CS 188: Artificial Intelligence

Introduction

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
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
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

Agent
- Sensors
  - ?
- Actuators

Environment

Percepts

Actions

SCORE: 18

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

Demo1: pacman-l1.mp4
Logistics!
Hi everyone, Welcome to CS188, Fall 2019! We're really excited to share the field of AI with you! This email contains important logistical information about the

Mail Delivery Subsystem <mailer-daemon@googlemail.com> to me

You have reached a limit for sending mail. Your message was not sent.
Anonymous 4 hours ago
RIP already bought plane tickets to a wedding for the 17th :( 

Can I get an F in the chat please, might not get off the waitlist next time. GL y'all

Victor Nicholas lancu 3 hours ago  F :(

Francisco R Galvan 3 hours ago  F, :(
:-( sorry buddy

Noah Kingdon 2 hours ago  f, D:

Tony Zhao 1 hour ago  F
it’s a reference to a popular meme: https://knowyourmeme.com/memes/press-f-to-pay-respects

usually said in response of an unfortunate circumstance

Know Your Meme

Press F to Pay Respects

Press F (X) to Pay Respects is an action prompt from a quick time event featured in the first-person shooter Call of Duty: Advanced Warfare. Following the game’s release in November 2014, many players mocked the event online for forcing interactivity into the cut scene. (70 kB)
Instructors

Anca Dragan

Email: anca@

GSIs

Wilson Yan

Head TA
Email: Admin cs188@, Personal wilson1.yan@

Hi everybody! I'm a fourth year CS and Applied Math major from the Bay Area. Aside from doing ML research, I enjoy reading, hiking, playing video games (Smash), and eating good food. Feel free to chat with me anytime, and I look forward to meeting you all!

Alan Rosenthal

Email: amrosenthal@

Hi! I'm a fourth year CS and math major. Outside of class, I love cooking, playing and listening to classical music, and badminton!

Albert Yu

Email: albertyu@


Andreea Bobu

Email: abobu@

Hi! I'm a third year PhD student working with Anca Dragan. My research interests lie at the intersection of machine learning, robotics, and human-robot interaction, with a focus on robot learning with uncertainty. In my free time, I play the guitar, do street photography, and do various outdoorsy activities.
Andy Yan
Email: yan.andy4@
Hi, I'm a 5th year masters student in CS. My research focuses on multi-task learning and robotics. Outside of school I love listening to all sorts of music and eating / spending time with friends. Hope you guys enjoy the semester :).

Carl Qi
Email: daguqihanwen@
Hello friends! I'm a 3rd-year undergrad student majoring in cs and math. In my free time, I like to play the guitar, go workout, and watch Dude Perfect. Looking forward to a fun semester!

Cathy Li
Email: cathy_li@
Hey! I'm a junior focusing on AI and ML, currently doing Computer Vision research under Prof. Gonzalez. In addition to CS, I'm broadly interested in cognition, psychology and linguistics. In my free time, I try to practice my really elementary Swedish.

Chandan Singh
Email: chandan_singh@
I'm a 3rd-year EECS PhD student studying interpretable machine learning advised by Prof. Bin Yu.

Danny Geithem
Email: dgeithem@
I'm a fourth year student, originally from Marin County, CA. In my free time I enjoy playing tennis and basketball, as well as watching movies. I'm also a part of Camp Kesem here at Cal. In the past I was a TA for EE120 but now I look forward to being a TA for CS188!

Emma Jaeger
Email: emmajaeager@
Hi everyone! I'm Emma and I'm a senior from the DC area studying computer science. In my free time, I love going to concerts and working out (even though I'm naturally super uncoordinated). Feel free to email me with any questions you have about artificial intelligence, CS at Berkeley, or life in general—I'm always happy to help out however I can :)
Gokul Swamy
Email: gokul.swamy@
Hey there! I’m a 4th Yr. M.S. student working with Profs. Dragan and Levine on making interaction between people and robots more intuitive and scalable. In my free time I like to read, listen to music, drink boba, and pet my friends’ cats. I’m so excited you’re here!

Jesse Zhang
Email: jessezhang@
I’m a 4th year CS student from Sacramento, CA, interested in deep reinforcement learning and machine learning generalization research. In my spare time I like playing smash, going to the gym, and recently just started BJJ!

Lawrence Chan
Email: chanlaw@
Hello! I’m a second year PhD Student working on building algorithms that can better infer and assist with human preferences. In my free time, I enjoy reading and hiking.

Henry Zhu
Email: henryzhu@
I’m a senior(!) studying computers and mechanics who likes to play with learning robots out of the classroom. Come find me to talk about food videos, really cool classes, how to also start playing with robots, or really anything other than sports.

Jinyu Kim
Email: jinyu.kim@
I am a fourth-year graduate student, pursuing a Ph.D. degree in Computer Science advised by Prof. John Canny. As a member of Berkeley Deep Drive and Berkeley AI Research Lab, I am currently interested in self-driving vehicles.

Lindsay Yang
Email: lindsayyang@
Hi! I’m a fourth year CS/Cog Sci major, and a big part of my life at this point is how much I like boba, memes, and Bojack Horseman. I’m also the janitor of UPE, and you’ll probably catch me karaokeing my heart out one of these days.
Mike Laielli
Email: laielli@
I’m a 3rd year PhD student working with Trevor Darrell and Bjoern Hartmann. My research focuses on the intersection of Computer Vision and Human-Computer Interaction.

