Website

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

- [https://courses.cs.washington.edu/courses/cse573/20wi/](https://courses.cs.washington.edu/courses/cse573/20wi/)
## Course Staff

<table>
<thead>
<tr>
<th>Name</th>
<th>Email</th>
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<th>Location</th>
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- **Office hours**
  - Schedule on the website
  - TAs: concepts, projects, homework
  - Hanna: concepts, high level guidance, homework
- **Introductions?**
Canvas

- Communication, grades, submitting assignments:
  - Discussion board: ask and answer questions; announcements
  - Private matters – private messages
    - If your message is not answered promptly enough, here is the staff email:
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

- Final Project:
  - Encourage to pick a project related to your research
  - 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)
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 Policies

Grade:

- Your **grade** will be: 5% class participation, 5% paper reports, 30% programming assignments, 30% 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?
AI
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
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
  - Bayes’ nets
  - Decision theory
  - Machine learning
- Throughout: Applications
  - Natural language, vision, robotics, games, ...
AI

Machine Learning
[learning decisions; sometimes independent]

Robots
[physically embodied]

Rational Agents
[decisions]

Human-AI Interaction

NLP

Computer Vision
Today

- Course overview
- What is artificial intelligence (AI)?
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A (Short) History of AI
A (Short) History of AI

- **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!**
  - Bid 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?
Unintentionally Funny Stories

- One day Joe Bear was hungry. He asked his friend Irving Bird where some honey was. Irving told him there was a beehive in the oak tree. Joe walked to the oak tree. He ate the beehive. The End.

- Henry Squirrel was thirsty. He walked over to the river bank where his good friend Bill Bird was sitting. Henry slipped and fell in the river. Gravity drowned. The End.

- Once upon a time there was a 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 up to the crow. The End.

[Shank, Tale-Spin System, 1984]
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 "n'étaient pas dans l'ilégalité".

Les faits Le dalaï-lama dénonce l'"enfer" imposé au Tibet depuis sa fuite, en 1959

Video 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

Video Anniversary of the Tibetan rebellion: China on guard

the friends family classmates said their final good buys yesterday at her funeral in east falls that these adams was buried today in on this day a major break in the case
Computer Vision

- Object Recognition
- Scene Classification
- Image Segmentation
- Human Activity Recognition
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.

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.

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

Image captioning: What begins to work
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.”

Text from Bart Selman, image from IBM’s Deep Blue pages
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
Robocup (Stockholm ’99)
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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Pac-Man as an Agent

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Agent

Sensors

Actuators

Environment

Percepts

Actions

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
This course vs. others

- CSE 515 – Stat methods
- CSE 517 – NLP
- CSE 546 – ML
- CSE 571 – Robotics
- CSE 576,7 – Vision
- Advanced RL
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: Ghostbusters

Goal:
• Help Pac-man hunt down the ghosts

Techniques:
• Probabilistic models: HMMS, Bayes Nets
• Inference: State estimation and particle filtering
PS4: Reinforcement Learning

Goal:
• Help Pac-man learn about the world

Techniques:
• Planning: MDPs, Value Iterations
• Learning: Reinforcement Learning
Important This Week

- **Important this week:**
  - Check out canvas--- our main resource for assignments and grades
  - Check out website— for schedule and slides
  - P0: Python tutorial is out

- **Also important:**
  - Office Hours start next week.