CSE 573: Artificial Intelligence

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slides adapted from
Dan Klein, Pieter Abbeel ai.berkeley.edu
And Dan Weld, Luke Zettlemoyer
Website

- Website
  - tentative schedule
  - lecture slides
  - course policies, etc.

- [https://courses.cs.washington.edu/courses/cse573/22sp/](https://courses.cs.washington.edu/courses/cse573/22sp/)
Course Staff

- **TAs:**
  - James Ferguson
  - Sewon Min
  - Bhargavi Paranjape

- **Office hours**
  - Schedule on the website
  - **TAs:** concepts, projects, homework
  - **Hanna:** concepts, high level guidance, homework

- Survey?
Logistics

- **Canvas**: grades, submitting programming assignments:
  - private matters – private messages
    - if your message is not answered promptly enough, use the staff email:

- **GradeScope** for written assignments

- **Ed**: Discussion board: ask and answer questions; announcements
Course Format

- Programming Assignments
  - 4 projects
  - Python
  - Autograded
  - Give you hands-on experience with the algorithms
  - I expect you to get 100% on projects

- Written homeworks
  - 2 written homeworks
  - Gives you a more conceptual understanding of the material
Course Format (continued)

- Paper report
  - Learn how to read and criticize research papers

- Final Project:
  - Encourage to pick a project related to your research or work
  - We will provide recommendations for picking projects
  - There will be a proposal day.
Prerequisites

- Data Structure or Equivalent:
  CSE 332

- Math:
  - Basic exposure to probability and data structures

- Programming – Familiar with Python
  - There is a 0\textsuperscript{th} project (P0)
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 Policies

- **Grade:**
  - Your *grade* will be: 5% paper reports, 40% programming assignments, 25% homeworks, and 30% project.

- Assignments should be done individually unless otherwise specified.

- Late Policy: **Six** penalty-free late day for the whole quarter; maximum 4 days per assignment. No late day for the final.
Today

- What is artificial intelligence (AI)?
- What can AI do?
- What is this course?
Artificial Intelligence in Action
What is AI?

The science of making machines that:

- Think like people
- Act like people
- Think rationally
- Act rationally
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
Maximize Your Expected Utility
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.
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.
Topics in This Course

- **Part I: Intelligence from Computation**
  - Fast search
  - Adversarial and uncertain search

- **Part II: Reasoning under Uncertainty**
  - Decision theory: Reinforcement Learning, Markov Decision Processes
  - Machine learning
  - Graphical Models - Bayes Nets; HMMs

- **Throughout: Applications**
  - Natural language, vision, robotics, games, ...
This course w.r.t. Current AI Research
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- Raw Data
- Modeling
  - State space
  - Probabilistic (Graphical Models)
  - Feature space & Linear functions
- Neural models

- Inference
- Decision Making & Planning
- Machine Learning
This course vs. others

- Stat methods
- NLP
- ML
- Robotics
- Vision
- Advanced RL
- Deep Learning
Today

- Course overview
- What is artificial intelligence (AI)?
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A (Short) History of AI
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- 1940-1950: Early days
  - 1943: McCulloch & Pitts: Boolean circuit model of brain
  - 1950: Turing's “Computing Machinery and Intelligence”

- 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

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

- 1990—2012: Statistical approaches
  - Resurgence of probability, focus on uncertainty
  - General increase in technical depth
  - Agents and learning systems… “AI Spring”?

- 2012—present: Excitement: Look, Ma, no hands!
  - Big Data, big compute, neural networks
  - Some re-unification of subfields
  - AI is being used in industry.
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 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?
- [✓] Perform a surgical operation?
- [✓] Unload a known dishwasher in collaboration with a person?
- [✓] Translate spoken Chinese into spoken English in real time?
- [✗] Write an intentionally funny story?
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 de Qinghai "n'étaient pas dans l'illégalité".
Les faits Le dalai-lama dénonce l""exit"" imposé au Tibet depuis sa fuite, en 1959
Viéo Anniversaire de la rébellion

"It is impossible for journalists to enter Tibetan areas"
Philip Bruno, 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
Viéo Anniversary of the Tibetan rebellion: China on guard
Computer Vision

Scene Segmentation

Object Recognition
Google Goggles

Smile Detection

Leaf Snap
The flower was so vivid and attractive.

Blue flowers are running rampant in my garden.

We sometimes do well: 1 out of 4 times, machine captions were preferred over the original Flickr captions:

Spring in a white dress.

Blue flowers have no scent. Small white flowers have no idea what they are.

Scenes around the lake on my bike ride.

This horse walking along the road as we drove by.
But many challenges remain (better examples of when things go awry)

- The couch is definitely bigger than it looks in this photo.
- My cat laying in my duffel bag.
- Yellow ball suspended in water.
- A high chair in the trees.
Game Agents

- **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

- **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."
Game Agents

- Reinforcement learning

Pong  
Enduro  
Beamrider  
Q*bert
AlphaGo deep RL defeats Lee Sedol (4-1)
Simulated Agents

Iteration 0

[Schulman, Moritz, Levine, Jordan, Abbeel, ICLR 2016]
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
Robots
Robocup

https://www.youtube.com/watch?v=_PC-V5GJP6Q
Tools for Predictions & Decisions
Decision Making

- Applied AI in many kinds of automation:
  - Scheduling, airline routing
  - Route planning
  - Medical diagnosis
  - Web search
  - Spam classification
  - Automated help desks
  - Smarter devices, like cameras
  - Fraud detection
  - Product recommendation
  - ... Lots more!
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Maximize Your Expected Utility
Pac-Man as an Agent

Agent

Sensors

Actuators

Environment

SCORE: 18

Pac-Man is a registered trademark of Namco-Bandai Games, used here for educational purposes.
Assignments: Pac-man

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

• Important this week:
  • Check out canvas--- our main resource for assignments and grades
  • Check out website – for schedule and slides
  • Check out Ed – for discussions; we have added everyone to Ed
  • Check out Gradescope -- for written assignments
  • P0: Python tutorial is out