Today

- Course Overview
- What is artificial intelligence?
- What can AI do?
- What is this course?
# CSE 473 - Introduction to Artificial Intelligence - Spring 2016
MWF 1:30-2:20 in MGH 241

**Instructor:** Luke Zettlemoyer (*lsz at cs*)  
**Office hours:** TBD  

**TA:** Justin Bare (*jbare at cs*)  
**Office hours:** TBD  

**TA:** Daniel Butler (*djbutler at cs*)  
**Office hours:** TBD  

**TA:** Kevin Liang (*kevin95 at cs*)  
**Office hours:** TBD

## Schedule [subject to change!]

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## Textbook

Textbook

- Not required, but for students who want to read more we recommend
  - Warning: Not a course textbook, so our presentation does not necessarily follow the presentation in the book.
Course Overview

Programming Projects

This quarter, we will do The Pac-Man Projects. Please complete the versions listed below, as they differ in places from the originals.

- Project 0: Python Tutorial (Not Graded)

Communication

- Discussion Forum
- Dropbox (submit assignments here)
- Grade Book

Course Administration and Policies

- Your grade will be as follows:
  - 55% programming assignments
  - 20% take home midterm
  - 20% take home final exam
  - 5% class participation.
- Assignments policy
  - Assignments will be done individually unless otherwise specified. You may discuss the subject matter with other students in the class, but all final answers must be your own work.
  - Each student has four penalty-free late day for the whole quarter. All other late submissions will be penalized 20% of the maximum grade per day.
Today

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

The science of making machines that:

- Think like people
- Act like people
- Think rationally
- Act rationally
What is AI?

The science of making machines that:

- Think like people
- Act like people
- Think rationally
- Act rationally
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
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 and simulation are key to decision making.
A (Short) History of AI
A Historic Idea....
**A (Short) History of AI**

- **1940-1950: Early days**
  - 1943: McCulloch & Pitts: Boolean circuit model of brain
  - 1950: Turing's “Computing Machinery and Intelligence”

I propose to consider the question, "Can machines think?" This should begin with definitions of the meaning of the terms "machine" and "think." The definitions might be framed...

- *Alan Turing*
A (Short) History of AI

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- **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

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

- *Herbert Simon*
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1970—90: Knowledge-based approaches
- 1969—79: Early development of knowledge-based systems
- 1980—88: Expert systems industry booms

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”
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- 1990—: Statistical approaches
  - Resurgence of probability, focus on uncertainty
  - General increase in technical depth
  - Agents and learning systems... “AI Spring”?

Every time I fire a linguist, the performance of the speech recognizer goes up. – Frederick Jelinek, IBM
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- **2000—: Where are we now?**
What Can AI Do?

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

☑ Play a decent game of table tennis?
☑ Play a decent game of Jeopardy?
☑ Drive safely along a curving mountain road?
☑ Drive safely along University Avenue?
☑ Buy a week's worth of groceries on the web?
☑ Buy a week's worth of groceries at QFC?
☒ Discover and prove a new mathematical theorem?
☒ Converse successfully with another person for an hour?
☒ Perform a surgical operation?
☑ Put away the dishes and fold the laundry?
☑ Translate spoken Chinese into spoken English in real time?
☒ Write an intentionally funny story?
One day Joe Bear was hungry. He asked Irving Bird where some honey was. Irving told him there was a beehive in the oak tree. Joe went to the oak tree. He ate the beehive.

Henry Squirrel was thirsty. He walked over to the river bank where his good friend Bill Bird was drinking. Henry slipped and fell in the river. He was drowned.

Once upon a time there was an 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.

[Shank, Tale-Spin System, 1984]
Natural Language

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

 Demo: NLP – ASR tvsample.avi
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...

"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 "étaient pas dans l'ilégalité".

"It is impossible for journalists to enter Tibetan areas"
Philip Brune, 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
Vision (Perception)

- Object and face recognition
- Scene segmentation
- Image classification

Images from Erik Sudderth (left), wikipedia (right)

Demo1: VISION – lec_1_t2_video.flv
Demo2: VISION – lec_1_obj_rec_0.mpg
An ideal visual understanding system...
Object Some Recent Results

- Stone wall [0.95, web]
- Dishwasher [0.91, web]
- Car show [0.99, web]
- Judo [0.96, web]
- Judo [0.92, web]
- Judo [0.91, web]
- Tractor [0.91, web]
- Tractor [0.91, web]
- Tractor [0.94, web]

Slides from Jeff Dean at Google
Number Detection

Slides from Jeff Dean at Google
Good Generalization

Both recognized as a “meal”

Slides from Jeff Dean at Google
Sensible Errors

“snake”

“dog”

Slides from Jeff Dean at Google
Works in practice for real users.

Wow.

The new Google Plus photo search is a bit insane.

I didn’t tag those... :(
Robotics

- Robotics
  - Part mech. eng.
  - Part AI
  - Reality much harder than simulations!

- Technologies
  - Vehicles
  - Rescue
  - Soccer!
  - Lots of automation...

- In this class:
  - We ignore mechanical aspects
  - Methods for planning
  - Methods for control

Images from UC Berkeley, Boston Dynamics, RoboCup, Google

Demo 1: ROBOTICS – soccer.avi
Demo 2: ROBOTICS – soccer2.avi
Demo 3: ROBOTICS – gcar.avi
Demo 4: ROBOTICS – laundry.avi
Demo 5: ROBOTICS – petman.avi
Robot Soccer
Robot Soccer
Google Car
Folding Laundry
Humanoid
Logic

- Logical systems
  - Theorem provers
  - NASA fault diagnosis
  - Question answering

- Methods:
  - Deduction systems
  - Constraint satisfaction
  - Satisfiability solvers (huge advances!)
Game Playing

- **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

- **Open question:**
  - How does human cognition deal with the search space explosion of chess?
  - Or: how can humans compete with computers at all??

- **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.”

- **Huge game-playing advances recently, e.g. in Go!**

Text from Bart Selman, image from IBM's Deep Blue pages
"I misjudged the capabilities of AlphaGo and felt powerless.", quote after game 3
Decision Making

- **Applied AI involves many kinds of automation**
  - Scheduling, e.g. airline routing, military
  - Route planning, e.g. Google maps
  - Medical diagnosis
  - Web search engines
  - Spam classifiers
  - Automated help desks
  - Fraud detection
  - Product recommendations
  - ... Lots more!
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

Pac-Man is a registered trademark of Namco-Bandai Games, used here for educational purposes.
Types of Environments

- Fully observable vs. partially observable
- Single agent vs. multiagent
- Deterministic vs. stochastic
- Static 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.
Deterministic vs. Stochastic

Is there uncertainty in how the world works?

vs.
Static vs. Sequential

Does the agent take more than one action?
Discrete vs. Continuous

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

- **Part I: Making Decisions**
  - Fast search / planning
  - Constraint satisfaction
  - Adversarial and uncertain search

- **Part II: Reasoning under Uncertainty**
  - Bayes’ nets
  - Decision theory
  - Machine learning

- **Throughout: Applications**
  - Natural language, vision, robotics, games, ...
Assignments: Pac-man

Originally developed at UC Berkeley:
http://www-inst.eecs.berkeley.edu/~cs188/pacman/pacman.html
PS1: Search

Goal:
• Help Pac-man find his 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 Iterations
• 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
To Do

• Look at the course website:
  https://courses.cs.washington.edu/courses/cse473/16sp/

• Do the python tutorial (not graded)