CSE 573: Artificial Intelligence
Winter 2017

Introduction & Agents

Dan Weld

TBD

Gagan Bansal

Mon 2:00pm (starting 1/23)

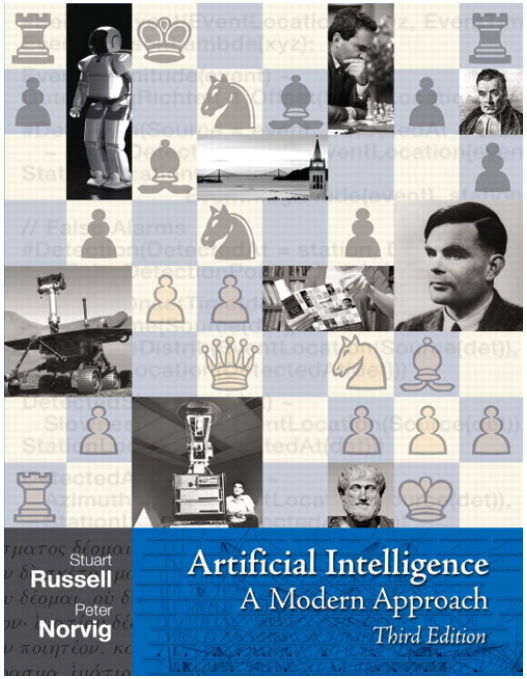
With slides from

Dieter Fox, Dan Klein, Stuart Russell, Andrew Moore, Luke Zettlemoyer

Course Logistics

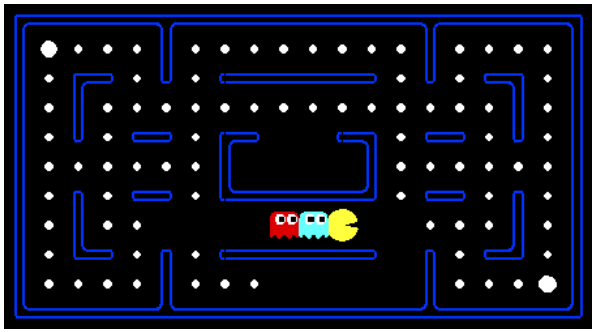
Textbook:

Artificial Intelligence: A Modern Approach, Russell and Norvig (3rd ed)



Work:

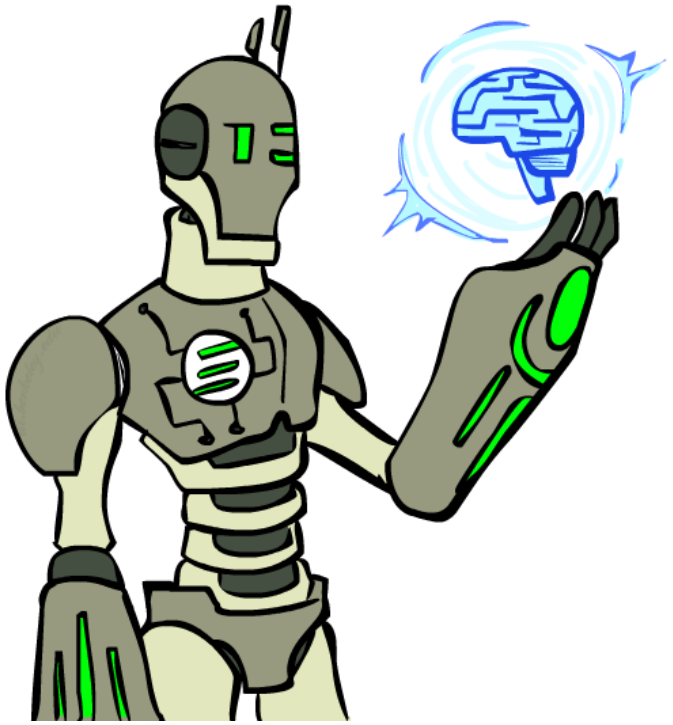
Programming Assignments
Final Exam
Mini-project
Paper Reviews &
Class participation



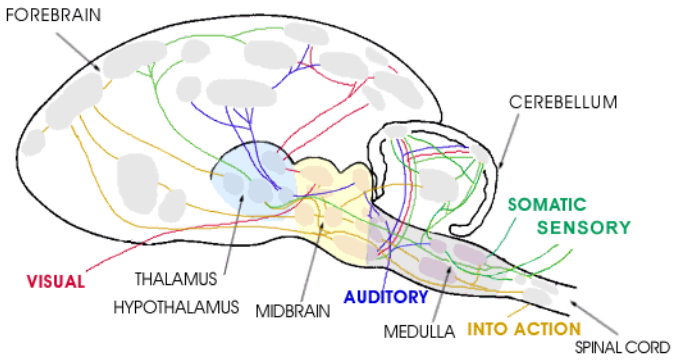
Pacman, autograder

Today

- What is (AI)?
- Agency
- What is this course?



Brain: Can We Build It?



10^{11} neurons
10^{14} synapses
cycle time: 10^{-3} sec

vs.

10^{9} transistors
10^{12} bits of RAM
cycle time: 10^{-9} sec

What is AI?

The science of making machines that:

Think like humans	Think rationally
Act like humans	Act rationally

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The science of making machines that:

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Rational Decisions

We'll use the term **rational** in a particular way:

- Rational: maximally achieving pre-defined goals
- Rational 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**

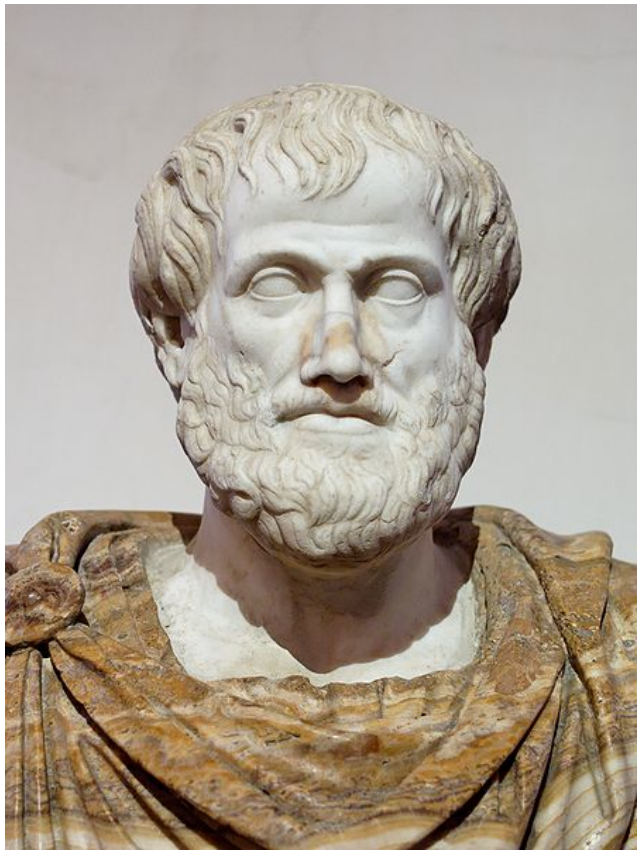
A better title for this course might be:

Computational Rationality

A (Short) History of AI

Prehistory

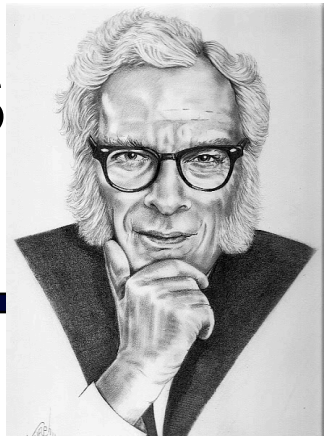
- Logical Reasoning: (4th C BC+) Aristotle, George Boole, Gottlob Frege, Alfred Tarski



Medieval Times

- Probabilistic Reasoning: (16th C+) Gerolamo Cardano, Pierre Fermat, James Bernoulli, Thomas Bayes

1940-1950: Early Days



1942: Asimov: Positronic Brain; Three Laws of Robotics

1. A robot may not injure a human being or, through inaction, allow a human being to come to harm.
2. A robot must obey the orders given to it by human beings, except where such orders would conflict with the First Law.
3. A robot must protect its own existence as long as such protection does not conflict with the First or Second Laws.

