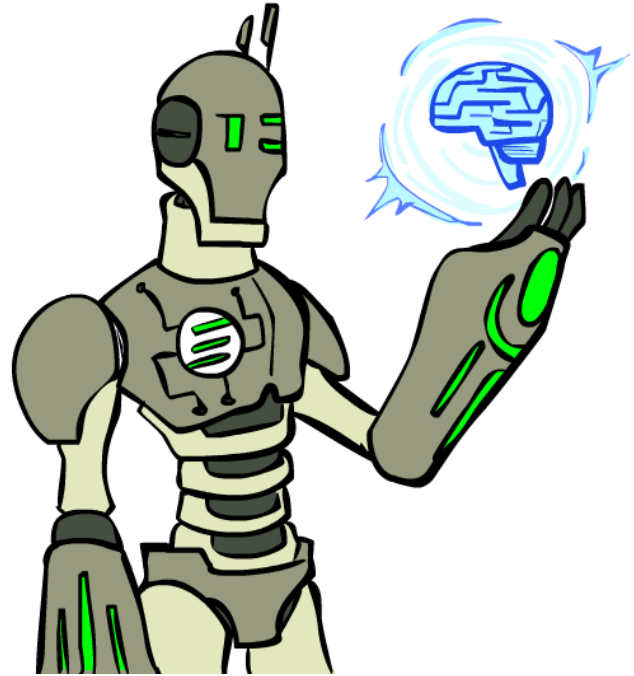
CAUTION  
MAY CONTAIN  
CHEMOTHERAPY DRUG



# Today

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



# 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:

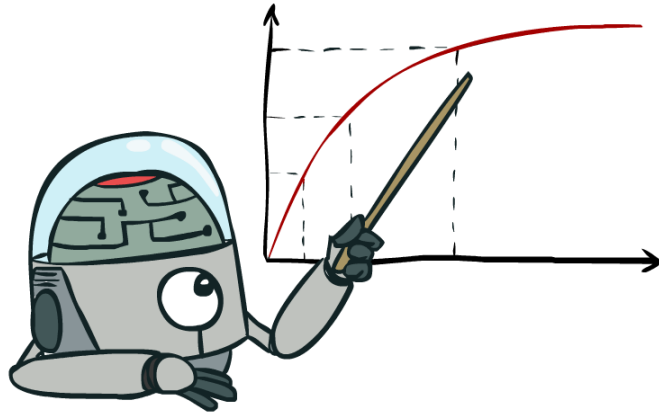
- Rational: maximally achieving pre-defined goals
- Rationality only concerns what decisions are made  
(not the thought process behind them)
- Goals are expressed in terms of the **utility** of outcomes
- Being rational means **maximizing your expected utility**

A better title for this course would be:

