Introduction to AI

Russell and Norvig:
Chapter 1

CMPS 140 – Winter 2015

Acknowledgements: Material in this course is based heavily on material from Dan Klein's UC Berkeley course.

Today

- Introduction
  - What is AI?
  - What will we learn in this class?
- Course Details and Logistics
  - Introduction to course staff
  - What are the course logistics?
  - How can I do well in this course?

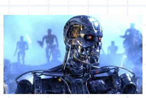
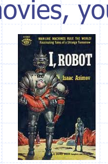
Introduction to AI

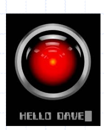
So you're taking an AI class….

- You and 160,000 other people!!
  - **2011: "Stanford's latest global virtual classroom may have more than 160,000 students"**
- The Stanford AI class was one of the big successes that kicked off the currently flurry in MOOCs, and companies Udacity, Coursera, and EdX

What is AI?

- You've seen the movies, you've read the books …



- What is *your* definition of AI?

Class Exercise #1, part A:

- On the 3x5 card you've been given, write
  - your name and email
  - ***your*** definition of AI

AI Characterizations

Discipline that systematizes and automates intellectual tasks to create machines that:

Think like humans	Think rationally
Act like humans	Act rationally

#1: Act Like Humans

- Behaviorist approach
- Not interested in how you get results, just the similarity to human results
- Exemplified by the **Turing Test** (Alan Turing, 1950)

Turing Test

- Interrogator interacts with a computer and a person via a teletype.
- Computer passes the Turing test if interrogator cannot determine which is which.
- Loebner contest: Modern version of Turing Test, held annually, w/ a $100,000 grand prize. http://www.loebner.net/Prizef/loebner-prize.html
  - Participants include a set of humans and a set of computers and a set of judges.
  - Scoring: Rank from least human to most human.
  - Highest median rank wins $4000.
  - If better than a human, win $100,000. (Nobody yet…)

#2: Think Like Humans

- How the computer performs functions does matter
- Comparison of the traces of the reasoning steps
- Cognitive science → testable theories of the workings of the human mind

•Exemplified by
  •General Problem Solver (Newell and Simon)

But:
• some early research conflated algorithm performance => like human (and vice-versa)
• Do we want to duplicate human imperfections?

#3: Thinking rationally

- Exemplified by "laws of thought"
- Aristotle: what are correct arguments/thought processes?
- Several Greek schools developed various forms of *logic*: *notation* and *rules of derivation* for thoughts
- Direct line through mathematics and philosophy to modern AI

Problems:
1. Not easy to translate informal real world problem into formal terms (problem formulation is difficult)
2. While may be able to solve the problem in principal (i.e. decidable), in practice, may not get the answer in a reasonable amount of time (computationally intractable)

#4: Acting Rationally

- Rational behavior: do the right thing
- Always make the best decision given

•Connection to economics, operational research, and control theory
•But ignores role of consciousness, emotions, fear of dying on intelligence

- Imperfect knowledge, limited resources → (limited) rationality

Class Exercise #1, part B

- Break into groups of **3 people**
- In your groups:
  - Start by giving a quick introduction: name, year, email, etc.
  - You may want to copy these to your notes as well; now you know two people to ask if you have questions on material, etc. (of course, there is the forum too!)
  - Each person has a card; read the card to the group, and the group should decide the category.
  - Write the category on the card.

#2: Think like humans	**#3: Think rationally**
#1: Act like humans	**#4: Act rationally**

AI Characterizations

Discipline that systematizes and automates intellectual tasks to create machines that:

#2: Think like humans	#3: Think rationally
#1: Act like humans	#4: Act rationally

1. Counts?
2. Examples of each?

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—88: 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"
- 1988—: 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 table tennis?
- ✔ Drive safely along a curving mountain road?
- ? Drive safely along Pacific Ave.?
- ✔ Buy a week's worth of groceries on the web?
- ✘ Buy a week's worth of groceries at New Leaf?
- ? Discover and prove a new mathematical theorem?
- ✘ Converse successfully with another person for an hour?
- ? Perform a complex surgical operation?
- ✔ Unload a dishwasher and put everything away?
- ✔ Translate spoken Chinese into spoken English in real time?
- ✘ Write an intentionally funny story?