1943: McCulloch & Pitts: Boolean circuit model of brain

1946: First digital computer - ENIAC

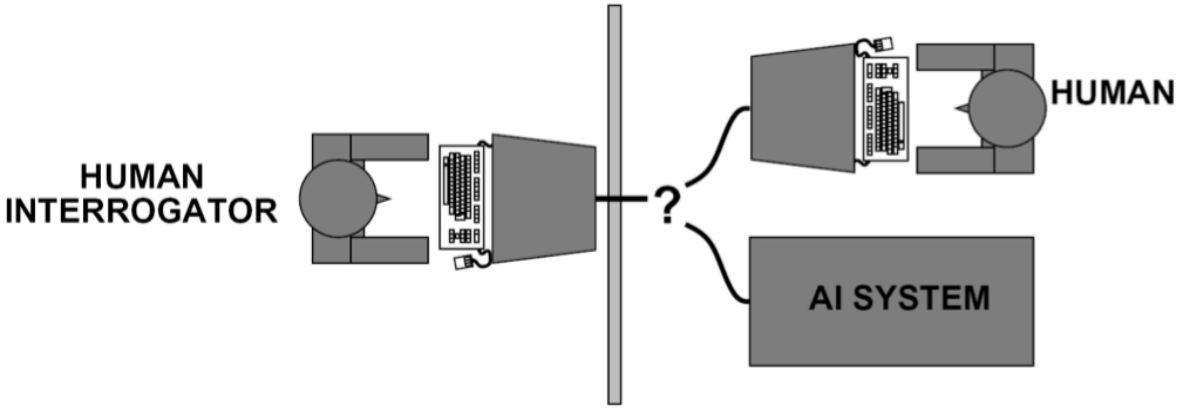
The Turing Test

Turing (1950) "Computing machinery and intelligence"

- "Can machines think?"

  "Can machines behave intelligently?"

- The *Imitation Game:*



- Suggested major components of AI: knowledge, reasoning, language understanding, learning

1950-1970: Excitement about ***Search***

- 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

"Over Christmas, Allen Newell and I created a thinking machine."

-Herbert Simon

1970-1980: Knowledge Based Systems

- 1969-79: Early development of knowledge-based systems
- 1980-88: Expert systems industry booms
- 1988-93: Expert systems industry busts

  "AI Winter"

> The knowledge engineer practices the art of bringing the principles and tools of AI research to bear on difficult applications problems requiring experts' knowledge for their solution.
>
> - *Edward Felgenbaum* in "The Art of Artificial Intelligence"

1988--: Statistical Approaches

- 1985-1990: Rise of Probability and Decision Theory

  Eg, Bayes Nets

  Judea Pearl - ACM Turing Award 2011

- 1990-2000: Machine learning takes over subfields:

  Vision, Natural Language, etc.

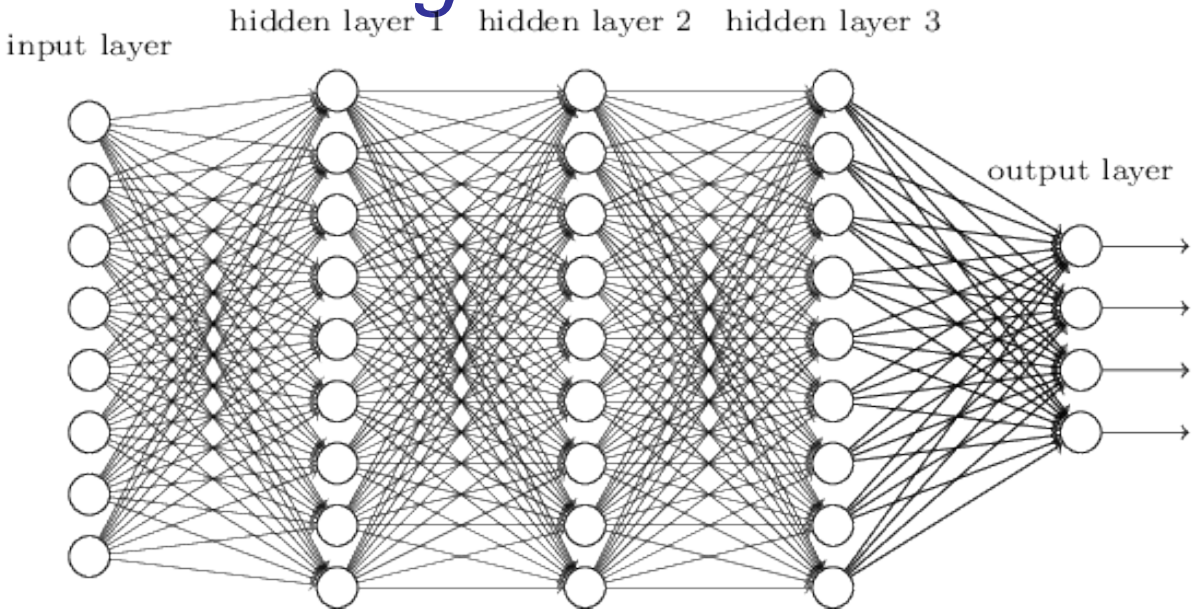
"Every time I fire a linguist, the performance of the speech recognizer goes up"

- *Fred Jelinek*, IBM Speech Team

2015 Deep NN Tsunami

"Deep Learning waves have lapped at the shores of computational linguistics for several years now, but 2015 seems like the year when the full force of the tsunami hit the major Natural Language Processing (NLP) conferences."