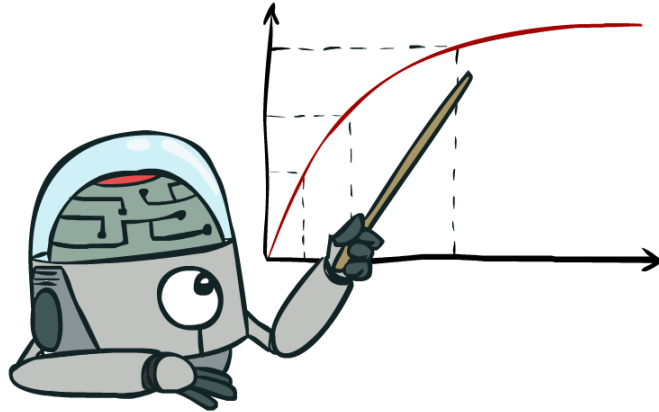
**Computational Rationality**



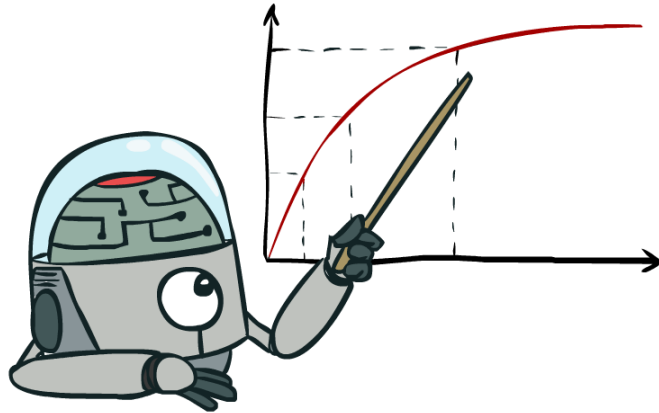
# Maximize Your Expected Utility



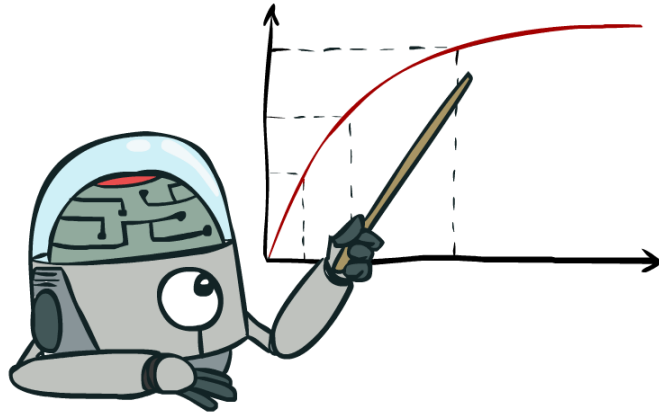
# Maximize Your Expected Utility



# Maximize Your Expected Utility

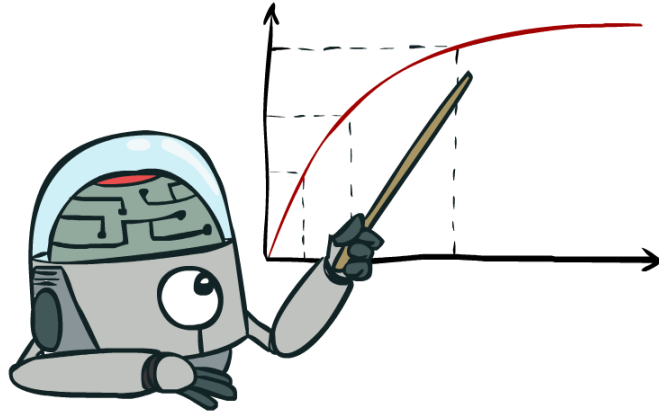


# Maximize Your Expected Utility





# Maximize Your Expected Utility



# What About the Brain?

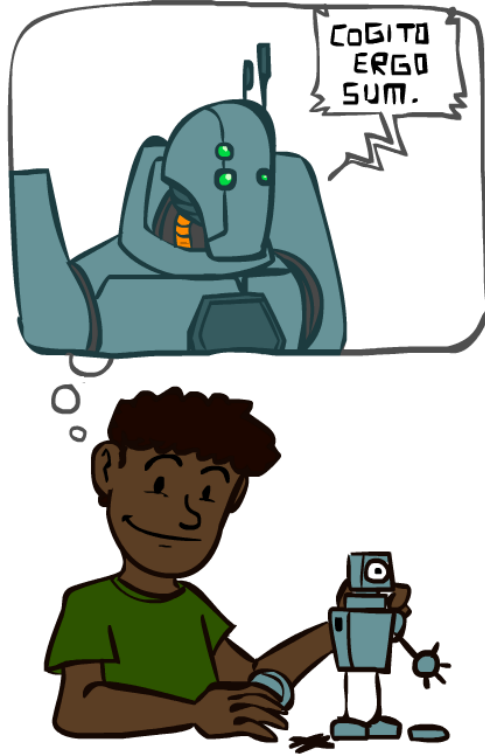
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- Brains (human minds) are very good at making rational decisions, but not perfect
- Brains aren't as modular as software, so hard to reverse engineer!
- "Brains are to intelligence as wings are to flight"
- Lessons learned from the brain: memory (data) and simulation (computation) are key to decision making



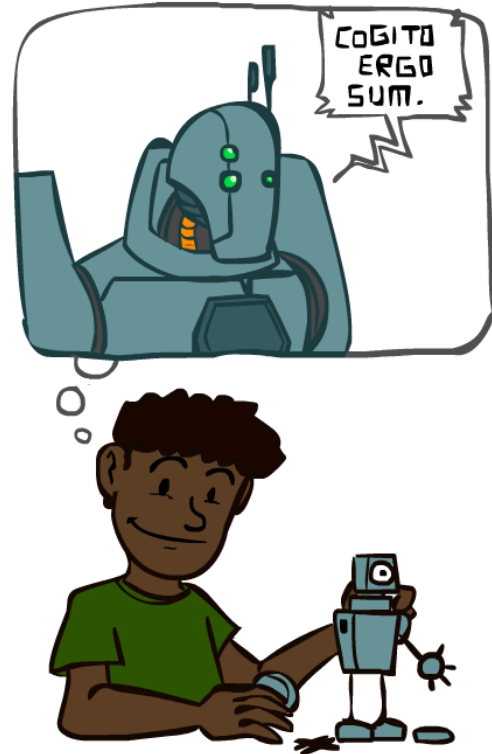
# A (Short) History of AI

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# 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!
  - Big data, big compute, neural networks
  - Some re-unification of subfields
  - AI used in many industries