Rachel Li
Email: rachel li@
Hey everyone! I’m a 5th year masters student from Virginia. My academic interests include networking, theory, and AI! In my nonexistent free time, I like to draw, play Clash Royale, and watch Netflix.

Ryan Deng
Email: rdeng2614@
Hi! I’m a rising 4th year CS major from Irvine, California. In my free time I like to watch lots of TV and play pickup basketball. I hope you all enjoy 188 this semester!

Sherman Luo
Email: shermanluo@
Nice to meet you, I’m Sherman. AI is super cool, and first became curious about it years ago when computer-controlled characters would whoop me in games like Super Smash Bros Melee or Mario Kart. I’m working with Prof. Dragan as a fourth-year masters and imo CS188 is the greatest class of all time, but your mileage may vary :) Catch me sometime and let’s talk about something totally random.

Shizhan Zhu
Email: shizhan_zhu@
Hello everyone! I am a third year PhD from BAIR lab. I am happy to join the CS 188 stuff team. My research interest lies in the area of computer vision and machine learning. I am looking forward to the experience communicating with everyone during the semester on CS 188!

Tony Zhao
Email: tonyzhao@
Hello friends! I’m a 4th year EECS undergrad here at Cal. Beyond research in machine learning, I like taking care of my hydroponic plants, building meme software, petting dogs, and occasionally getting lost.
Xiaocheng Mesut Yang

Email: xiaocheng.yang@

Hello everyone! I am a fourth year CS major. I TA'd CS188 in Summer 2018, Spring 2019, Summer 2019 (Head TA), and I am happy to rejoin this semester. My interest lies in the intersection of computer vision and reinforcement learning. In my free time, I travel to race radio-controlled vehicles at national and international events. Feel free to come talk to me, about anything!
Website

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

http://inst.eecs.berkeley.edu/~cs188/fa19/
Piazza

**Communication:**

- piazza – ask and answer questions; announcements
  - [https://piazza.com/berkeley/fall2019/cs188](https://piazza.com/berkeley/fall2019/cs188)
- private matters – private messages
  - if your message is not answered promptly enough, here is the staff email: cs188@berkeley.edu
- exceptions – email Wilson (head GSI) at wilson1.yan AT berkeley.edu
Course Format

Lectures TuTh
- I want for you to show up and actively engage
- No webcasts (we all fit in this room!!)
  - Slides will be posted after lecture
  - We’ll make lecture notes too
  - There are previous offering webcasts if you want to go over lecture again

Discussion Sections
- schedule soon on piazza
- Pick 1 to go to; show up to it consistently
- Videos posted at end of the week (or soon thereafter)
- No sections this week
Course Format (continued)

- Electronic Homework
  - Due Wednesdays at midnight (11:59pm)
  - 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 2. *No slip days* -- use drops instead.
Course Format (continued)

- 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
Course Format (continued)

- Contests
  - Submit your own agents and compete with each other!!
  - 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
    - PacLivesMatter
    - myTeam.py
    - extracredit plz try 2
    - Eh
    - Shotsandgoggles
    - Pieter <3 Anca 4 Life
Course Format (continued)

- **Written Homework**
  - A few (4?) throughout the semester
  - Gives you a more conceptual understanding of the material
  - Combo of GSI and peer grading
  - You get 1 drop (no slip days!)
Course Format (continued)

- Exams
  - Midterm: Thursday, Oct 17 8-10pm
  - Final: Tuesday Dec 17 8-11am
  - No makeup exams
  - **Exams are the main assessment tool, so they are hard**

- Exam Practice Sessions
  - Schedule soon on piazza
  - Will start a week later than discussion sections
Course Format (continued)

- Office hours
  - Schedule coming up soon
  - 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 0th project (P0) – mandatory
Laptops in Lecture

The New York Times

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

Economic View
By SUSAN DYNARSKI  NOV. 22, 2017
Laptops in Lecture

(starting next lecture)

- I prefer if you don’t use laptops or phones in lecture.
- If you really want to use a laptop, sit in the back.
- (everyone else -- I encourage you to sit in the front so that we can have an interaction.)
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.
Build a great community

- Help out your peers on piazza and in person!
- Be mindful of the tone you use – be respectful and supportive, help everyone feel at home.
  - Also, please don’t interrupt your peers or instructors.
- Watch out for implicit bias – catch yourself before acting on it.
  - 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; use the entry code **M5DV3E**
  • Register for the class on piazza --- our main resource for discussion and communication
  • **P0: Python tutorial** is out; due Monday 9/2 at midnight; office hour Friday 7-9pm 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. Contact Cindy Conners for details.
  • **Office Hours** start next week.
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?
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 gravity drowned. The End.

- Once upon a time there was an honest fox and a vain crow. One day the crow was sitting in his tree with a piece of cheese in his mouth. He noticed that he was holding the cheese. He became hungry, and swallowed the cheese. The fox walked over 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…
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
Tools for Predictions & Decisions
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.”

- 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
Utility?

Clear utility function

Not so clear utility function
Maximize Your Expected Utility
CS 188: Artificial Intelligence

Introduction

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