– Chris Manning

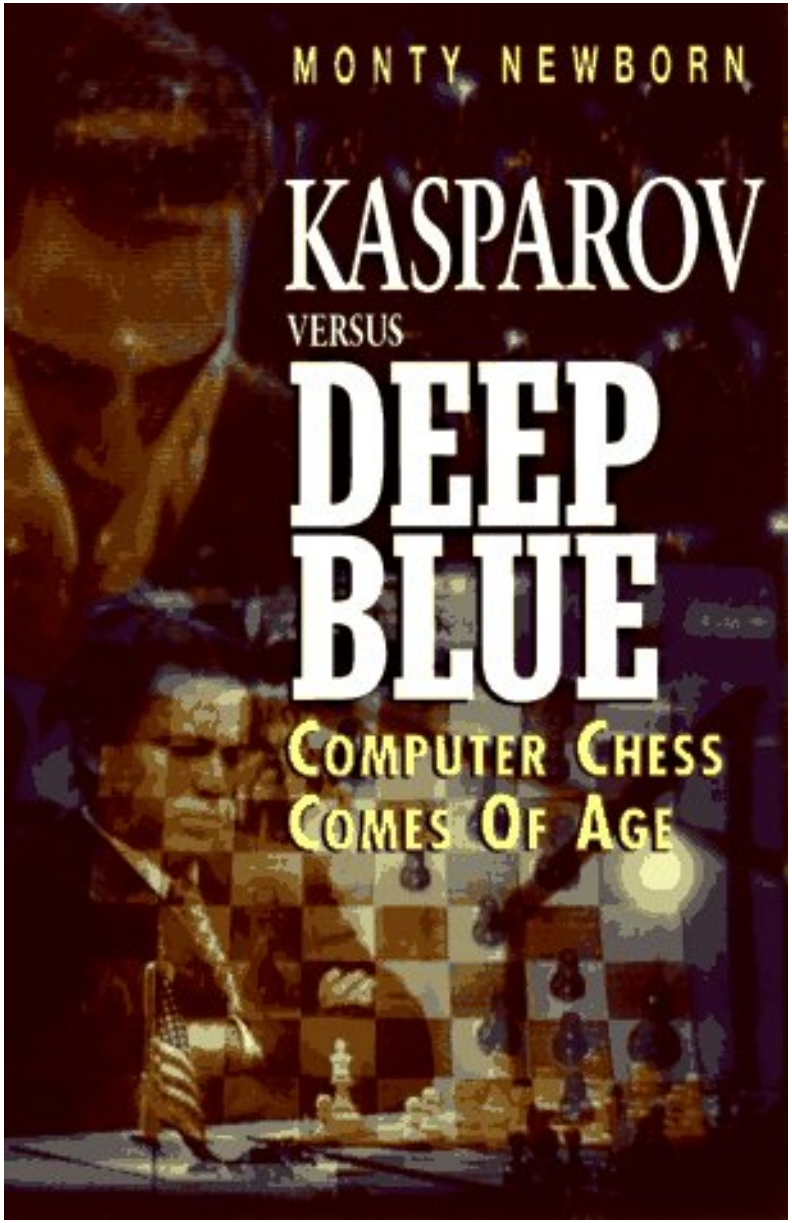


Milestones

1997

"I could feel – I could smell – a new kind of intelligence across the table"

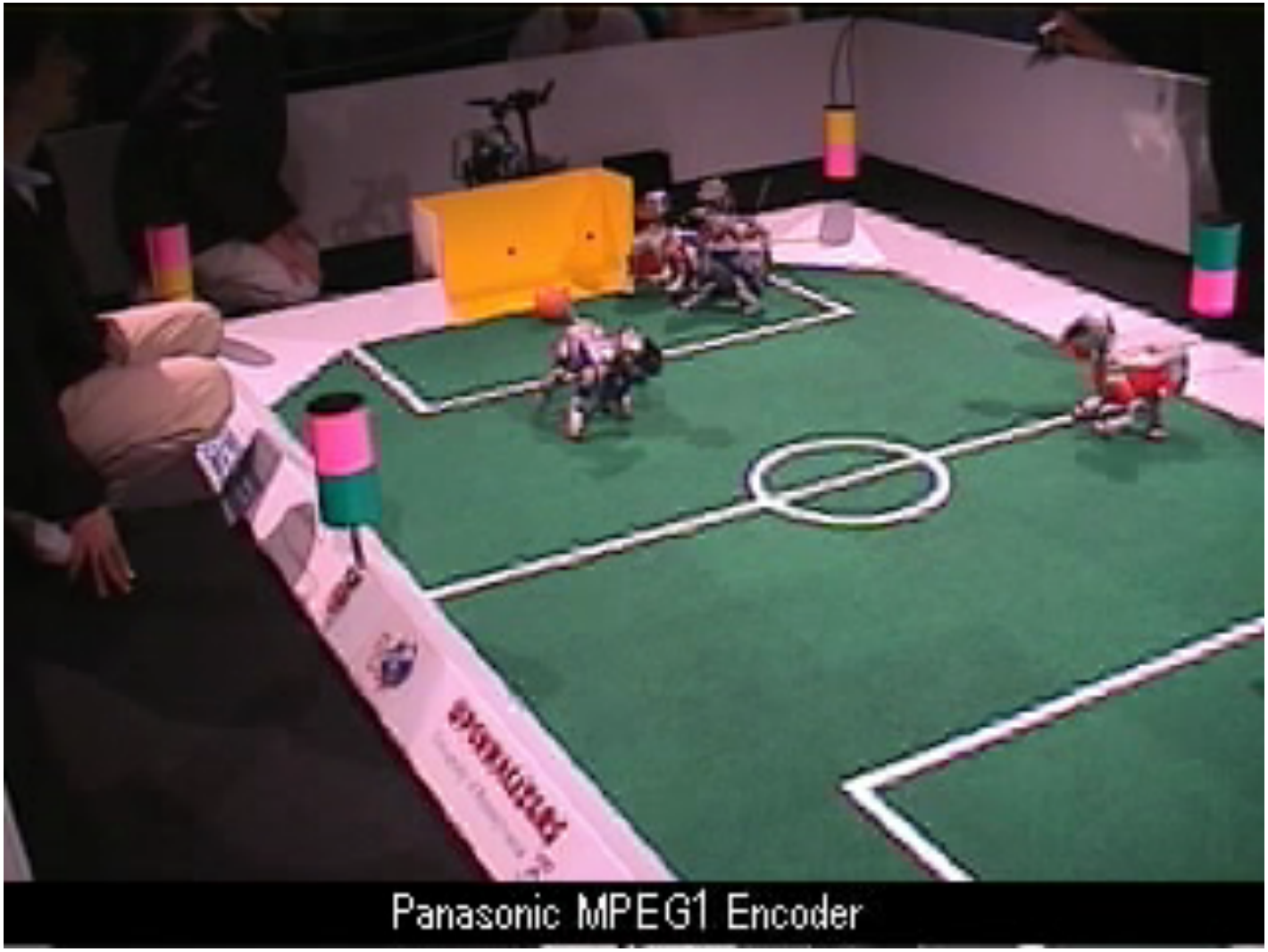
-*Gary Kasparov*



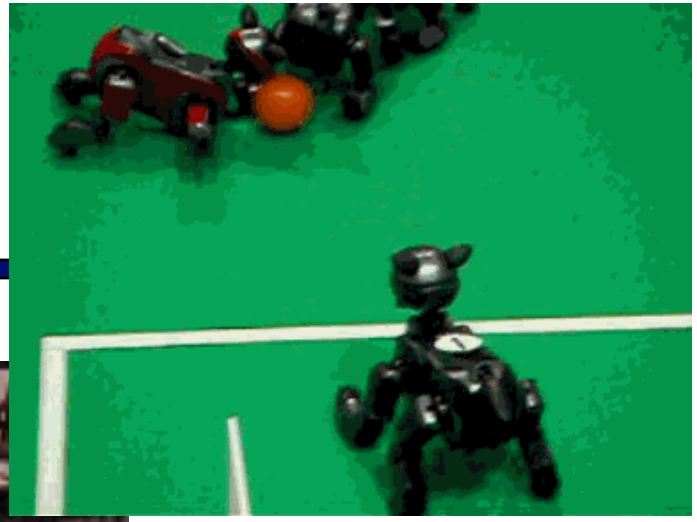
Saying Deep Blue doesn't really think about chess is like saying an airplane doesn't really fly because it doesn't flap its wings.