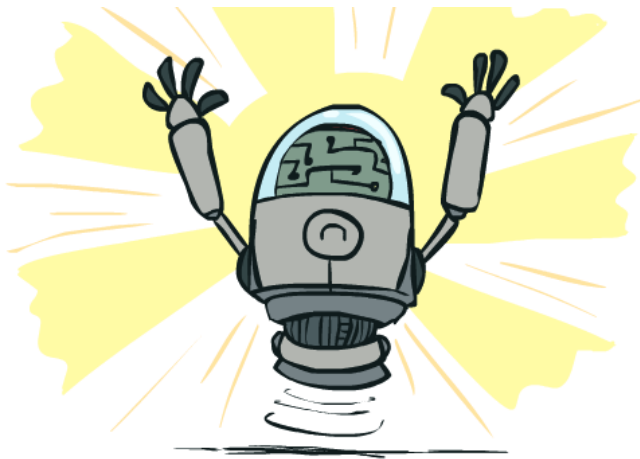




# What Can AI Do?

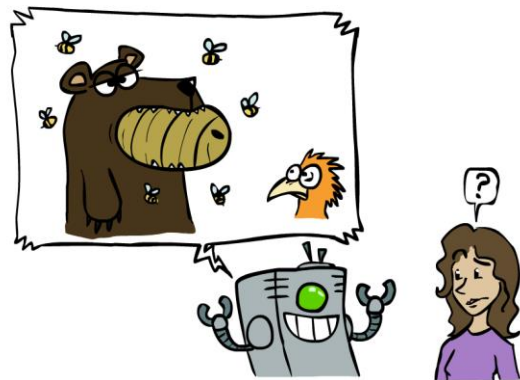
Quiz: Which of the following can be done at present?

- ✓ Play a decent game of Jeopardy?
- ✓ Win against any human at chess?
- ✓ Win against the best humans at Go?
- ✓ 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?
- ✗ 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?
- ? Perform a surgical operation?
- ✓ Translate spoken Chinese into spoken English in real time?
- ✗ Write an intentionally funny story?



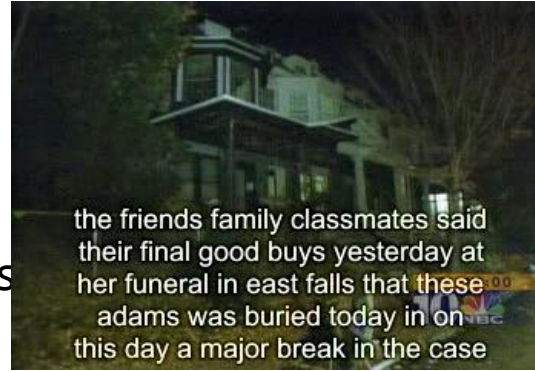
# Unintentionally Funny Stories

- One day Joe Bear was hungry. He asked his friend Irving Bird where some honey was. Irving told him there was a beehive in the oak tree. Joe walked to the oak tree. He ate the beehive. 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 the river. Gravity drowned. The End.
- Once upon a time there was a dishonest fox and a vain crow. One day the crow was sitting in his tree, holding a piece of cheese in his mouth. He noticed that he was holding the piece of cheese. He became hungry, and swallowed the cheese. The fox walked over to the crow. The End.



# 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



**"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



**"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

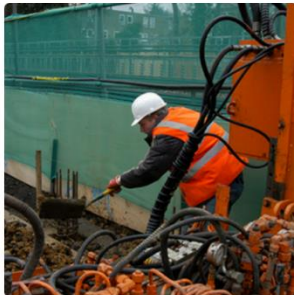


- Web search
- Text classification, spam filtering, etc...

# Computer Vision



"man in black shirt is playing guitar."



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



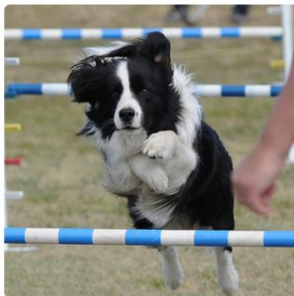
"two young girls are playing with lego toy."



"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."

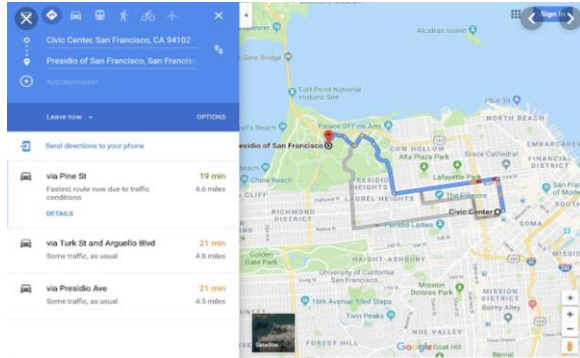


"man in blue wetsuit is surfing on wave."

