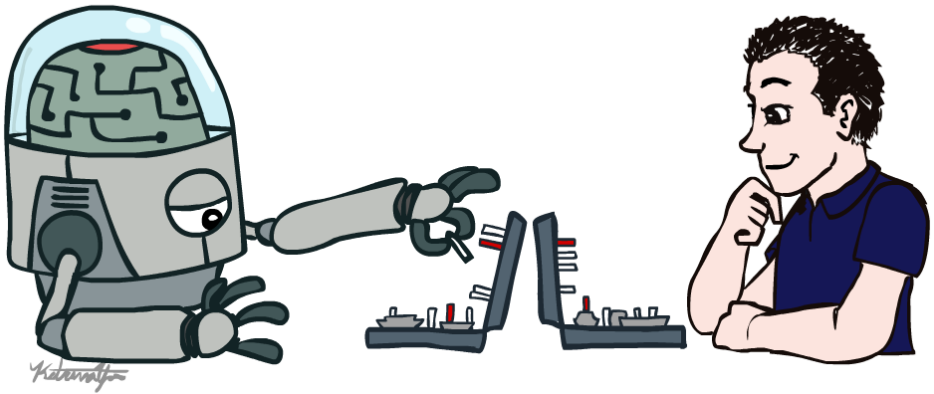
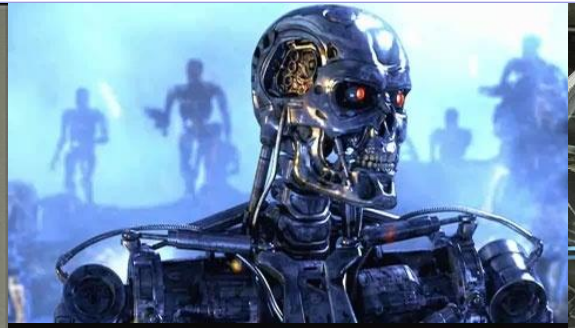
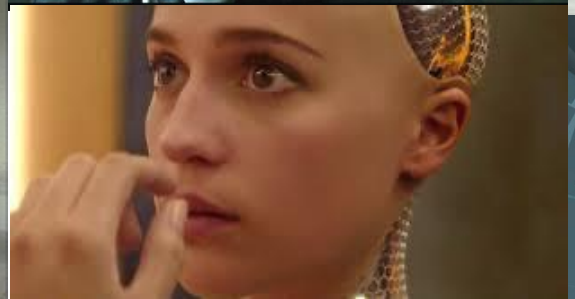
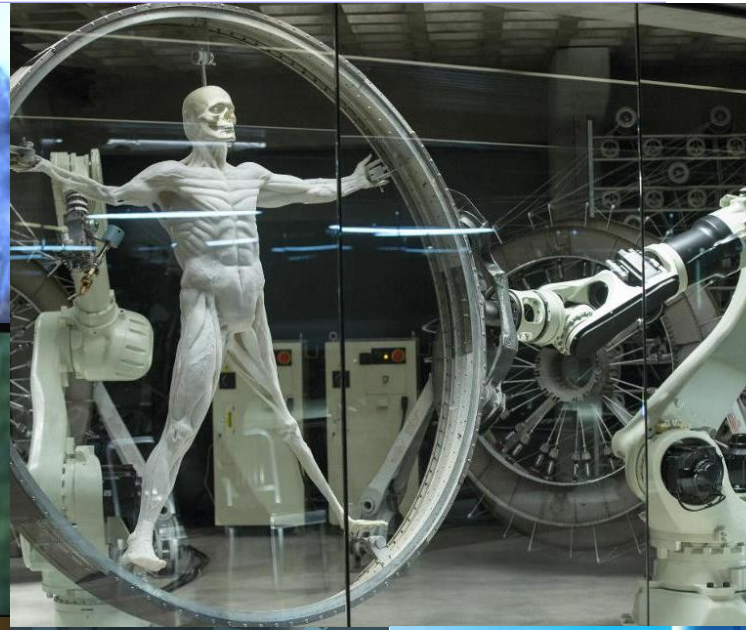
Artificial Intelligence



Sci-Fi AI?







