CS 188: Artificial Intelligence

Before 5:10 -- AMA

Instructor: Anca Dragan
University of California, Berkeley
(slides adapted from Dan Klein, Pieter Abbeel)
AI
Today

- What is artificial intelligence?
- Where did it come from / What can AI do?
  - What should we and shouldn’t we worry about? What can we do about the things we should worry about?
- What is this course?
This lecture:

- What is it / what are the basics of how it works?
- What are things we should and should not worry about?
  - How might we fix the things we should worry about?
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
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
Pac-Man as an Agent

Sensors → Percepts → Environment → Actions

Agent

Score: 18

Pac-Man is a registered trademark of Namco-Bandai Games, used here for educational purposes.
Logistics!
Instructors

Anca Dragan
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GSIs

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Hello everyone! I am an EECS 5th-Year-Master student. This will be the 6th time I am a TA for CS 188, and the 3rd time as the Head TA. My current research interest is human-robot-interaction under uncertainties. In my free time, I like to hike with friends, and to travel to race radio-controlled vehicles at national events. Feel free to come talk to me about anything!

Akshit Dewan
Email: akshit@
Hello! I am a buffoon’s needle.
Albert Yu
Email: alibertyu@

Aneri Shah
Email: aneri.shah@
Hi! I’m a third year EECS major from Fremont. In my free time, I enjoy dancing, trying new food places, and hiking around. I’m super excited about TAing for a class I learned so much from and I’m looking forward to meeting you all!

Andrea Bajcsy
Email: abajcsy@
Hi! I’m Andrea, a fifth year EECS Ph.D. student. I’m advised by professors Anca Dragan and Claire Tomlin and my research interests lie in the intersection of robotics, machine learning, control theory, and human-robot interaction. In my free time, I enjoy cooking (and eating) new foods, playing with my dog, watching TV, and hanging out with friends.

Angela Yan
Email: abyanh@
Hello! I’m Angela, a fourth year CS/Cog-Sci major from San Diego. In my free time, I love being a mellophone player in the Cal Band, binging shows on Netflix (hmu with recommendations), and gaming (Valorant has been consuming all my free time this summer)! I also like to consider myself a boba connoisseur. Really excited to teach and meet all of you this semester :)

Arin Nair
Email: arinnair@
Hello! I’m Arin, a 4th year CS Major. I grew up in Chicago but now I live in the Bay full time. I love CS and AI so I am excited to work with all of you. However, I live for my free time which I spend listening to rap music, hiking, playing games, and fishing. I am also a fan of fitness and being active, but my favorite thing to do is to just talk to people about life. Feel free to reach out to me about anything at all!

Arjun Sripathy
Email: arjun.sripathy@
Hi there! I’m a 3rd year EECS major and excited to enjoy 288 with all of you this semester! I find Artificial Intelligence and related fields fascinating, especially the way we can leverage readily available information to power amazing algorithms. I love playing sports, hiking, biking or anything else outdoors really! I also enjoy the NBA & NFL as well as their video games. Look forward to meeting everyone!
Arvind Sridhar
Email: arvindsridhar@
Hey friends! I’m Arvind, a senior from the South Bay. Here at Cal, I’m working on research to improve the robustness of neural networks against certified adversarial attacks. In my free time, I love playing basketball, hiking, driving exotic cars, and watching Netflix (ATLA superfans wya??).

Cathy Li
Email: cathy_li@
Hey! I’m a fourth year undergrad and this is my last semester at Cal. I love AI and am happy to rejoin the 188 TA team! In my free time, I enjoy staying indoor and eating a lot of ice cream. I’m excited to know more about you all, and I look forward to a rewarding semester with you!

Carl Qi
Email: daguqihanwen@
Hi! I’m a senior majoring in cs and math. My research interests are deep reinforcement learning and unsupervised learning, and my daily interests include eating Chick-fil-A and watching Dude Perfect. Looking forward to a fun semester with y’all!

Emma Tao
Email: jiayue_tao@
Hi everyone! I’m a 4th-year CS/Philosophy/Econ major, born and raised in Beijing, China. I love everything in the intersection (or union) of humanities and tech, and my special talent is the ability to nap everywhere. (Sadly this semester I’ll just be napping at home.) In my free time, I like to read long novels and rewatch Rick & Morty for the thousandth time. Look forward to getting to know you all and learn together!

Jeffrey Tao
Email: jtao@
Hi, I’m Jeffrey! Feel free to talk to me if you’re interested in RL research.