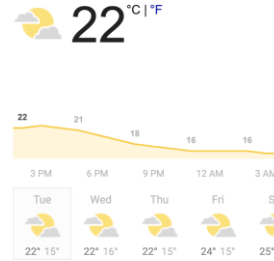
Karpathy & Fei-Fei, 2015; Donahue et al., 2015; Xu et al, 2015; many more



# Tools for Predictions & Decisions

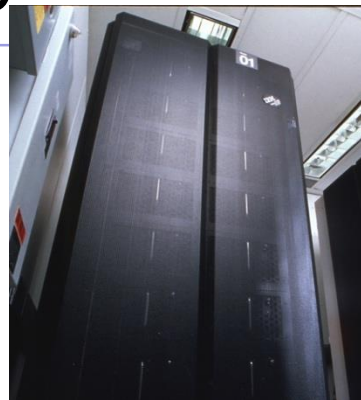


Berkeley, CA 94709  
Tuesday 2:00 PM  
Mostly Sunny



# Game Agents

- 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
- 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.”





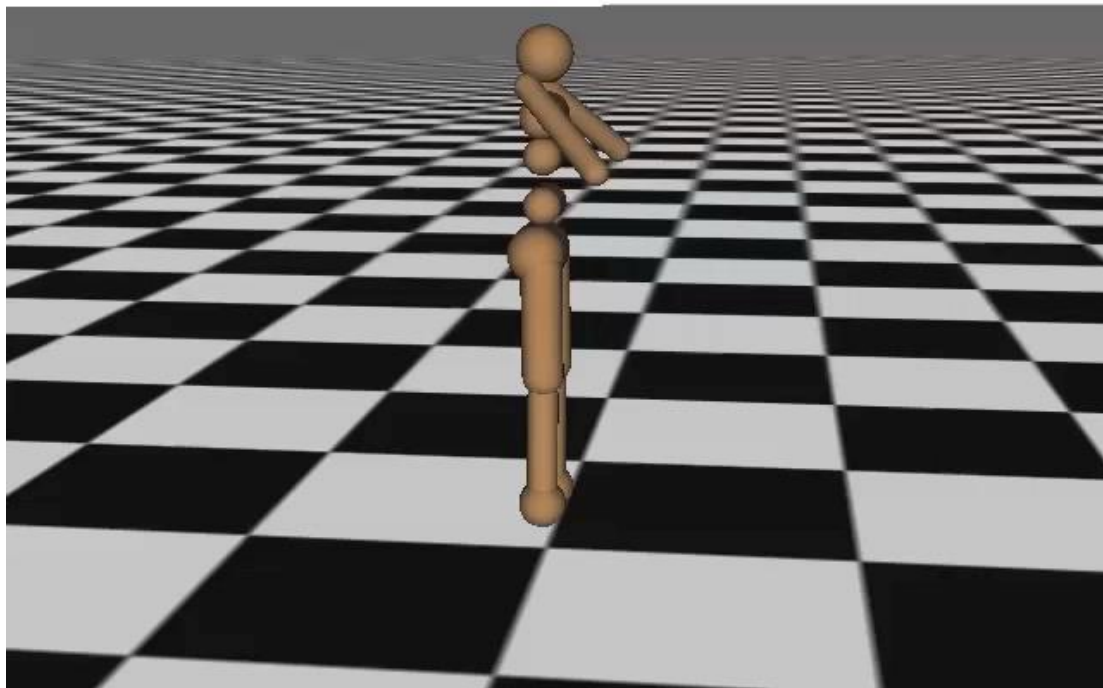




# Simulated Agents

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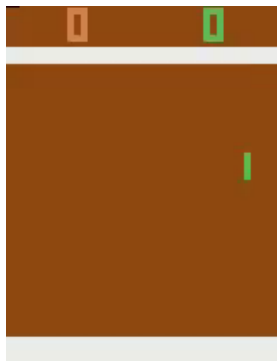
Iteration 0