– *Drew McDermott*

Robocup (Stockholm ’99)



Robocup



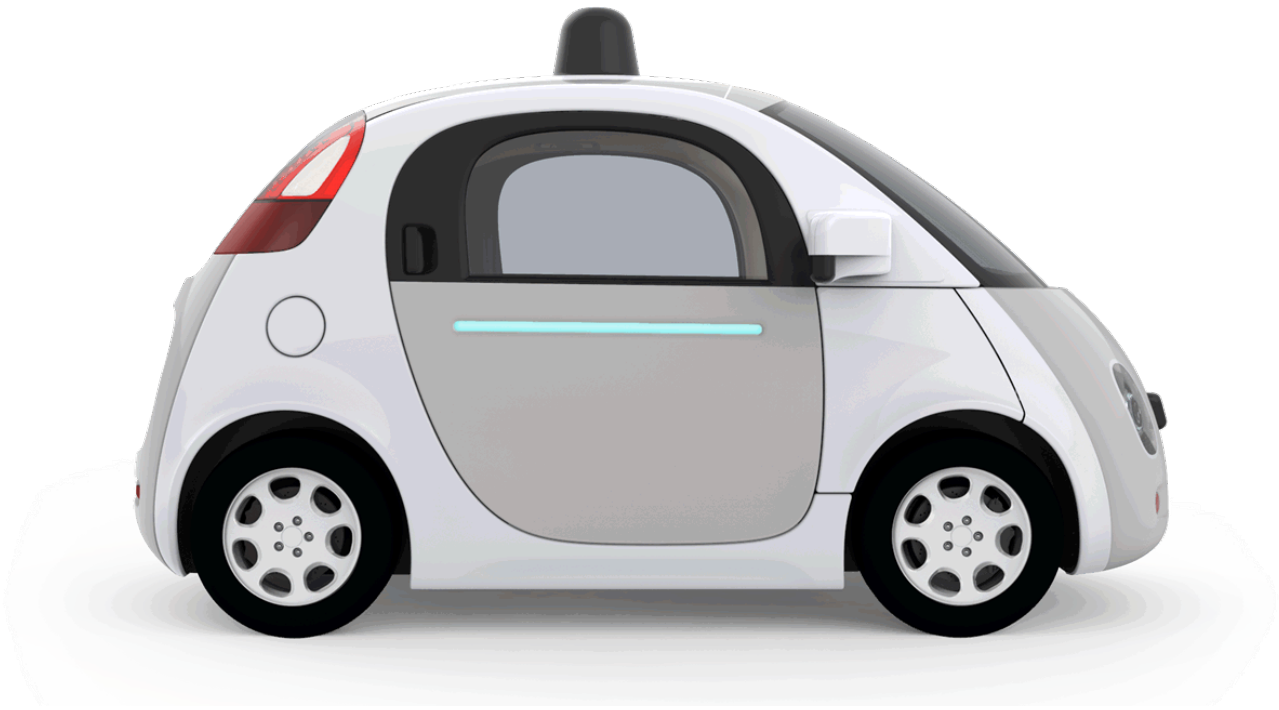
2005

Stanford Car
DARPA Grand Challenge

Google Self-Driving Car 2014

https://www.youtube.com/watch?v=TsaES--OTzM

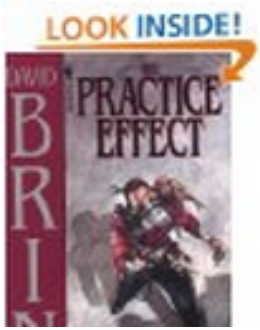
2016



2009

amazon Prime

More Top Picks for You

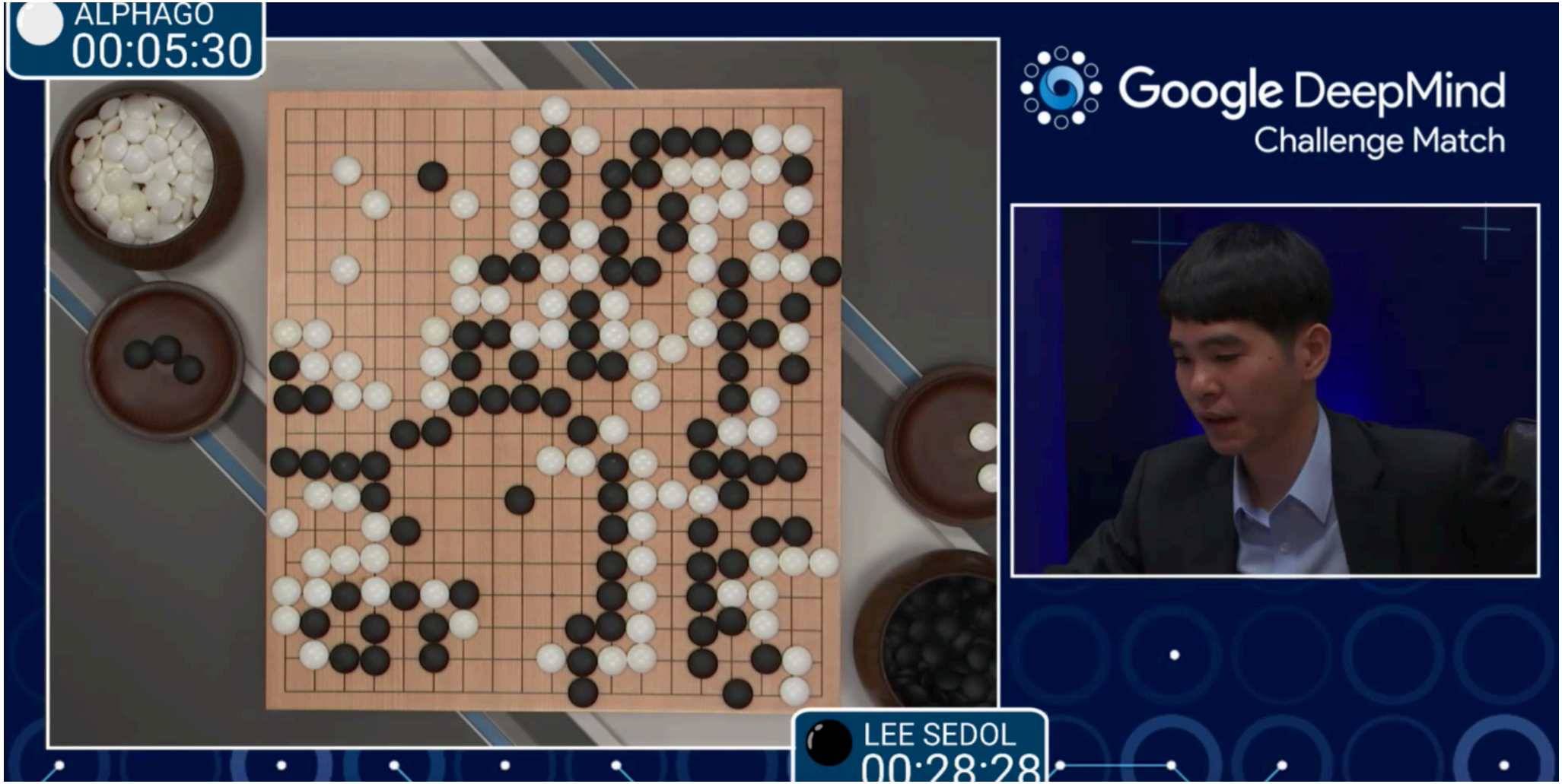


Recommendations,
Search result ordering
Ad placement,

2011

http://www.youtube.com/watch?v=WFR3lOm_xhE

2016



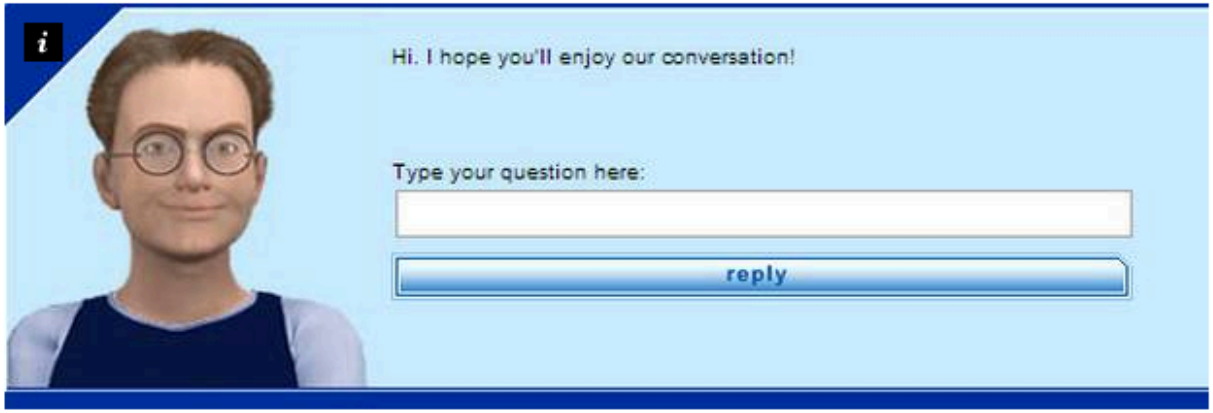
AlphaGo deep RL defeats Lee Sedol (4-1)

2014 = Momentous Times!

