

Spring 2021  
TTh 2:00-3:30

**Cosi 101A:  
Fundamentals of  
Artificial Intelligence**

**The Popular view of AI?**



## Professor

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- TA's Tom, Jack, Chris, Osamah

## Prerequisites

CS21A (but CS21b - Scheme helps)

- Computing
  - Programming
  - Recursion
  - Data Structures and Algorithms
- Math
  - for search? Combinatorics
  - For Neural Networks? Calculus, Linear Algebra
  - For Deep Learning? Statistics
- philosophy
  - AI was once seen as Automating Logic

## Course Summary

Covers concepts and well-practiced  
programming approaches in AI  
and Machine Learning

*High Effort programming is the only  
way to really learn AI.*

*AI programming traditionally done in LISP  
(Prolog in EU)*

## Grading Procedures

- Lisp Warmup (2%)
- 3 Programming Problems 30%
- Reading of Original Literature 20%
  - your best 10 comments on nb.mit.edu
- Midterm 20%
- Final 25%
- Class Participation 3%

## Homework, 32%

- *The most valuable learning experience is programming the algorithms and data structures yourself.*
- After a self-graded (2%) LISP warmup,
- There will be 3 projects (10% each), in LISP
  - Due to student demand, *Python will be accepted*
- Approx 2.5 weeks each.
- Electronic submission of well-documented programs and text scripts demonstrating your results.
  - A) Source Code
  - B) condensed script of runs
  - C) explanation, graphs, short answers, etc.

## Most Likely Machine Projects

- Write code to solve some kind of combinatorial puzzle using heuristic search
- Write code which plays a two-player game
- Write a machine-learning system which measurably improves at a given task
- reconstruct an historic neural network or evolutionary computation success.

## Readings 20% at nb.mit.edu

- in lieu of a textbook (They all suck) I've selected about 17 papers from the historical literature in AI.
- PDF's are available on Notabene
- with your account, you can paste a sticky note right into the PDF and classmates can respond in dialogue.
- *Your best 10 commentaries not copied from Wikipedia will count for 1 or 2 points towards 20% of grade.*

## Famous Papers or People

- Alan Turing and his intelligence "test"
- Tesauro's ML result TD-Gammon
- Chomsky's 3 models of syntax
- Quillian's Semantic Networks
- Pollack's invention of neural trees
- Quinlan's Induction of Decision trees
- Rumelhart-Hinton-Williams Backprop
- Something on CNN or Deep Learning
- Deep Blue or AlphaZero

## Tests 45%

- there will be a midterm (20%) during class, and
- a final (25%) in finals week. The final will be cumulative, but focus mostly on post-midterm content (Learning).

## Class participation 3%

- With a class this size, lectures are unavoidable, but if you ask questions, the hour and a half will move faster.
- Turn on your video, unmute, and identify yourself by name (if I don't know your name) so I can keep track.
  - I will post CP dailies on Latte, so if I missed you, you can correct me.
- I may take attendance as part of 3%

## zoom recording

- Class sessions will be recorded for educational purposes and linked from LATTE. You may decline to be recorded; if so, please contact me to identify suitable alternatives for class participation. These recordings will be deleted within two months after the end of the semester. If you can be personally identified in a recording, no other use is permitted without your formal permission. You may not record classes on your own without my express permission, and may not share the URL and/or password to anyone unaffiliated with this course.

## Outline

- 1** Definition, History
- 2** Lisp Review
- 3** Problems and State Spaces
- 4** Basic Search
- 5** Natural Language Processing

## Outline

**6** Logic and Representation

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**7** Game Playing

**8** Machine Learning

**9** Neural and Deep Learning

**10** Game Learning

**11** Evolutionary Learning

## Steel Bank Common Lisp

- SBCL.org is new fork of CMU Common Lisp
- Common lisp was culmination of the merger of 7 major LISP dialects.
  - It is a large language
  - Scheme was a simplification response.

