

CSEP 573: Artificial Intelligence

Winter 2019

Introduction & Agents

Dan Weld

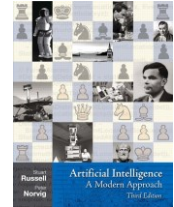
Quanze (Jim) Chen & Koosha Khalvati

With slides from
Dieter Fox, Dan Klein, Stuart Russell, Andrew Moore, Luke Zettlemoyer

Course Logistics

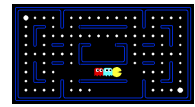
Textbook:

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



Work:

Programming Assignments
Paper Reviews
Class participation &
Final Exam



Pacman, autograder

Logistics

- Read R&N Chapters 1-3, **especially 3**
- Start Problem Set 1

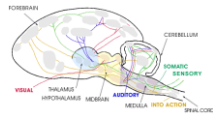
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Today

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



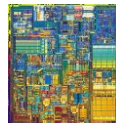
Brain: Can We Build It?



10¹¹ neurons
10¹⁴ synapses
cycle time: 10⁻³ sec

VS.

10⁹ transistors
10¹² 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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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:

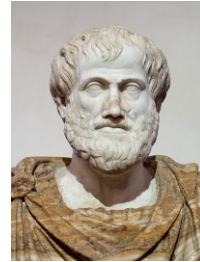
Computational Rationality

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.

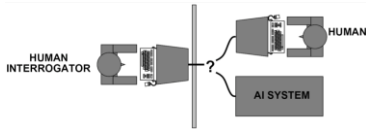
1943: **McCulloch & Pitts**: Boolean circuit model of brain

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,
 - Gelemter'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 Feigenbaum 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*



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Milestones

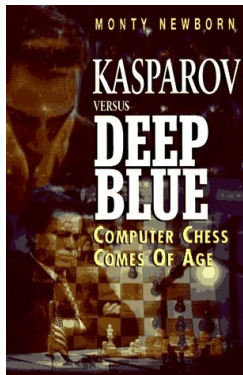


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1997

"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.

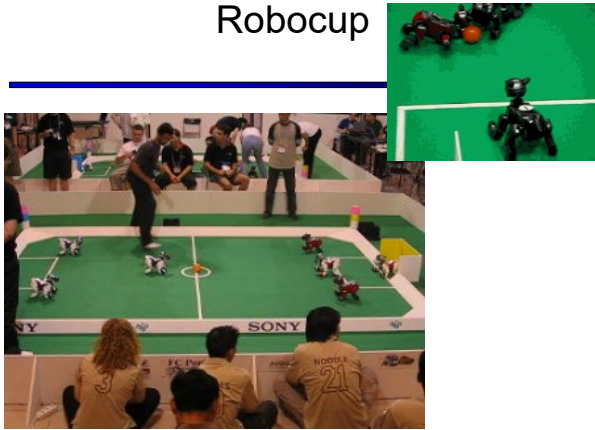
– Drew McDermott

Robocup (Stockholm '99)



Panasonic MPEG1 Encoder

Robocup



2005



Stanford Car
DARPA Grand Challenge

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Waymo
~~Google~~ ^ Self-Driving Car 2015

<https://www.youtube.com/watch?v=uHbMt6WDhQ8>

15 – 50 sec



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2009

amazon
prime

More Top Picks for You



Recommendations,
Search result ordering,
Ad placement,

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2011



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

Start at 20 sec

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2016



AlphaGo deep RL defeats Lee Sedol (4-1)

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2018

Microsoft | The AI Blog The Official Microsoft Blog Microsoft On the Issues

Microsoft creates AI that can read a document and answer questions about it as well as a person

January 15, 2018 | Allison Linn

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Example: SQuAD

Paragraph

Martin Luther (10 November 1483 – 18 February 1546) was a German professor of theology, composer, priest, former monk and a seminal figure in the Protestant Reformation. Luther came to reject several teachings and practices of the Late Medieval Catholic Church. He strongly disputed the claim that freedom from God's punishment for sin could be purchased with money. He proposed an academic discussion of the power and usefulness of indulgences in his Ninety-Five Theses of 1517. His refusal to retract all of his writings at the demand of Pope Leo X in 1520 and the Holy Roman Emperor Charles V at the Diet of Worms in 1521 resulted in his excommunication by the Pope and condemnation as an outlaw by the Emperor.

Question

Who asked Luther to disavow his writings?

Human F1 86.8%

Rajpurkat et al. "SQuAD: 100,000+ Questions for Machine Comprehension of Text," <https://arxiv.org/pdf/1606.05250.pdf>

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Impressive Results

Paragraph

Martin Luther (10 November 1483 – 18 February 1546) was a professor of theology, composer, priest, former monk and a reformer in the Protestant Reformation. Luther came to reject several teachings and practices of the Late Medieval Catholic Church. He strongly disputed the claim that freedom from God's punishment for sin could be purchased with money. He proposed an academic discussion of the power and usefulness of indulgences in his Ninety-Five Theses of 1517. His refusal to retract all of his writings at the demand of Pope Leo X in 1520 and the Holy Roman Emperor Charles V at the Diet of Worms in 1521 resulted in his excommunication by the Pope and condemnation as an outlaw by the Emperor.

