CIS 471/571 (Winter 2019): Introduction to Artificial Intelligence

Lecture 1: Introduction

Thanh H. Nguyen

Most slides are by Pieter Abbeel, Dan Klein, Luke Zettlemoyer, John DeNero, Stuart Russell, Andrew Moore, or Daniel Lowd
Source: http://ai.berkeley.edu/home.html
Course Information

- Course website: [https://classes.cs.uoregon.edu/19W/cis471/](https://classes.cs.uoregon.edu/19W/cis471/)
- Instructor: Thanh H. Nguyen (thanhhng@cs.uoregon.edu)
- TA: Gong Zhang (gzhang7@uoregon.edu)
- Book: Russell & Norvig, 3rd Edition
- Office hour:
  - Thanh Nguyen: Thursdays (10:30 am – 11:30 am)
  - Gong Zhang: Wednesdays (10 am – 12:30 pm)
- Coursework:
  - 3 programming assignments: 30%
  - 3 written assignments: 30%
  - 1 midterm: 20%
  - 1 final exam: 20%
- Extra credits:
  - 1 additional programming assignment: 10%
  - Class attendance: 5%
Late Policy

- You can ask for one extension at most.*
- The earlier you ask, the better. Don’t wait until the last minute.
- I will probably say yes.

- Send email to both:
  - thanhhng@cs.uoregon.edu
  - gzhang7@uoregon.edu
Academic Honesty

Submit your own work:

- Write up homework solutions individually
- Solve programming projects alone (grad students) or in pairs (undergrads)

Follow rules for collaboration:

- No notes (written or electronic) from study groups
- Acknowledge all collaborations
Today: Introduction and Overview

- What is Artificial Intelligence?
- What can AI do?
- What is this course?
What is AI?

The science of making machines that:

Think like people

Think rationally

Act like people

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**
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 (data) and simulation (computation) are key to decision making.
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 + subfield expertise**
  - Resurgence of probability, focus on uncertainty
  - General increase in technical depth
  - Agents and learning systems… “AI Spring”?

- **2012—: Excitement**
  - Big data, big compute, neural networks
  - Some re-unification of sub-fields
  - AI used in many industries
What Can AI Do?

Quiz: Which of the following can be done at present?

✔ Play a decent game of table tennis?
✔ Drive safely along a curving mountain road?
❓ Drive safely in New York?
✔ Buy a week's worth of groceries on the web?
✖ Buy a week's worth of groceries at Costco?
❓ Discover and prove a new mathematical theorem?
✖ Converse successfully with another person for an hour?
❓ Perform a surgical operation?
❓ Put away the dishes and fold the laundry?
✔ Translate spoken Chinese into spoken English in real time?
✖ Write an intentionally funny story?
Robotics

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

- Technologies
  - Vehicles
  - Rescue
  - Soccer!
  - Lots of automation...

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

Images from UC Berkeley, Boston Dynamics, RoboCup, Google
Vision (Perception)

- Face detection and recognition
  
  Source: MIT technology review

- 3D understanding
  
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…
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 commodity parts
  - 1996: Kasparov beats Deep Blue: “I could feel --- I could smell --- a new kind of intelligence across the table.”

- **2016**: AlphaGo beats Lee Sedol – huge advance: sparse rollouts and self-play
- **2017**: Carnegie Mellon Artificial Intelligence Beats Top Poker Pros

- **Open question:**
  - How does human cognition deal with the search space explosion of the games?
  - Or: how can humans compete with computers at all??
Societal Problems

Public Safety and Security

Conservation

Public Health
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!
Is AI Dangerous?

- “We need to be super careful with AI. Potentially more dangerous than nukes.”
  - Elon Musk, CEO of SpaceX and Tesla Motors

- “Our demise may instead result from the habitat destruction that ensues when the AI begins massive global construction projects using nanotech factories and assemblers—construction.”
  - Nick Bostrom, author of “Superintelligence”

- “There's a big difference between intelligence and sentience. There could be a race of killer robots in the far future, but I don’t work on not turning AI evil today for the same reason I don't worry about the problem of overpopulation on the planet Mars.”
  - Andrew Ng, Chief Scientist at Baidu, Prof. at Stanford
Does AI Pose New Risks?

- Are self-driving cars dangerous?
- Are human-driven cars dangerous?
- Are machine-controlled weapons dangerous?
- Are human-controlled weapons dangerous?
- Are humans well-understood?
- Are complex artificial intelligence systems well-understood?
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
Course Topics

- Part I: Intelligence from Computation
  - Fast search / planning
  - Constraint satisfaction
  - Game playing

- Part II: Intelligence from Data
  - Bayesian network
  - Decision theory
  - Machine learning

- Throughout: Applications
  - Natural language, vision, robotics, games, ...
Pac-Man as an Agent

Pac-Man is a registered trademark of Namco-Bandai Games, used here for educational purposes.
Project 1: Search

**Goal:** Help Pac-Man find his way through a maze

**Methods:** Uninformed search (DFS, BFS), heuristic search (A*)
Project 2: Multi-Agent Search

Goal: Play Pac-Man!

Methods: Adversarial search, minimax, expectimax, alpha-beta, etc.
Project 3: Reinforcement Learning

**Goal:** Help Pac-Man learn about the world

**Methods:** MDPs, value iteration, reinforcement learning
Project 4: Ghostbusters

**Goal:** Hunt down invisible ghosts

**Methods:** Bayesian networks, HMMs, particle filtering