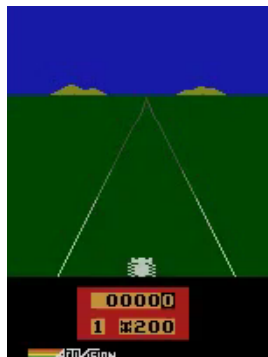
# Game Agents

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- Reinforcement learning



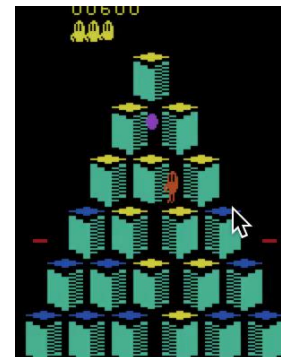
Pong



Enduro



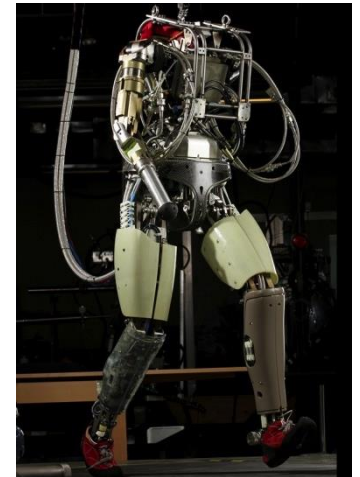
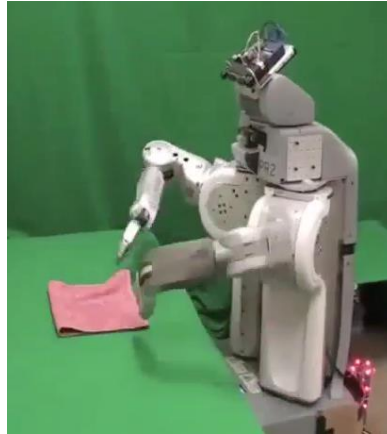
Beamrider



Q\*bert

# Robotics

- Robotics
  - Part mech. eng.
  - Part AI
  - Reality much harder than simulations!
- Technologies
  - Vehicles
  - Rescue
  - Help in the home
  - Lots of automation...