Question

Who asked Luther to disavow his writings?

Answer

Pope Leo X

Human F1 86.8%
Seo et al. F1 81.1%

http://35.165.153.16:1995/

Seo et al. "Bidirectional Attention Flow for Machine Comprehension" [arXiv:1611.01603v5](https://arxiv.org/abs/1611.01603v5)

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But...

Paragraph

Alice and Dave went to school. Only one liked science. Alice liked chemistry. Dave only liked music.

Question

who didn't like science?

Answer

Alice

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2014 = Momentous Times!

News > Technology

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

Fooled 33% of judges!



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

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

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Judges weren't very 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"?

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Summary Status of AI

Where are we?

Today's AI Systems are **Idiot Savants**
 Super-human here & super-stupid there

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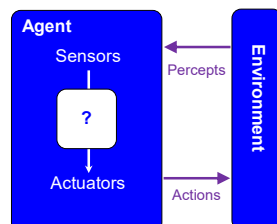
What is AI?

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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.



Actions? Percepts?



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Actions? Percepts?



More Top Picks for You



Recommender System

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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

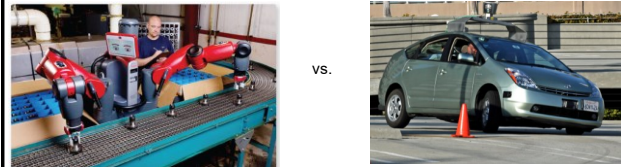
Deterministic vs. Stochastic

Is there uncertainty in how the world works?



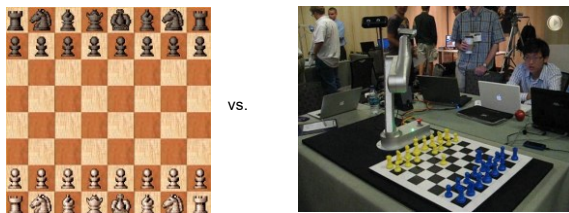
Episodic vs. Sequential

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



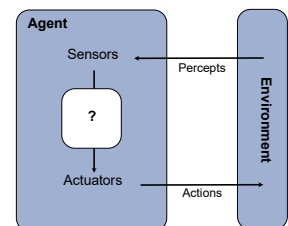
Discrete vs. Continuous

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



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



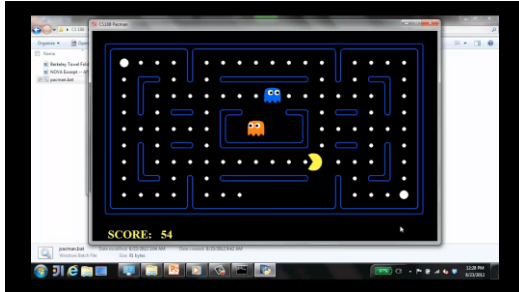
Reinforcement-Learning Agents

- Type of utility-based agent
 - Learn utility function (Explicitly or implicitly)
- Act to maximize expected sum of discounted rewards



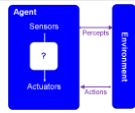
Alpha Zero

Pacman as an Agent



Originally developed at UC Berkeley:

<http://www-inst.eecs.berkeley.edu/~cs188/pacman/pacman.html>



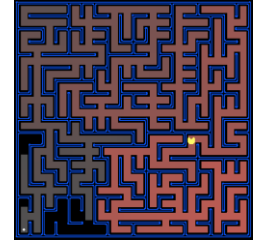
PS1: Search → 1/22

Goal:

- Help Pac-man find its way through the maze

Techniques:

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



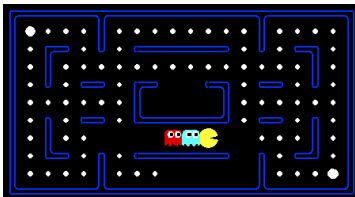
PS2: Game Playing

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



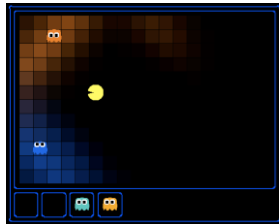
PS4: Ghostbusters

Goal:

- Help Pac-man hunt down the ghosts

Techniques:

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



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

Part III Special Topics

- Fairness, Accountability & Transparency in ML
- Explainable AI



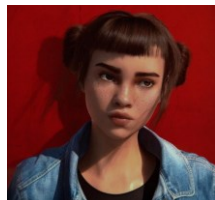
How Much of the Internet is Fake?

Read: <https://nym.ag/2EQULje>

which redirects to <http://nymag.com/intelligencer/2018/12/how-much-of-the-internet-is-fake.html>



A Chinese Click Farm



Lil Miquela
1.5 M followers on Instagram