WAYMO

TUG
CAUTION
MAY CONTAIN
CHEMOTHERAPY DRUG
CAUTION
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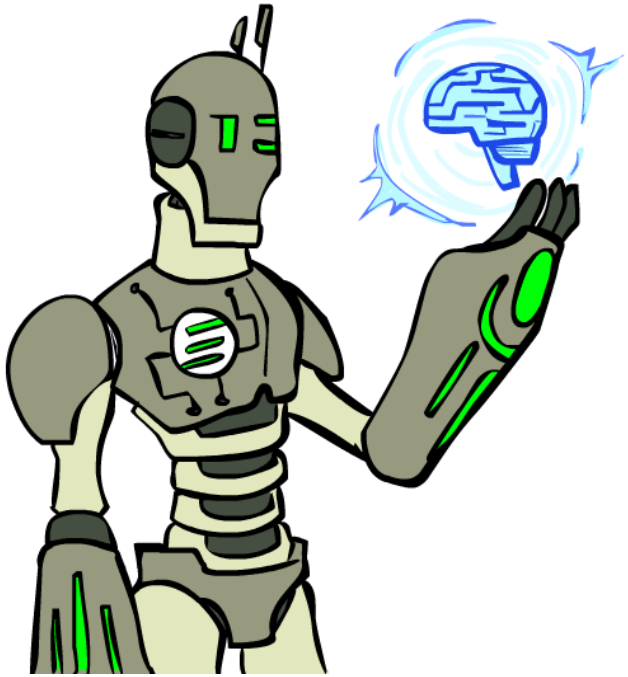
Today

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

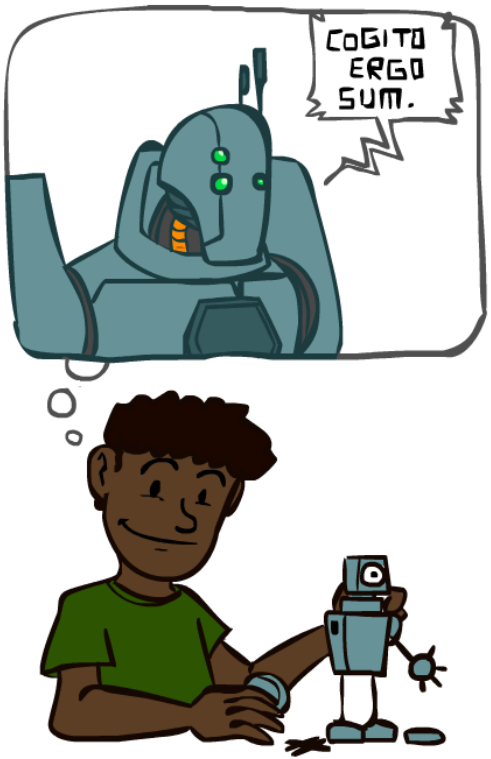


About Course

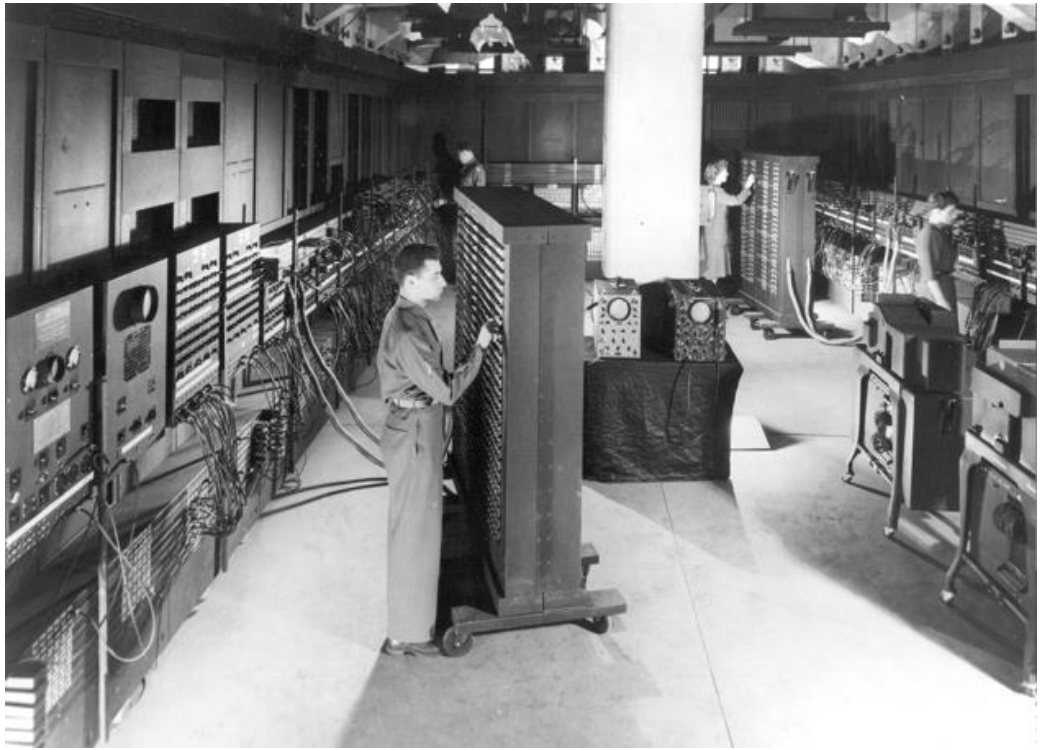
- *Text Book:*
  - *Artificial Intelligence: A Modern Approach. Third Edition. – Stuart Russell and Peter Norvig* ***(AIMA)***