# Robots

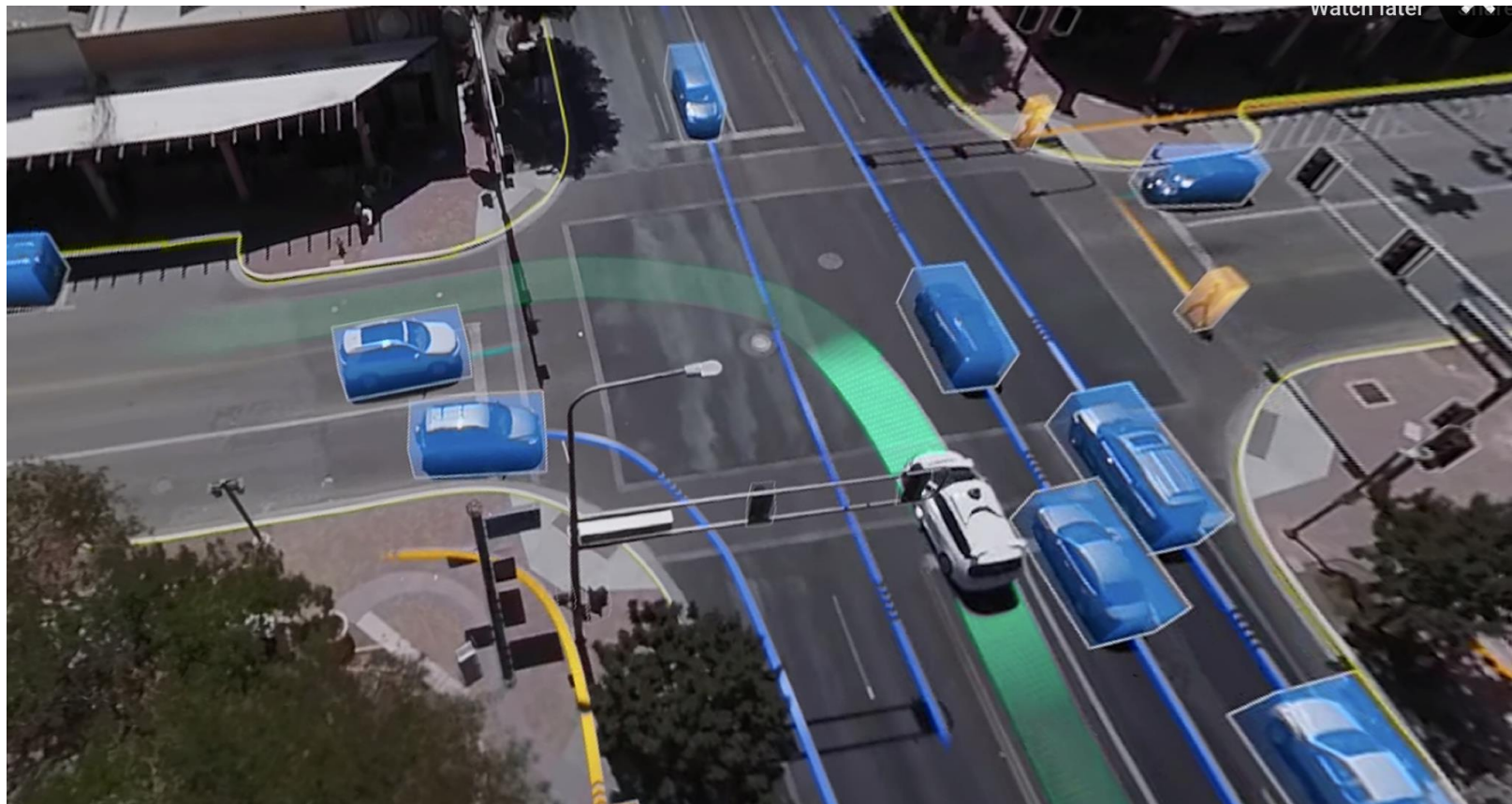
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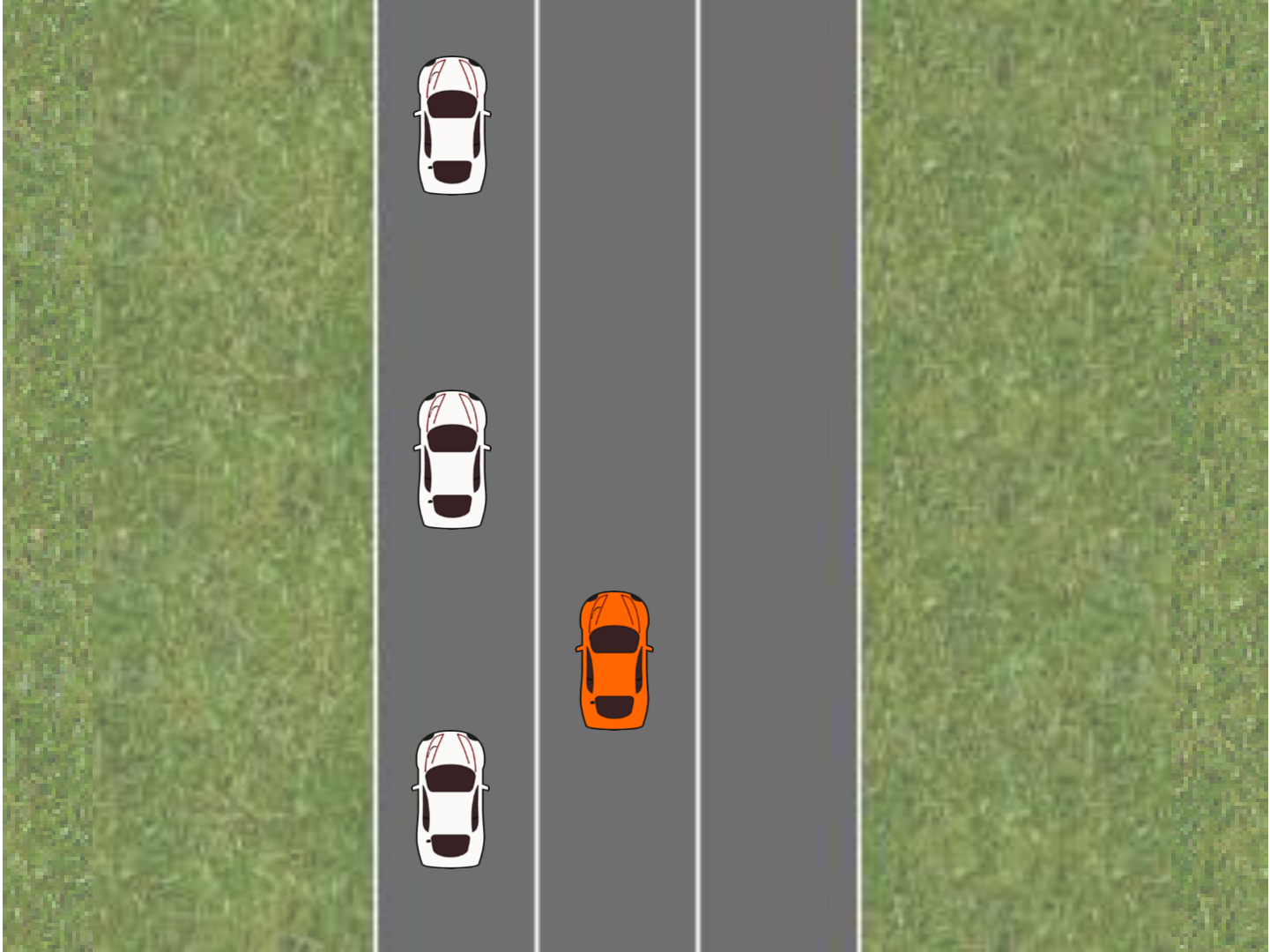
# Human-AI Interaction