Fooled 33% of judges!

News > Technology

Turing Test breakthrough as super-computer becomes first to convince us it's human



Eugene Goostman, a computer programme pretending to be a young Ukrainian boy, successfully duped enough humans to pass the iconic test

ANDREW GRIFFIN | Sunday 08 June 2014

SHARE TWEET REDDIT SHARE Shares: 41K PRINT | A A A

A programme that convinced humans that it was a 13-year-old boy has become the first computer ever to pass the Turing Test. The test — which requires that computers are indistinguishable

Judges were not so smart

Conversation with Scott Aaronson:

Scott: Which is bigger, a shoebox or Mount Everest?

Eugene: I can't make a choice right now. I should think it out later. And I forgot to ask you where you are from…

Scott: How many legs does a camel have?

Eugene: Something between 2 and 4. Maybe, three? :-))) By the way, I still don't know your specialty – or, possibly, I've missed it?

Scott: How many legs does a millipede have?

Eugene: Just two, but Chernobyl mutants may have them up to five. I know you are supposed to trick me.

Scott: No, I need to know that you're not a chatbot. Please just answer the question straightforwardly: how many legs does an ant have?

Eugene: Something between 2 and 4. Maybe, three? :-))) Oh, what a fruitful conversation;-)

Scott: Do you understand why I'm asking such basic questions? Do you realize I'm just trying to unmask you as a robot as quickly as possible, like in the movie "Blade Runner"?

Summary Status of AI

- Where are we?

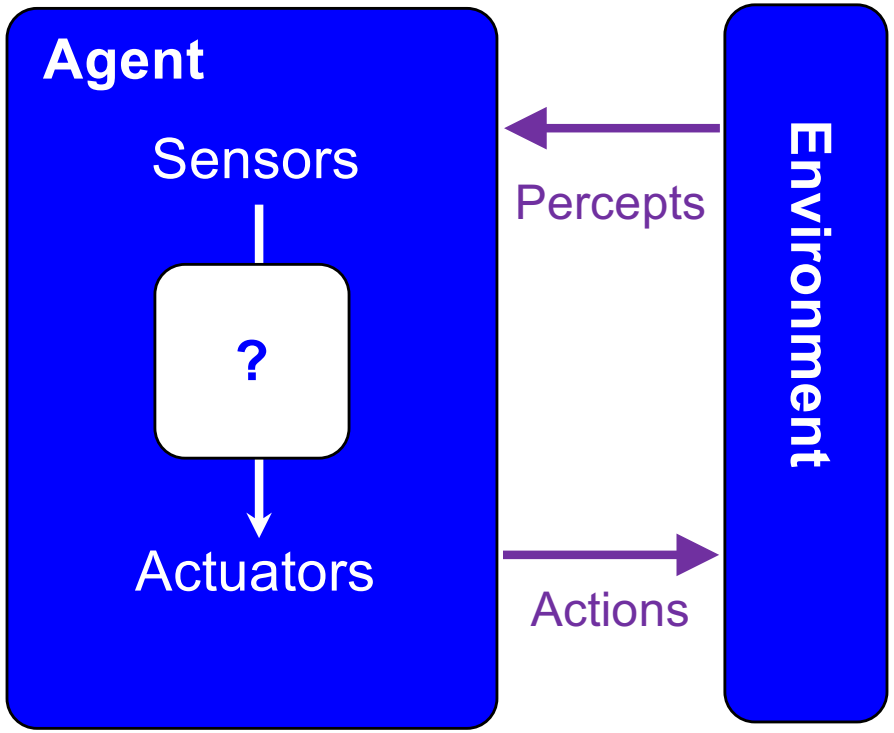
What is AI?

The science of making machines that:

Think like humans	Think rationally
Act like humans	**Act rationally**

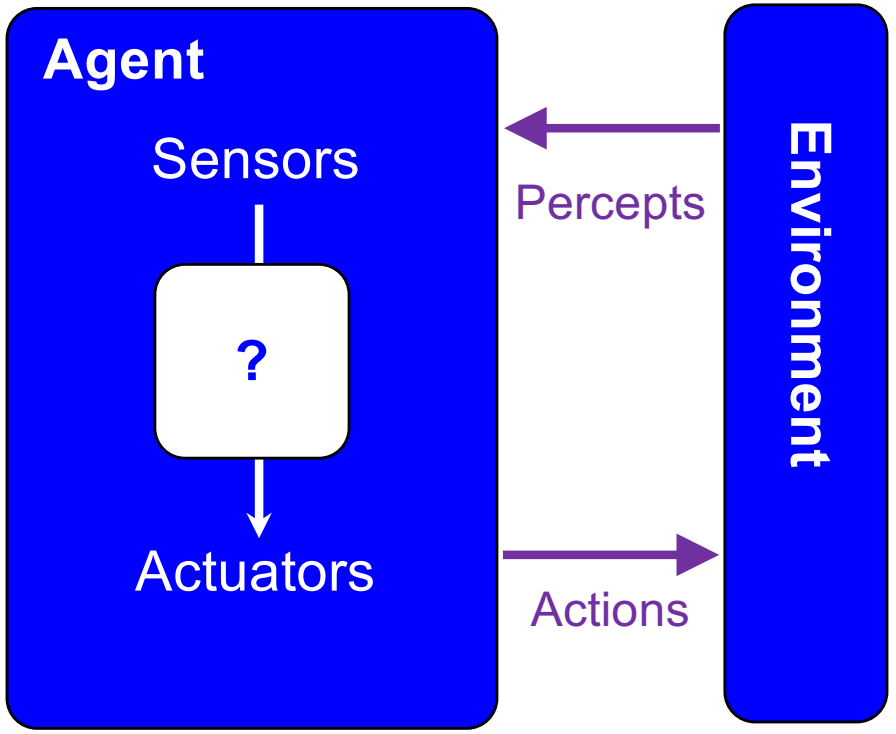
Agent *vs.* Environment

- An **agent** is an entity that *perceives* and *acts*.
- A **rational agent** selects actions that maximize its **utility function**.
- Characteristics of the **percepts, environment,** and **action space** dictate techniques for selecting rational actions.



CSE 573 *vs…?*

- CSE 515 – Stat methods
- CSE 517 – NLP
- CSE 546,7 – ML
- CSE 571 – Robotics
- CSE 574
- CSE 576,7 – Vision

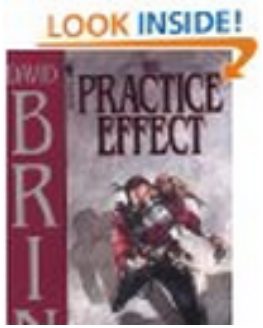


Actions? Percepts?