- *References:*
  - *Building Problem Solvers – K.D.Forbus and J.D.Kleer*
  - *Knowledge Representation and Reasoning*– R. Brachman & H. Levesque
  - *Artificial Intelligence. Third Edition – Patrick Winston*

A (Short) History of AI



ENIAC (1940s)



Early AI: 1940-1950

- 1943- McCulloch and Walter Pitts- Neural Network

Turing Test-1950s

1950: Turing asks the question….

I propose to consider the question:

"Can machines think?"

--Alan Turing, 1950

Early AI: 1950—70

- 1950s: Early AI programs, including Samuel's checkers program, Newell & Simon's Logic Theorist, Gelernter's Geometry Engine

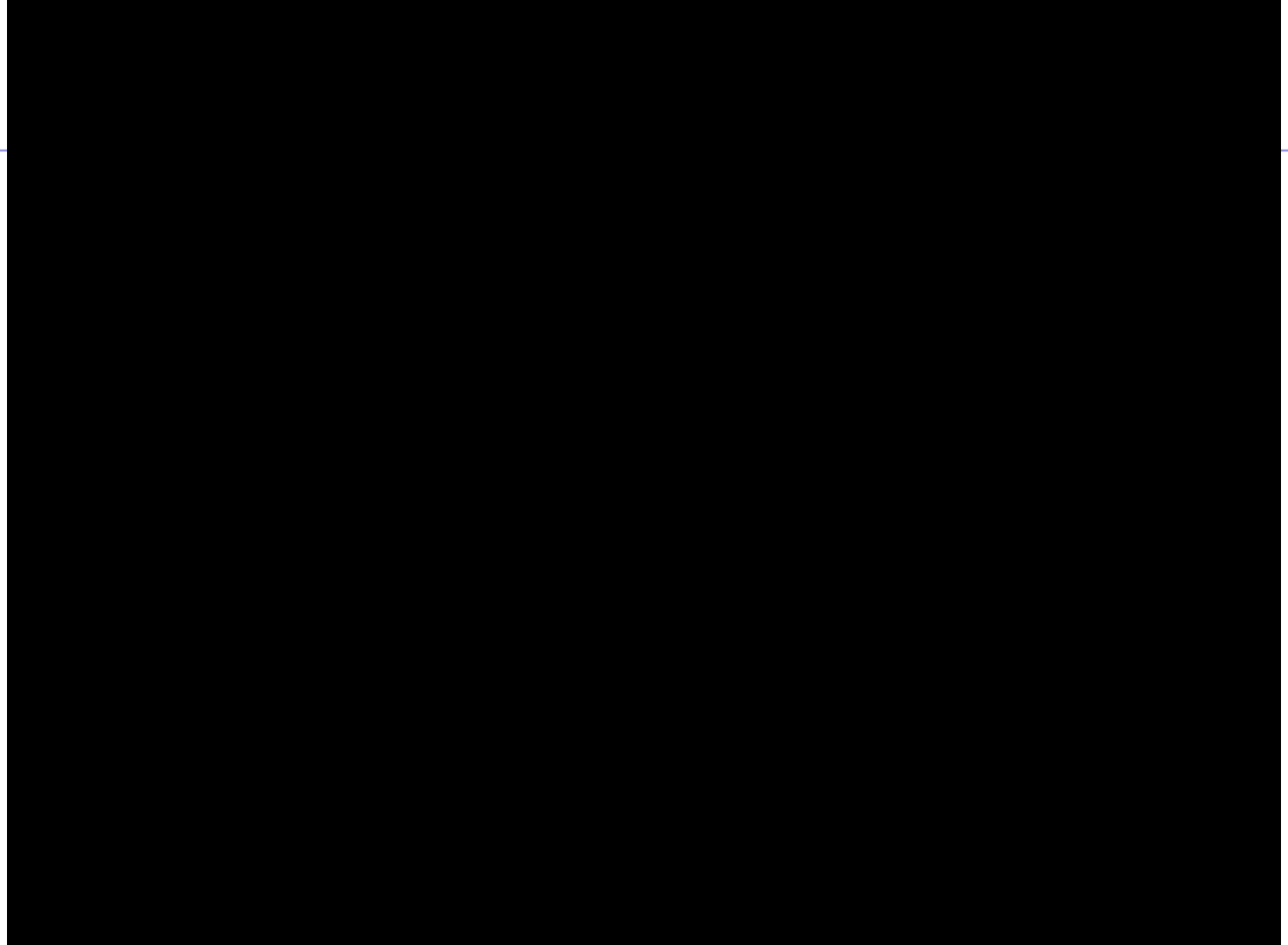
- 1956: Dartmouth meeting: "Artificial Intelligence" adopted as a separate field
  - 4 people: John McCarthy, Marvin Minsky, Claude Shannon and Nathaniel Rochester.
  - The Dartmouth Summer Research Project on Artificial Intelligence was a 1956 summer workshop widely considered to be the founding event of artificial intelligence as a field.