## get ready, get set.

- download from sbcl.org for PC or Mac, or use departmental ssh machines or Vertica IMacs.
- There exists an IDE called LISPWORKS but it couldn't run (factorial 50).
- You can edit lisp as plain text in notepad or another editor, but it is easiest to learn EMACS and use "lisp-mode" with 2 windows

## Using department machines

- using an ssh client like putty or mosh
- ssh to tiara.cs.brandeis.edu
- emacs -nw
- ^x^v ~/.emacs (to open profile)
- (setq inferior-lisp-program  
"/usr/local/bin/sbcl")
- ^x^s (to save)
- ^x^c (to exit)

## in emacs (minimally)

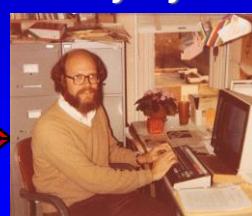
- **`^x^v`** ;;to visit a file
- **`~/.emacs`** ;;your initialization file
- **`(setq inferior-lisp-program  
"c:/sbcl/sbcl.exe")`**
- **`^x^s`** ;;to save the file.
- **restart emacs**

## About Professor Pollack

- Ph.D. 1987, University of Illinois
- 26 years at Brandeis, OMG!
- 6 Years at Ohio State
- 5+ Years in Computer Industry
- Third Generation of AI Royalty



Marvin Minsky



David Waltz



Jordan Pollack

## About Professor Pollack

- Always in AI since Undergrad in mid 70's
  - Game Playing, Logic,
  - Natural Language
  - Connectionist and Neural net models
  - Dynamical Systems & Fractal models
  - Artificial Life, Coevolution
  - Evolutionary Robotics
  - Educational Technology

## The New York Times

THURSDAY, AUGUST 31, 2000

### *Scientists Report They Have Made Robot That Makes Its Own Robots*

By KENNETH CHANG

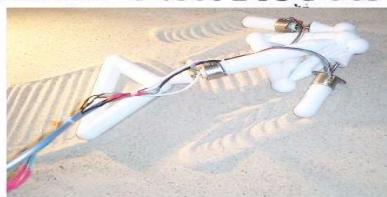
For the first time, computer scientists have created a robot that designs and builds other robots, almost entirely without human help.

In the short run, this advance could lead to a new industry of inexpensive robots customized for specific tasks. In the long run — decades at least — robots may one day be truly regarded as “artificial life,” able to reproduce and evolve, building improved versions of themselves.

Such durable, adaptive robots, astronomers have suggested, could someday be sent into space to explore the galaxy or search for other life.

But the quest to create artificial life also revives concerns that computer scientists could eventually create a robotic species that would supplant biological life, including humans.

“Some things we probably can do we shouldn’t do,” said Bill Joy, chief scientist at Sun Microsystems, who wrote a recent article warning of the power of emerging technologies. “Just like we can kill things with DDT, but we shouldn’t.”



The “Arrow” left a trail as it crawled across a bed of sand.

were not manufactured by humans.”

Dr. Pollack and Dr. Lipson, a research scientist, report their results in today’s issue of the journal *Nature*.

“This is the first example of pretty much 100 percent automated evolution of a machine,” said Dr. Philip Husbands, a professor of artificial intelligence at the University of Sussex in England. “It’s a rather primitive example, but it’s the first step to something that could be quite significant.”

## I've seen Booms and Busts

- Mainframes sold as Big Brains
- Bust of Neural Nets in 70s
- Lisp Machine Investments
- Expert System Shells
- Boom of Symbolic ML 80's
- Beginning of New Neural Nets
  - Hecht Nielson Neurocomputing!
- Growth of WWW -> Semantic Web NLP
- TODAY: Deep Learning, SIRI ALexa

## The Dynamic

- Some interesting result or algorithm
- Low-Hanging Fruity Applications
- Some Overclaiming
- Venture Investments made
- Marketing types take over
- A Tulip (Beanie Baby) Craze ensues!
- The Bubble inevitably Bursts
- AI Winter!