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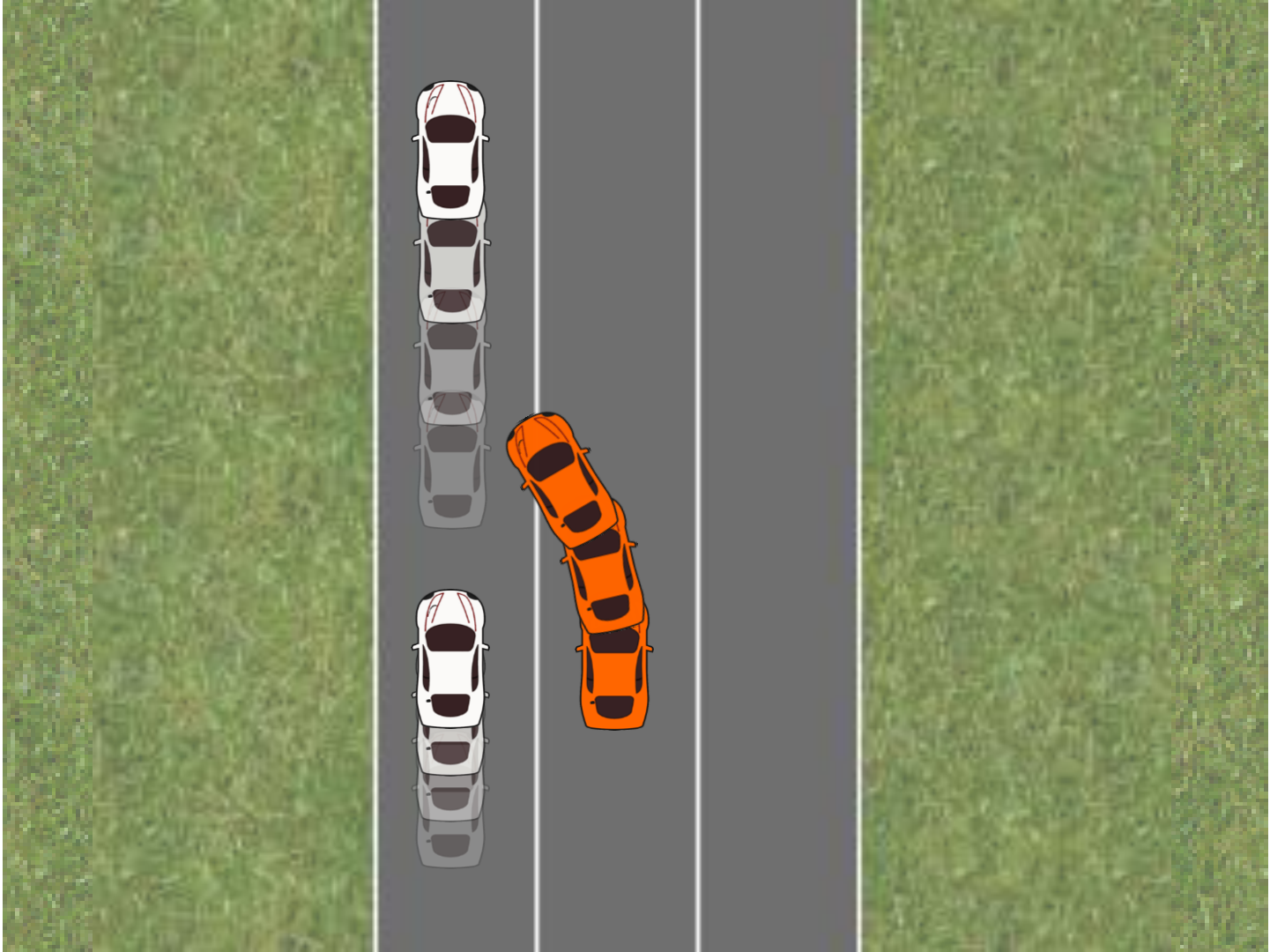












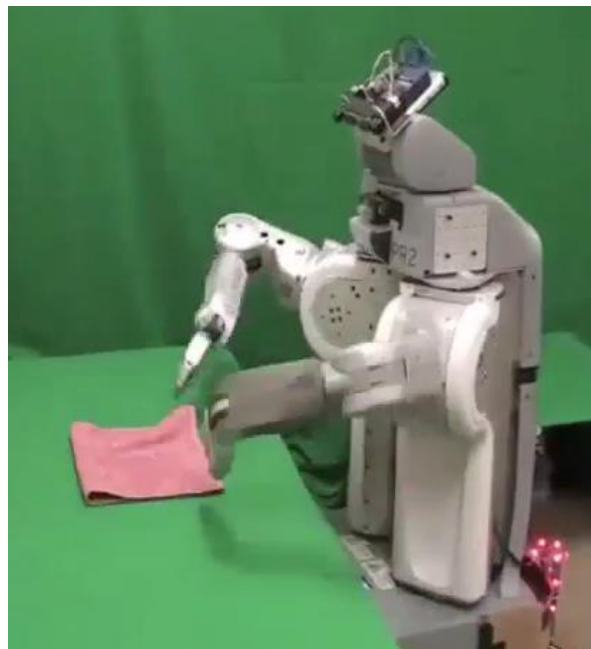
# Utility?

