CS 6300: Artificial Intelligence

Introduction

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[These slides adapted from those created by Dan Klein and Pieter Abbeel for CS188 Intro to AI at UC Berkeley. http://ai.berkeley.edu.]
Course Staff

Professor

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TAs

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Course Information

- **Communication:**
  - Announcements on Canvas
  - Questions? Discussion on piazza

- **Course format:**
  - Homeworks and programming assignments turned in via Gradescope.
  - In class midterms and final.

- **Class Website:**
  - [https://www.cs.utah.edu/~dsbrown/classes/cs6300/](https://www.cs.utah.edu/~dsbrown/classes/cs6300/)
Course Information

- There will be a lot of math (and programming)
- Work and Grading:
  - 5 programming projects: Python,
    - 10% penalty for each day late.
  - ~10 homework assignments.
    - Hands on experience working through math.
  - Two midterms, one final
  - Class participation can help if your grade is on the margins
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.
Also not required, but for students who want to read more about Reinforcement Learning we recommend:

- Sutton and Barto “Reinforcement Learning: An Introduction”

Some notation in our class will be closer to Sutton and Barto than Russell and Norvig.
Important This Week

• Important this week:
  • Register for the class on piazza --- our main resource for discussion and communication
  • P0: Python tutorial is out (due on Wed 1/18 by 11:59pm)

• Also important:
  • Office Hours
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
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
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

Demo: HISTORY – MT1950.wmv
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
  - 1988—93: Expert systems industry busts: "AI Winter"

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

- **2014—: Deep Learning and Scaling Things Up**
  - Big data
  - Powerful compute (e.g. GPUs)
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?
- ✔ Buy a week's worth of groceries on the web?
- ✔ Buy a week's worth of groceries at Walmart?
- ✔ Discover and prove a new mathematical theorem?
- 🟣 Converse successfully with another person for an hour?
- ✗ Perform a surgical operation?
- ✗ Come into your apartment and unload your dishwasher
- ✔ Translate spoken Chinese into spoken English in real time?
- 🟣 Write decent poetry?
- 🟣 Create aesthetically pleasing artwork
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".


"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 "exile" imposed since he fled Tibet in 1959.

**Video**: Anniversary of the Tibetan rebellion: China on guard.
ChatGPT: Optimizing Language Models for Dialogue

We've trained a model called ChatGPT which interacts in a conversational way. The dialogue format makes it possible for ChatGPT to answer followup questions, admit its mistakes, challenge incorrect premises, and reject inappropriate requests. ChatGPT is a sibling model to InstructGPT, which is trained to follow an instruction in a prompt and provide a detailed response.

TRY CHATGPT
“An astronaut riding a horse in a photorealistic way”

“An armchair in the shape of an avocado.”
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
Robotics

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

- Technologies
  - Autonomous Vehicles
  - Rescue
  - Soccer!
  - Lots of automation...
  - But increasing amounts of learning...

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

Images from UC Berkeley, Boston Dynamics, RoboCup, Google
Boston Dynamics Atlas
https://vision-locomotion.github.io/
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
Winning at Games
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!
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
Google: “play pacman doodle”
Course Topics

- **Part I: Making Decisions**
  - Fast search
  - Adversarial and uncertain search

- **Part II: Markov Decision Process (MDP) Basics**
  - Planning
  - Reinforcement learning
  - Imitation learning

- **Part III: Reasoning Under Uncertainty**
  - Bayes Nets
  - Hidden Markov Models (HMMs)
  - Partially Observable MDPs (POMDPs)