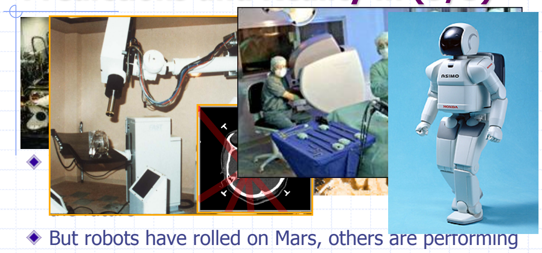
Predictions and Reality … (1/3)

- In the 60's, a famous AI professor from MIT said: "At the end of the summer, we will have developed an electronic eye"
- As of 2015, there is still no general computer vision system capable of understanding complex dynamic scenes
- But computer systems routinely perform road traffic monitoring, facial recognition, some medical image analysis, part inspection, etc…

Predictions and Reality … (2/3)

- In 1958, Herbert Simon (CMU) predicted that within 10 years a computer would be Chess champion
- This prediction became true in 1998
- Today, computers have won over world champions in several games, including Checkers, Othello, and Chess, but still do not do well in Go

Predictions and Reality … (3/3)



- But robots have rolled on Mars, others are performing brain and heart surgery, and humanoid robots are operational , (see: http://en.wikipedia.org/wiki/ASIMO)

Why is AI Hard?

- Simple syntactic manipulation is not enough

- Machine Translation
  - Big project in 1957 following Sputnik launch
  - Translation of Russian documents
    - 'The spirit is willing but the flesh is weak'
    - 'The vodka is strong but the meat is rotten'

Why is AI Hard?

- Computational intractability

- AI goal defined before notion of NP-completeness
  - people thought to solve larger problems we simply need larger/faster computers
  - didn't understand the notion of exponential growth

ALL of the algorithms we study will be computationally intractable (NP-complete at best) in the **WORST** case …

How does the fact that we are dealing with the **REAL WORLD** make solving these computationally challenging problems feasible **IN PRACTICE?**

CMPS 140

- We will focus on the rational agents ("engineering") paradigm
- Make computers act more intelligently
- Three major components:
  - representation
  - reasoning
  - learning

Rational Decisions

We'll use the term **rational** in a particular way:

- Rational: maximally achieving pre-defined goals
- Rational 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**

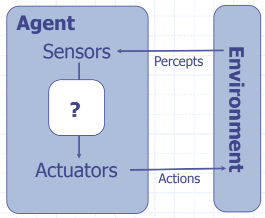
A better title for this course would be:

Computational Rationality

Maximize your Expected Utility

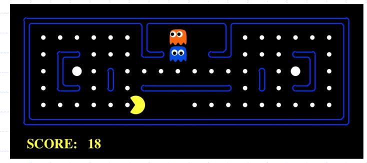
Designing Rational Agents

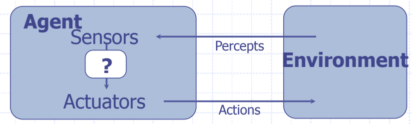
- An **agent** is an entity that *perceives* and *acts*.
- A **rational agent** selects actions that maximize its **utility function**.
- Characteristics of the **percepts, environment,** and **action space** dictate techniques for selecting rational actions.



- 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

Pacman as an Agent





Course Topics

- Part I: Making Decisions
  - Fast search
  - Constraint satisfaction
  - Adversarial and uncertain search
  - Markov Decision Processes and Reinforcement Learning
- Part II: Modeling Structure & Uncertainty
  - Logic
  - Bayes' nets
  - Decision theory
  - Machine learning
- Throughout: Applications
  - Natural language, vision, robotics, games

Disclaimers

- This is my FAVORITE class
- This class is HARD
- This is my first UG class at UCSC
- My goal is to help you LEARN
  - The material
  - How to learn

Learning Goals for Class

- You will learn a bunch of tools that are useful for building useful, adaptive software… to solve fun and challenging problems
- These tools will be useful for you whether you go into AI research (basics that anyone should know) or any other discipline (oh, hey, that looks like the CSP problems we studied way back in cmps 140)
- Help you separate hype from what's easily achievable using existing tools (and avoid reinventing them!)
- Teach you how to look for new results, new methods, AI, like all of CS, is very, very rapidly developing field! This course will give you the basics, that should help you to find, understand and appreciate new developments

What are the prerequisites?