- 1958: LISP by John McCarrthy. Became a dominant AI language.

Early AI: 1950—70

- 1964: First Chat bot- Eliza-psychotherapist
- 1965: Robinson's complete algorithm for logical reasoning
- 1966: Shakey- the general purpose mobile robot at Stanford research institute

"Look ma, no hands!" era- John McCarthy



Knowledge-based approaches: 1970—90

- 1969—79: Early development of knowledge-based systems
  - Failure of neural network
  - Poor speech understanding
  - Failed machine translation (Russian to English)
    - Caused cancelation of govt. funds

- 1980—88: Expert systems industry booms
  - Decline of LISP

- 1988—93: Expert systems industry busts: “AI Winter”
- 1988- Backpropagation

Statistical approaches + subfield expertise: 1990—2012

- 1996: EQP (an algorithm) proves Robbins algebra are Booleans
- 1997: Deep blue wins chess vs Gary Kasparov
  - "I could feel human level intelligence across room- Gary Kasparov"
  - "Deep Blue hasn't proven anything."
  - "If it works it is not AI"
  - But now can a human defeat the machine in a series of game??????

- Early 2000s: Resurgence of probability, focus on uncertainty
- 2005: DARPA- Driverless car (first working demonstration)
- Agents and learning systems… "AI Spring"?

Present AI: 2010s to present

- 2011: IBM Watson won the Jeopardy vs Ken Jennings and Brad Rutter
  - “I, for one, welcome our new computer overlords,” - Ken Jennings

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

2016:Alpha Go

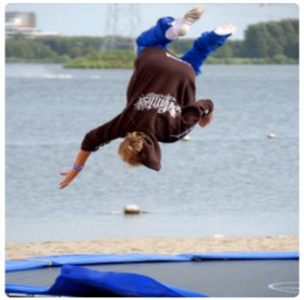
Lee Se-dol while playing with the AI

Computer Vision

"man in black shirt is playing guitar."

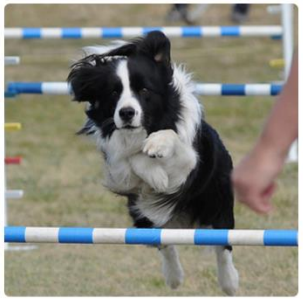
"construction worker in orange safety vest is working on road."

"two young girls are playing with lego toy."



"boy is doing backflip on wakeboard."

"girl in pink dress is jumping in air."



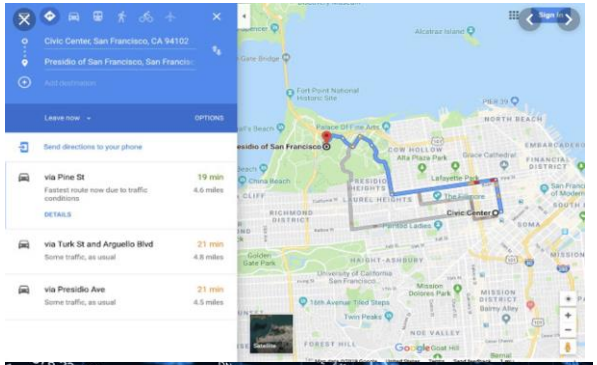
"black and white dog jumps over bar."