Actions? Percepts?

amazon Prime

More Top Picks for You



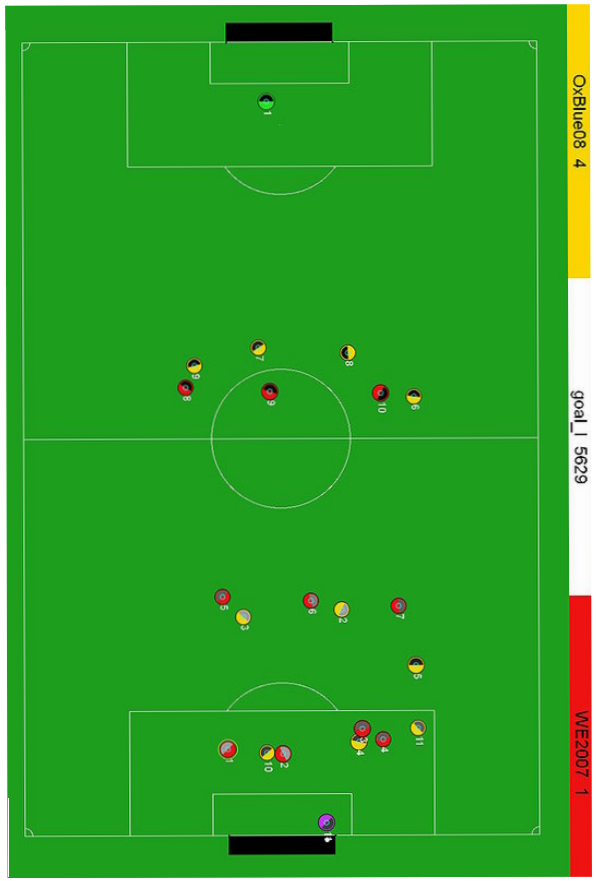
Recommender System

Types of Environments

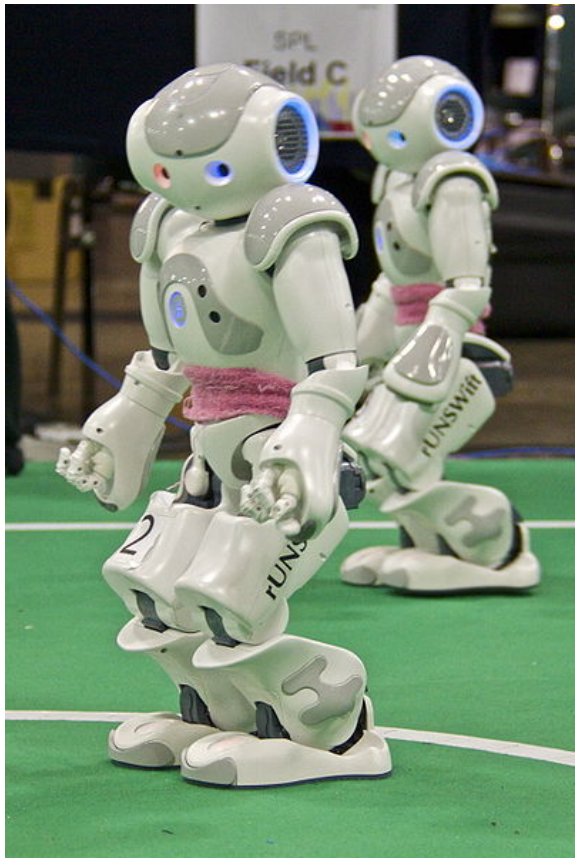
- Fully observable *vs.* partially observable
- Single agent *vs.* multiagent
- Deterministic *vs.* stochastic
- Episodic *vs.* sequential
- Discrete *vs.* continuous

Fully observable vs. Partially observable

Can the agent observe the complete state of the environment?



vs.



Single agent vs. Multiagent

Is the agent the only thing acting in the world?

vs.

Aka static *vs.* dynamic

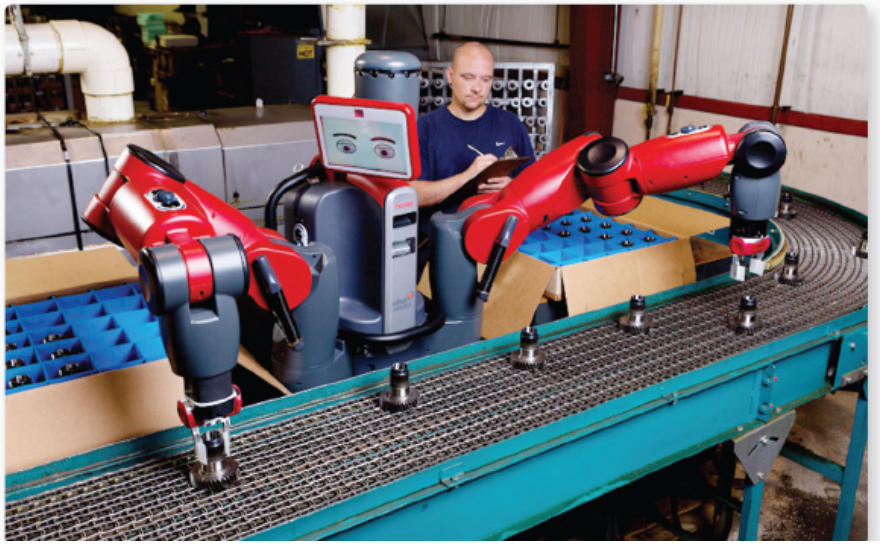
Deterministic vs. Stochastic

Is there uncertainty in how the world works?

vs.

Episodic vs. Sequential

Episodic: next episode doesn't depend on previous actions.



vs.

Discrete vs. Continuous

- Is there a finite (or countable) number of possible environment states?

vs.

Types of Agent

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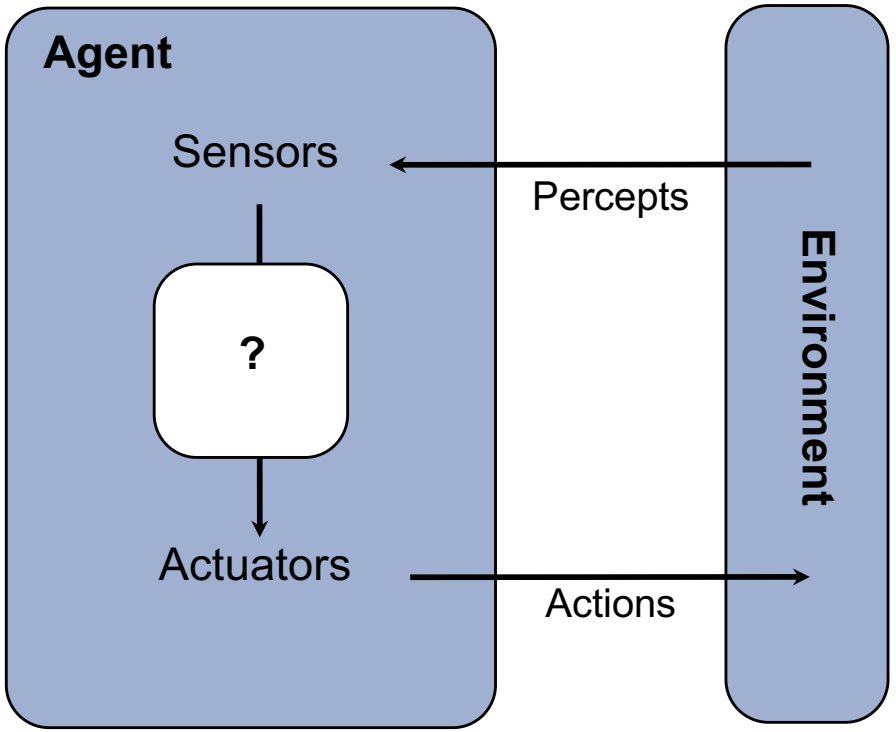


Reflex Agents

- Reflex agents:
  - Choose action based on current percept (and maybe memory)
  - Do not consider the future consequences of their actions
  - Act on how the world IS

Goal Based Agents

- Plan ahead
- Ask “what if”

