CIS 471/571(Winter 2020): 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/20W/cis471/
- Instructor: Thanh H. Nguyen (thanhhng@cs.uoregon.edu)
- TA: AJ Spivey(aspivey@uoregon.edu)
- Book: Russell & Norvig, 3rd Edition
- Office hour:
  - Thanh Nguyen:
    - Tuesdays (10 am – 12 pm) (appointment only)
    - Office: Room 358 Deschutes Hall
  - AJ Spivey:
    - Mondays and Wednesdays (11:30 am – 12:30 pm)
    - Office: Room 232 Deschutes Hall
- Coursework:
  - 3 programming assignments: 30%
  - 4 written assignments: 40%
  - 1 final exam: 30%

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:
  - Instructor: thanhhng@cs.uoregon.edu
  - TA: aspivey@uoregon.edu
  - Email title: "CIS471/571:…"

Academic Honesty

Submit your own work:

- Write up homework solutions individually
- Programming projects:
  - Grad students: 1-student groups
  - Undergrads: 1-2 student groups

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:

AI: Think Humanly

- Model the cognitive functions of human beings
- Methods:
  - Introspection-catch our own thoughts as they go by;
  - Psychological experiments: observe a person in action;
  - Brain imaging: observe the brains in action.
- Humans are an example of intelligence
- Problems?
  - Study how people's minds operate, rather than thinking about what intelligence ought to mean in various domains.

AI: Act Humanly

- The Turing Test (Alan Turing 1950): consider computers intelligent when people can't tell them apart from other people
- But… is acting just like a person what we really want?
- For example, don't people often do things that we don't consider intelligent?

AI: Think Rationally

- Rationality: an abstract "ideal" of intelligence, rather than "whatever humans do"
- Refers to the laws of thought approach to AI
- Example: ancient Greeks invented syllogisms (logics): argument structures that always yield correct conclusions given correct premises
- Can we characterize what rational thought ought to look like in a clear (formal) way?

AI: Act Rationally

- An agent (computer program) is rational if it acts to achieve a best expected outcome.

- Rational decision: 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!
- 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:
  - 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—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

Source: http://www.cs.toronto.edu/~fidler/projects/scenes3D.html

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 (Chess computer) vs. Kasparov
  - First match won against world champion
  - 200 million board positions per second
  - Humans understood 99.9 of Deep Blue's moves
  - 1996: Kasparov beats Deep Blue
  - 1997: Deep Blue beats Kasparaov
- 2016: AlphaGo (Go computer) beats Lee Sedol – huge advance: sparse rollouts and self-play
- 2017: Carnegie Mellon Artificial Intelligence (Poker computer) beats Top Poker Pros: imperfect information
- Open question:
  - How does human cognition deal with the search space explosion of the games?
  - Or: how can humans compete with computers at all??

Deep Blue

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!

Societal Problems

Public Safety and Security

Conservation

Public Health

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, …

Course Projects

- Grad students: 1-student groups
- Undergrads: 1-2 student groups
  - If you work in pairs, email me and the TA.

- All three projects are posted!
- Deadlines:
  - Project 1: 01/19/2020
  - Project 2: 02/02/2020
  - Project 3: 02/17/2020

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