Jennifer Grannen
Email: jenngrannen@
Hi! I’m Jennifer, a fourth year CS major and I’m really excited to TA 188 this semester! My current research focuses on deformable object manipulation and NLP calibration techniques. In the free time, I love hiking, making music, and baking banana bread :}
Jerry Zhiyang He
Email: hxyjerry@
Hello everyone! I am a second year CS Ph.D. interested in Human Robot Interactions. This is my first time TAing CS188 and I am quite excited to make the most out of it :) I love cooking, basketball, jiu jitsu, stand-up comedy and improv. Hit me up if you have any recs for fun activities at home!

Jonathan Yang
Email: jy2370@
Hello! I’m a third year EECS undergrad from Pleasanton, CA. My current research is in reinforcement learning and robotics. In my free time, I like to play clarinet in the wind ensemble, watch sitcoms, bake Brazilian cheese bread, and fetch toys that my dog loses under the sofa. I hope all of you are doing well and I am looking forward to a great semester!

Katherine Shu
Email: katherineshu@
Hi! I’m a third year EECS Major from around LA, I enjoy travelling, dancing, and drawing. Against popular belief, I don’t like chocolate and I drink boba with no sugar and no ice. I hope you all have an amazing semester!! :)

Nathan Lambert
Email: nel@
Hi all. I am a PhD candidate here in EECS working at the intersection of robotics and machine learning. I’m happy to rejoin the staff. Any other time I have is spent cooking, doing triathlons, or outdoorsing. I’m excited to get to know the students, so please come talk to me about anything!

Jocelyn Chen
Email: jocelynchen1246@
Hi! I’m a third year CS major! I love boba, dancing, watching Netflix, and playing games (unfortunately League is the major one). Feel free to reach out to me to talk about anything. I’m looking forward to a great semester!

Ryan Koh
Email: ryan_koh@
Hi, I’m a CS student from SoCal, looking forward to meeting you all this semester! CS188 is a great class, where you not only learn about AI, but also develop a love-hate relationship with Pacman. Feel free to reach out about anything, and let’s have a great semester! We stan robots <3 Website: kaipiryan.koh.github.io
Saagar Sanghavi

Email: ssanghavi404@

All of life is just one giant puzzle to solve. Let's solve some fun puzzles together this semester :) Puzzle 1, Puzzle 2, Puzzle 3

Yanlai Yang

Email: yyang22@

Hello! I'm a third-year CS and applied math major from Shanghai. My research is currently focused on reinforcement learning. This is my second time being a TA for this course and I am really excited to meet everyone! I took CS 188 last fall with Prof. Dragan and loved it. Outside of school, I love to play card games (especially contract bridge) and solve various kinds of puzzles.
Website

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

http://inst.eecs.berkeley.edu/~cs188/fa20/
Piazza

○ Communication:
  ○ piazza – ask and answer questions; announcements
    ○ https://piazza.com/berkeley/fall2020/cs188
  ○ private matters – private messages
    ○ if your message is not answered promptly enough, here is the staff email: cs188@berkeley.edu
  ○ exceptions – email Mesut (head GSI) xiaocheng.yang AT berkeley.edu
Course Format

- Lectures TuTh
  - I’d love for you to show up and actively engage; participation credit
    - If you’re comfortable, consider turning your camera on.
    - Raise your hand to ask question (preferred; chat also ok)
    - You can use reactions, e.g. thumbs up, clap
  - Recorded, will upload to bdrive
    - Slides will be posted after lecture
    - We’ll have lecture notes too
    - There are also pre-pandemic webcasts available
Course Format

- Discussion Sections
  - schedule on piazza
  - Pick 1 to go to; show up to it consistently; participation credit
  - Some videos will also be posted
  - Start 8/31
Course Format

- **Exam prep sections**
  - Exams are super hard. We try to prep you for them throughout.
  - Schedule on piazza
  - Start one week after discussion sections
  - Some videos will be posted
Electronic Homework
  - Due Mondays at 11pm (except for HW0)
  - Exercises based on class material
  - Get you comfortable with the basics
  - Solve together, submit alone
    - Academic integrity!
  - Autograded, multiple submissions!
  - I expect you to get 100% on electronic homework
  - You get to drop 1. *No slip days* -- use drop instead.
Projects
- Due Fridays at midnight
- 5 projects, groups of 1-2
  - Academic integrity!
- Python
- Give you hands-on experience with the algorithms
- Also autograded
- I expect you to get 100% on projects
- 5 slip days, max 2 per project
  - After that, loose 20% per day turned in late
Contests

- Submit your own agents to do cool creative things!!
- Give you a chance to exercise going from a problem statement to devising your own solution based on algorithms you know
- Give your agents cool names!
  - AlphaGhost
  - myTeam.py
  - extracredit plz try 2
  - Eh
  - Shotsandgoggles
  - Pieter <3 Anca 4 Life
Course Format (continued)