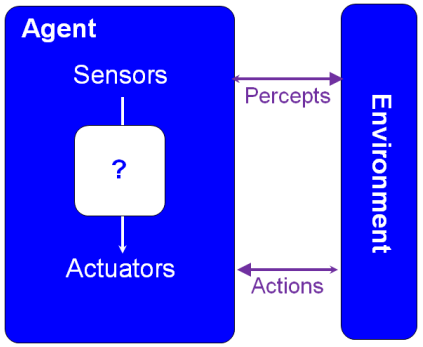
- Decisions based on (hypothesized) consequences of actions
- Uses a model of how the world evolves in response to actions

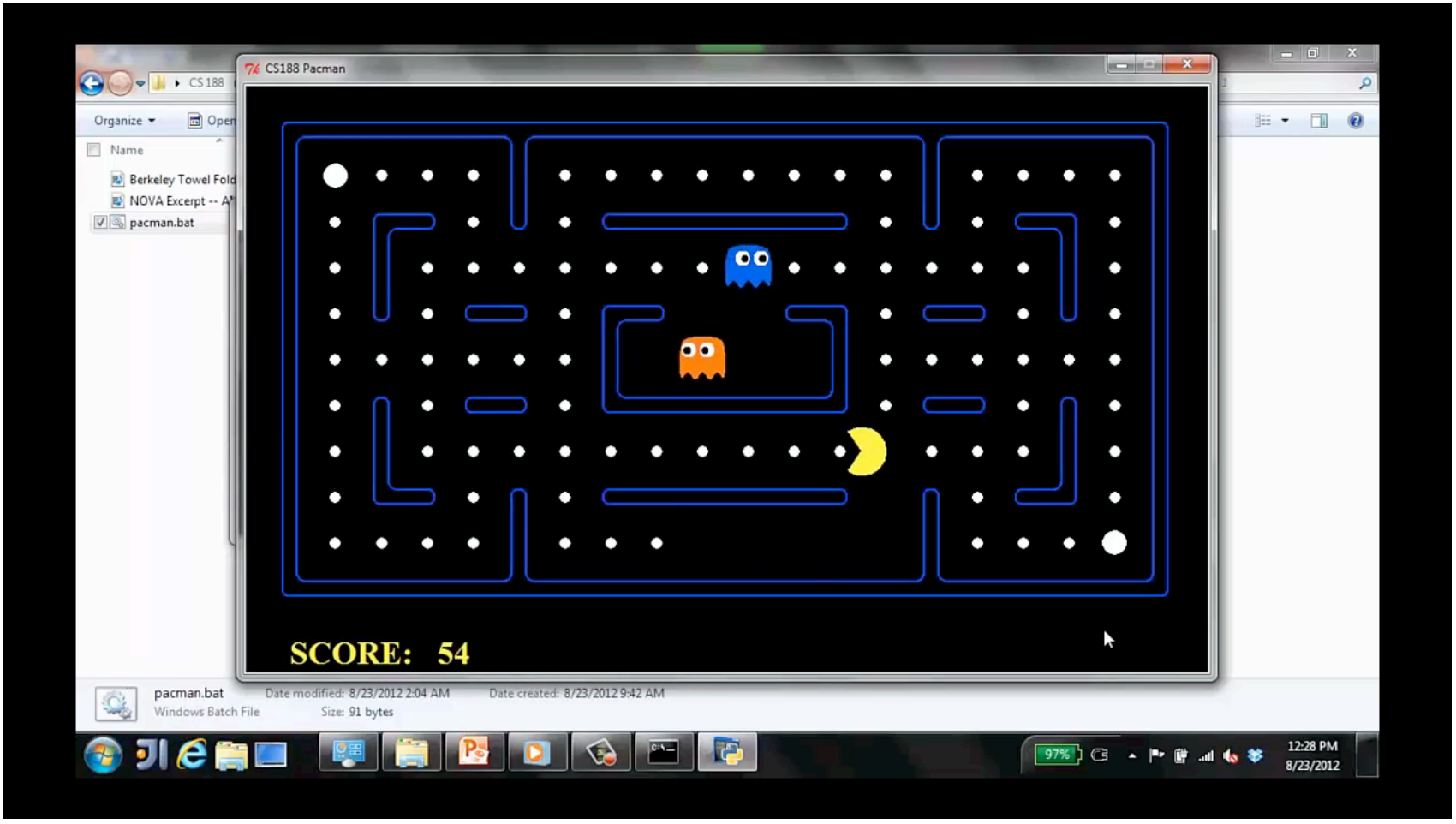
- Act on how the world WOULD BE

Utility Based Agents

- Like goal-based, but
- Trade off multiple goals
- Reason about probabilities of outcomes
- Act on how the world will LIKELY be

Pacman as an Agent





Originally developed at UC Berkeley:
http://www-inst.eecs.berkeley.edu/~cs188/pacman/pacman.html

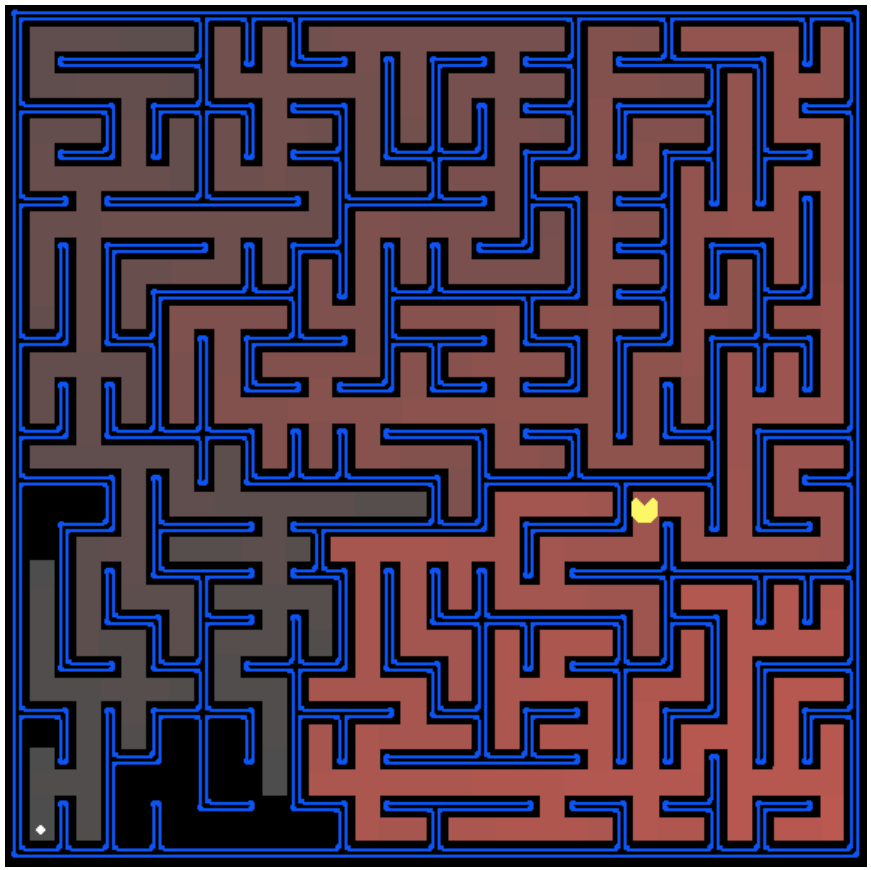
PS1: Search → 1/19

Goal:

- Help Pac-man find its way through the maze

Techniques:

- Search: breadth-first, depth-first, etc.
- Heuristic Search: Best-first, A*, etc.