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**Clear utility function**



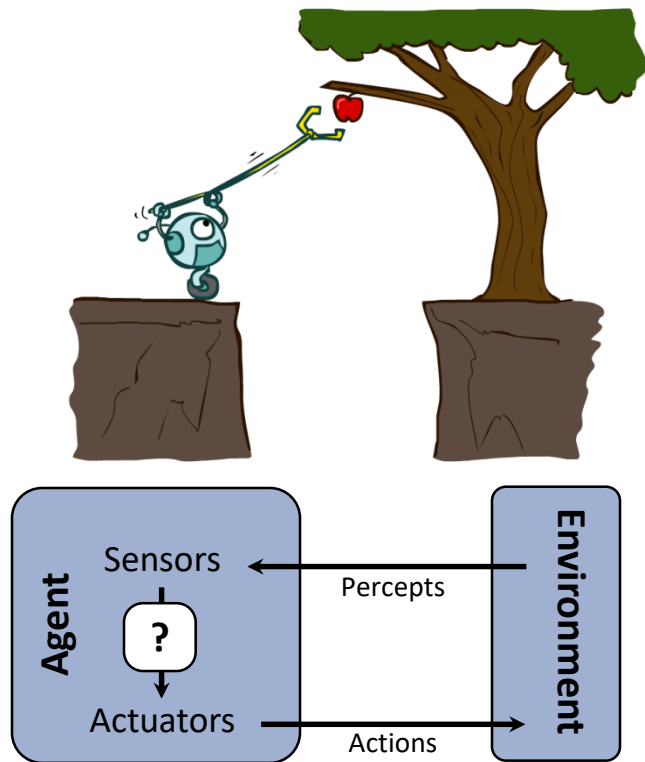
**Not so clear utility function**



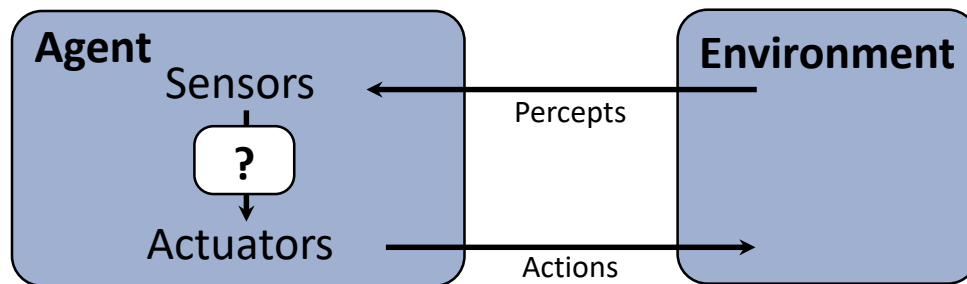
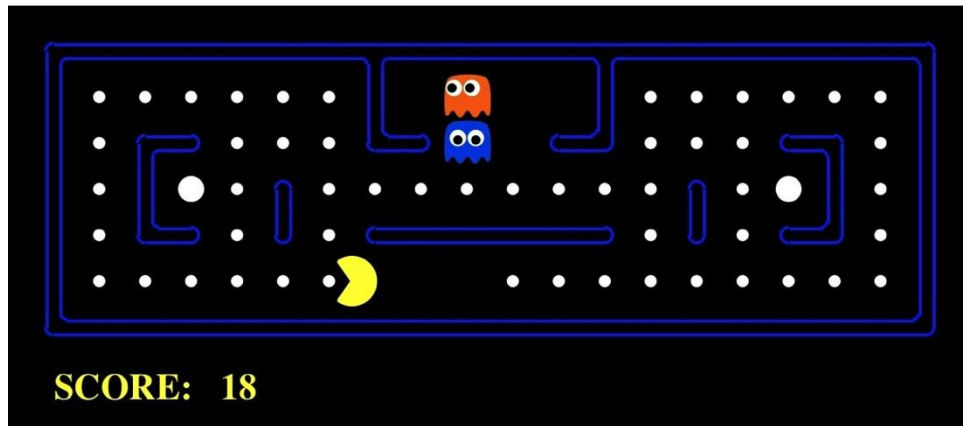


# Designing Rational Agents

- 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



# Maximize Your Expected Utility