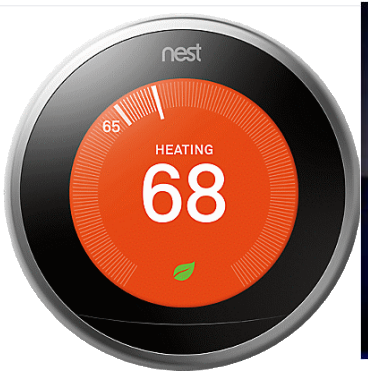
"young girl in pink shirt is swinging on swing."

"man in blue wetsuit is surfing on wave."

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

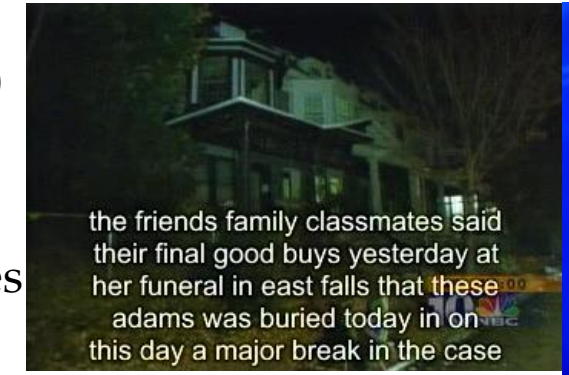
Tools for Predictions & Decisions



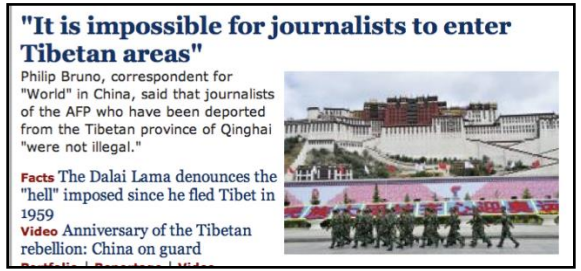


Natural Language

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



- Language processing technologies
  - Question answering
  - Machine translation

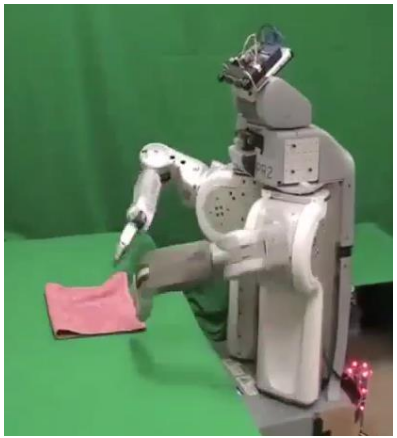


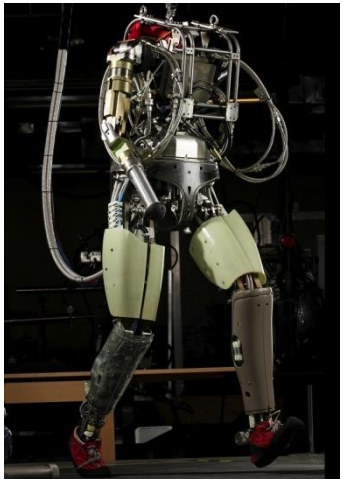
  - Web search
  - Text classification, spam filtering, etc…

https://play.aidungeon.io/

Robotics

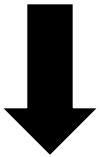
- Robotics
  - Part mech. eng.
  - Part AI
  - Reality much harder than simulations!
- Technologies
  - Vehicles
  - Rescue
  - Help in the home
  - Lots of automation…
- In this class:
  - We ignore mechanical aspects
  - Methods for planning
  - Methods for control