- Written Homework
  - A few throughout the semester
  - Due Wednesdays at 11pm
  - Give you a more conceptual understanding of the material
  - More exam-style questions
  - They are hard, and there to help you, not stress you out, so you get credit for completion
  - You get 1 drop (no slip days!)
Exams

- Thursday, Oct 15 5-7pm Midterm
- Wednesday, Dec 16 11:30am-2:30pm Final Exam

If different time zone, you can petition for alternate:
- Friday, Oct 16 8-10am Midterm
- Wednesday, Dec 16 10:00pm-1:00am (Thursday) Final Exam
- You can also petition if you have an exam conflict

Exams are the main assessment tool, so they are hard
- Exam practice sessions!
- Written homework, exam style!
Office hours

- Schedule is on piazza
- GSI and uGSI: concepts, projects, homework
- Anca: concepts, high level guidance, etc.
Prerequisites

- 61A and 61B and 70
  - math
    - There is a math self diagnostic test on gradescope – take it! (not graded)
  - programming
    - There is a 0\textsuperscript{th} project (P0) – mandatory
I used to say: Laptops in Lecture

Laptops Are Great. But Not During a Lecture or a Meeting.

Economic View
By SUSAN DYNARSKI  NOV. 22, 2017
Textbook

- Not required, but for students who want to read more we recommend
  - Russell & Norvig, AI: A Modern Approach

- Warning: Not a course textbook, so our presentation does not necessarily follow the presentation in the book.
Build a great community

- Help out your peers on piazza and in meetings!
- Be mindful of the tone you use – be respectful and supportive, help everyone feel at home.
- Watch out for implicit bias.
  - Someone’s gender, race, ethnicity, sexual orientation, etc. do NOT have anything to do with how awesome they will be in this class.
  - Having a ton of programming experience will help some with projects, but does NOT give anyone an edge on how well they can understand the material and how highly they can score on the exams.
Important This Week

Important this week:

- Register for the class on gradescope
- Register for the class on piazza --- our main resource for discussion and communication
- P0: Python tutorial is out; due Monday 8/31 at midnight; office hours Friday 5-7pm for this
- Math self-diagnostic is out --- important to check your preparedness for second half
- Mark exam dates in your calendars

Also important:

- Sections start next week (exam sessions the week after).
- If you are wait-listed, you might or might not get in depending on how many students drop.
- Office Hours start next week.
  - Special P0 OH 5-7PM Friday
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—: Statistical approaches**
  - Resurgence of probability, focus on uncertainty
  - General increase in technical depth
  - Agents and learning systems... “AI Spring”?

- **2000—: Where are we now?**
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 Telegraph Avenue?
✓ Buy a week's worth of groceries on the web?
✓ Buy a week's worth of groceries at Berkeley Bowl?
✓ Discover and prove a new mathematical theorem?
✓ Perform a surgical operation?
✓ Unload a know dishwasher in collaboration with a person?
✓ Translate spoken Chinese into spoken English in real time?
✗ Write an intentionally funny story?
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. He then walked over to the crow. The End.
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
Game Agents

Reinforcement learning
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
Robots

[Levine*, Finn*, Darrell, Abbeel, JMLR 2016]
Human-AI Interaction
Tools for Predictions & Decisions
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...

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"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'illégalité".

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

**Video:** Anniversary of the Tibetan rebellion

"It is impossible for journalists to enter Tibetan areas"

Philip Bruno, correspondant 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
Computer Vision

"man in black shirt is playing guitar."
"construction worker in orange safety vest is working on road."
"two young girls are playing with lego toy."
"boy is doing backflip on wakeboard."
"girl in pink dress is jumping in air."
"black and white dog jumps over bar."
"young girl in pink shirt is swinging on swing."
"man in blue wetsuit is surfing on wave."

Karpathy & Fei-Fei, 2015; Donahue et al., 2015; Xu et al, 2015; many more
Topics

- Constraint satisfaction, e.g. scheduling
- Search, planning, reinforcement learning, e.g. routing, robot navigation
- Probabilistic inference, e.g. robot localization
- A bit of supervised machine learning, e.g. spam detection
The kinds of AI problems in 188 (*) need continuous time versions (*) briefly in our ML topic
Should I take 188?

- Yes, if you want to know how to design rational agents!
  - 188 also teaches you a different way of thinking.
- Disclaimer: If you’re interested in making yourself more competitive for AI jobs, 189 and 182 are actually much better fits.
Maximize Your Expected Utility
CS 188: Artificial Intelligence

Introduction

Instructor: Anca Dragan

University of California, Berkeley

(slides adapted from Dan Klein, Pieter Abbeel)