- Assume you know how to program, know algorithms and know math. You should know:
  - basic algorithms, data structures and computational complexity
    - i.e., searching graphs (DFS, BFS), lists, trees, graphs, hashtables, etc.
    - Difference between an O(n) and an O(2^n) algorithm
  - basic logic
    - Truth table for x OR y, x AND y, x IMPLIES y
  - basic probability
    - P(A v B) = P(A) + P(B) – P(A & B)
    - P(A | B) = P(A & B) / P(B)
  - basic math
    - Exponents, logs
- **Q0 (online quiz in eCommons) is a self-diagnostic – Please submit by Thu (required but not graded!)**

What are the course logistics?

- Web Page:
  - https://courses.soe.ucsc.edu/courses/cmps140/Winter15/01
- Communication:
  - eCommons
  - Piazza
- There is a survey (S0), a quiz (Q0) and programming assignment (P0), all up on eCommons. There will be an extra-credit discussion question (E0) on Piazza by Thu.
- Use this as opportunity to familiarize yourself w/ eCommons, Piazza make sure you are able to logon, ask us any questions, etc.
- S0 and Q0 are due by Tue. E0 and P0 are due next Tue.

Course Personnel

- Prof:
  - Lise Getoor, E2 341B
  - Office hours: Tue 3:00-5:00 & by appt

- TAs:
  - Dhanya Sridhar
  - Office hours: TTH 1PM-2PM Soc Sci 1 Rm 135, Tues 4PM - 5PM, E2-480 & by appt

  - Vasileios (**Vassilis**) Polychronopoulos
  - Office hours: Wed 1PM-3PM Soc Sci 1 Rm 135, Wed 4PM-5PM BE312C/D & by appt

Course Work

- Participation & in class exercises – 10%
- Quizzes - 15%
- 5 programming assignments - 20%
- Midterm - 20%
- Final - 30%

Late Days: 7 free late days, use as you see fit; max 4 per assignment; **no additional** late days given

Academic Integrity: You are responsible for both the University's Code of Academic Integrity and UCSC's Guidelines for Acceptable Use of Computing Resources.

Grading

- Grades are on the following fixed scale:

A	[90 -- 100]%
A-	[85 – 90)%
B+	[80 -- 85)%
B	[75 -- 80)%
B-	[70 -- 75)%
C+	[65 -- 70)%
C	[60 -- 65)%
C-	[55 -- 60)%
D+	[50 -- 55)%
D	[45 -- 50)%
D-	[40 -- 45)%
F	[0 -- 40)%

- These cutoffs represent grade **minimums**. We may adjust grades upward based on class participation, extra credit, etc. The grade of A+ will be awarded at the professor's discretion based on exceptional performance.

How do I do well in this course?

- Attend class
- Participate in class; participate in online discussions
- Take Notes
- Do reading
  - Suggestion: 1) Set aside 20 minutes to skim chapter before lecture. 2) After lecture, go back and read the text in depth.
- Start quizzes early
- Start programming assignments EARLY
- Assignments are not designed to be done the night before they are due
- Do practice problems to study for exams
- Form study groups. Working together (not copying) is highly encouraged!

How do we get the most out of class?

- and learn something, ☺!
- Course Ettiquette:
  - Arrive to class on time; if you must leave during class, please try to limit the disruption/distraction
  - No cell phones, no side discussions
  - No laptops during lectures
  - Participate, Participate, *Participate*
    - ask questions – if you don't understand the material, probably there is someone else who does not either!
    - some in class/group exercises
  - Feedback:
    - please provide feedback
    - there will be several opportunities, but also feel free to just come talk to me!

Announcements

- Important this week:
  - **S0:** Survey, fill out on eCommons, due Thu
  - **Q0:** Quiz, Background prep, fill out on eCommons, due Thu
    - Neither of these is graded, we just check that you turn them in, so turn them in, ☺!
  - **P0: Python tutorial** is available on eCommons, due next Tue
  - **E0:** Extra-credit discussion will be available shortly on Piazza, deadline next Tue