Images from UC Berkeley, Boston Dynamics, RoboCup, Google

- If it works its not AI

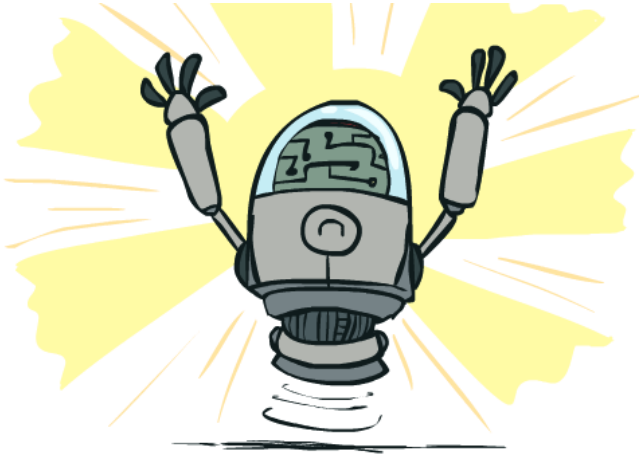


- It’s all AI

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?



How so much increase???

- DATA
- Computational Power
- Algorithms

Artificial Intelligence

- AI: What is the nature of intelligent thought?
- What is intelligence?????
  - *Dictionary meaning: capacity for learning, reasoning, understanding and similar for of mental activity*
- Ability to perceive and act in the world
- Reasoning: Proving theorems, Medical Diagnosis
- Planning: Take decisions
- Learning and Adaptation: Recommend Movies, learn traffic Patterns
- Understanding: Text, speech, visual scene

- Are human intelligent??????
- Are human *always* intelligent??????????
- Can non-human behavior be intelligent??????

What is AI?

The science of making machines that:

- Acting humanly
  - Turning Test
    - Do you want machine to make human like errors????
- Thinking humanly
  - Cognitive modeling
    - (very hard to understand how human think)
    - Intelligent tutor
    - Elderly healthcare bot
- Thinking Rationally
  - Laws of thought (Logic and reasoning, inferences and conclusion)
  - Purposeful thinking?
- Acting Rationally
  - Rational behavior: Doing right thing
  - What is rationality??

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 (data) and simulation (computation) are key to decision making

Rational Agents

- An agents should strive to do right thing, based on what it can perceive and the actions it can perform.
- The right action is the one that will cause the agent to be the most successful
- Performance measure: An objective criterion for success of an agent's behavior
- For example: performance measure of a vacuum cleaner agent could be the amount of dirt cleaned up, time taken, electricity consumed, etc.

Ideal Rational Agents

- "For each possible percept sequence, does whatever action is expected to maximize its performance measure on the basis of evidence perceived so far and built in knowledge"

- RATIONALITY vs OMINISCIENCE???
- Acting in order to obtain information

Rational Decisions

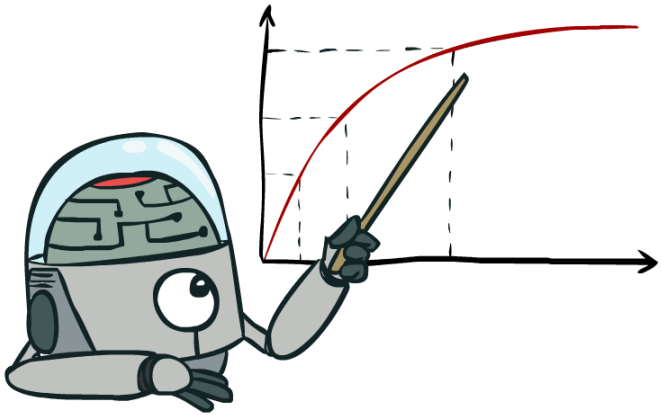
We'll use the term **rational** in a very specific, technical way:

- 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**

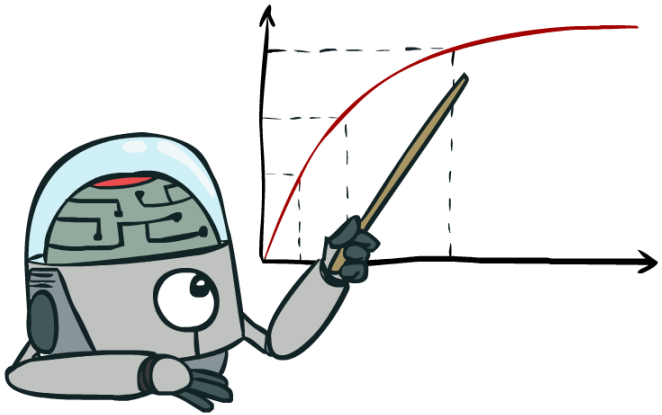
A better title for this course would be:

Computational Rationality

Maximize Your Expected Utility



Maximize Your Expected Utility



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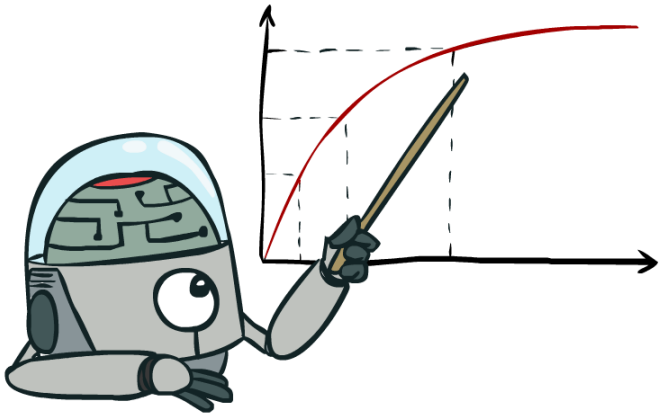

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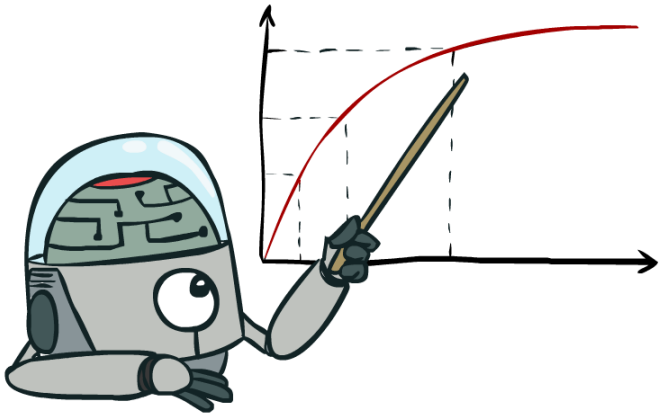

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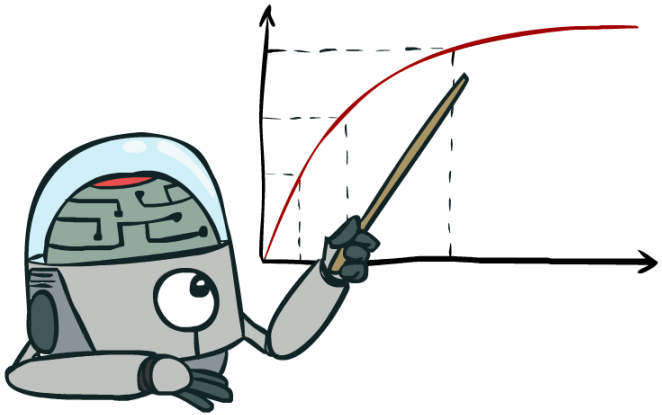
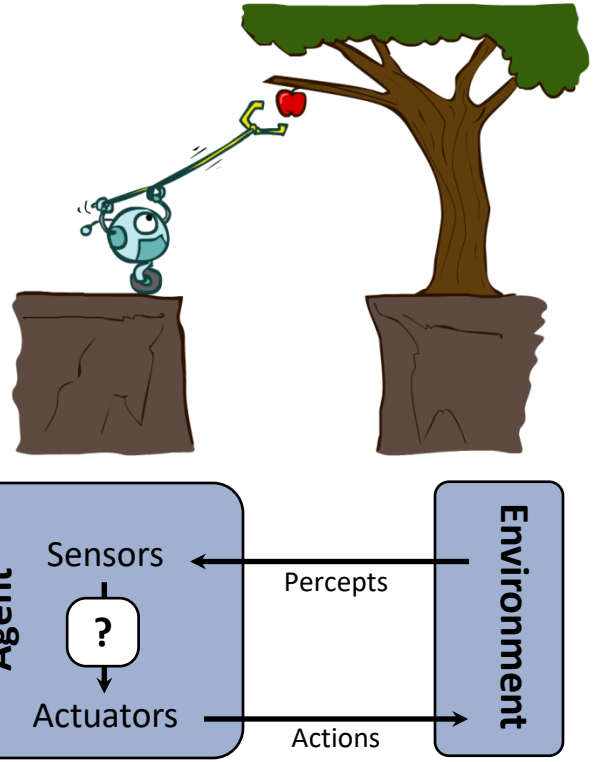


Designing Rational Agents

- 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