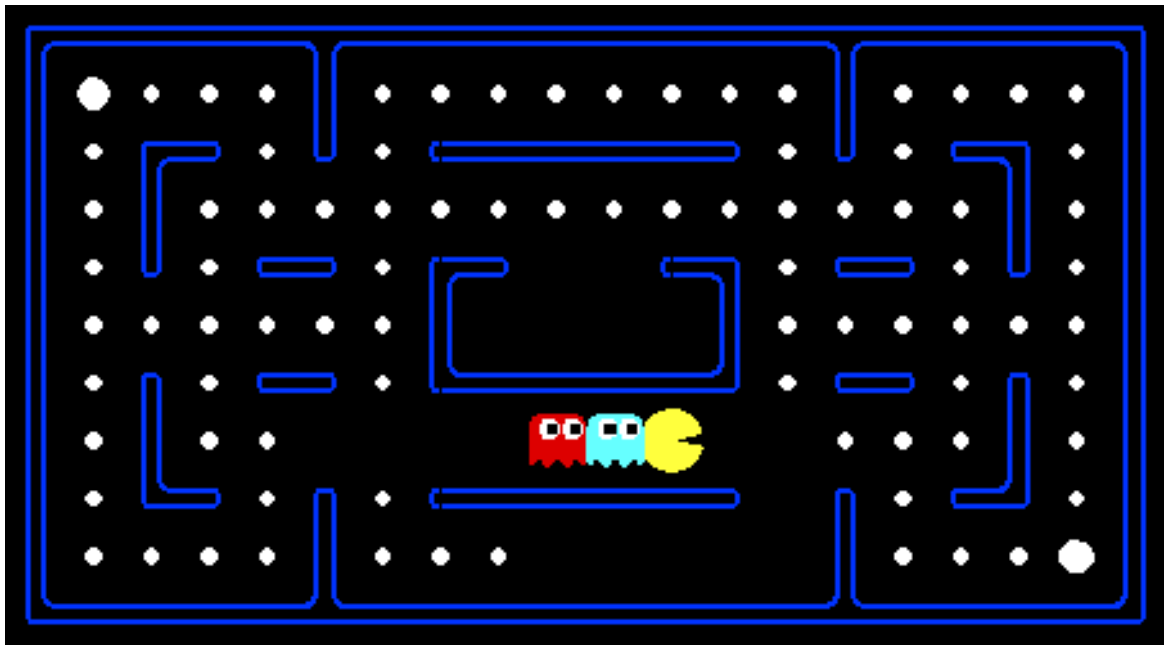
PS2: Game Playing

Goal:

- Play Pac-man!

Techniques:

- Adversarial Search: minimax, alpha-beta, expectimax, etc.



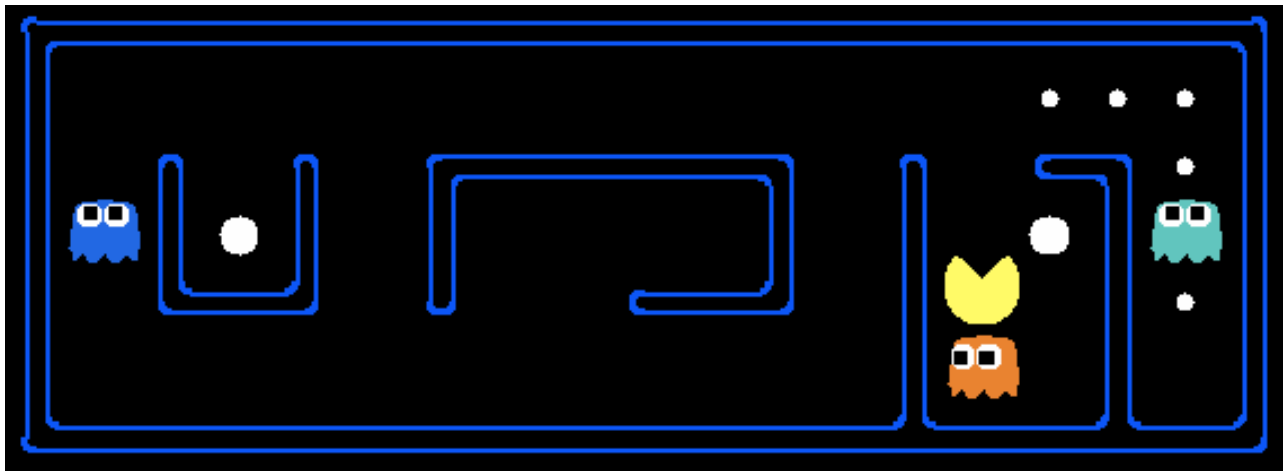
PS3: Planning and Learning

Goal:

- Help Pac-man learn about the world

Techniques:

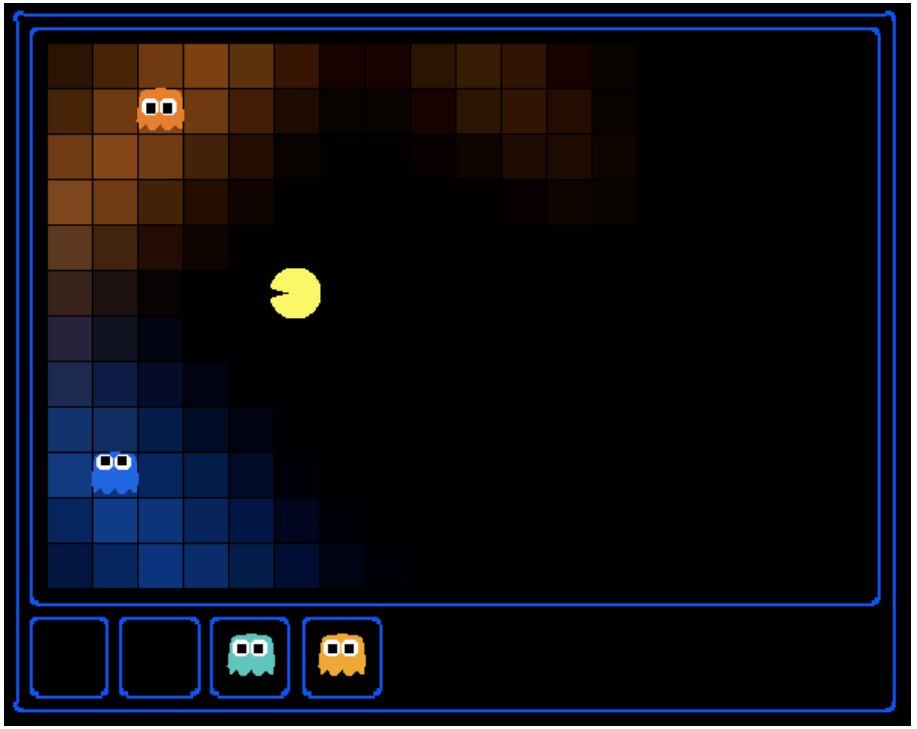
- Planning: MDPs, Value Iteration
- Learning: Reinforcement Learning



PS4: Ghostbusters

Goal:

- Help Pac-man hunt down the ghosts



Techniques:

- Probabilistic models: HMMs, Bayes Nets
- Inference: State estimation and particle filtering

Paper Reviews

- Historical & breaking papers
  - Online review before class
  - Discussion

Mini-Project

- Groups welcome to propose ideas (early!)
- Must exercise course material
  - Ideally MDP, POMDP, RL
- Default: Deep Q-learning / Atari

https://www.youtube.com/watch?v=V1eYniJ0Rnk

Course Topics

- Part I: Making Decisions
  - Fast search / planning
  - Constraint satisfaction
  - Adversarial and uncertain search
  - Markov decision processes
  - Reinforcement learning
  - POMDPs
- Part II: Reasoning under Uncertainty
  - Bayes' nets
  - Decision theory
  - Machine learning
- Throughout: Applications
  - Natural language, vision, robotics, games, …