CS 188: Artificial Intelligence
Spring 2011

Lecture 1: Introduction
1/19/2011

Pieter Abbeel – UC Berkeley
Many slides from Dan Klein.

Course Information

Course Staff

- **Course Staff**
  - Professor
  - Pieter Abbeel

- **GSIs**
  - Jon Barron
  - Lubomir Bourdev
  - John Duchil
  - Arjun Singh

Announcements

- Important this week:
  - **P0**: Python tutorial going out on Thursday --- due next week Friday
  - **One time lab hours** next week (specifies TBD)
  - Get your account forms in front after class
  - **P1**: Search, going out on Monday --- due Friday 2/3

- Also important:
  - **Sections** start next week. You may change sections, but you have seating priority where you are registered. New section coming?
  - The Waiting list will take a while to sort out. We don’t control enrollment. Contact Michael-David Sasson (msasson@cs) with any questions on the process.

Today

- What is artificial intelligence?
- What can AI do?
- What is this course?
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
  - 1955: Robinson's complete algorithm for logical reasoning
- 1956-64: Look, Ma, no hands!
  - 1958: Newell & Simon's "Gopher"
  - 1960-66: Early expert systems
- 1965: Eliza: "… mother …" → "Tell me more about your family"
  - 1965: Robinson's complete algorithm for logical reasoning
  - 1966: Weizenbaum's Eliza / Turing test
- 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
- 1990—: Where are we now?

Herb Simon, 1957

It is not my aim to surprise or shock you—but the simplest way I can summarize is to say that there are now in the world machines that think, that learn and that create. Moreover, their ability to do these things is going to increase rapidly until—in a visible future—the range of problems they can handle will be coextensive with the range to which human mind has been applied.

More precisely: within 10 years a computer would be chess champion, and an important new mathematical theorem would be proved by a computer.

Harder than originally thought

- Herb Simon's prediction came true, but after roughly 40 years instead of after 10
- Eliza:
  - "… mother …" → "Tell me more about your family"
  - "I wanted to adopt a puppy, but it's too young to be separated from its mother." → ???
- 1957: Sputnik
  - Automatic Russian → English translation
  - Famous example:
    - "The spirit is willing but the flesh is weak."
  - E → R → E: "The vodka is strong but the meat is rotten."

Observations

- Need some understanding about the world
- Computational tractability, NP-completeness, exponential scaling.

A (Short) History of AI (ctd)

- 1970—88: Knowledge-based approaches
  - 1969—70: 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 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?
- 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?
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 fell in the river. Gravity drowned. The End.

- Once upon a time there was a dishonest fox and a vain crow. One day the crow was sitting in his tree, holding a piece of cheese in his mouth. He noticed that he was holding the piece of 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**
  - Automatic speech recognition (ASR)
  - Text-to-speech synthesis (TTS)
  - Dialog systems

- **Language processing technologies**
  - Machine translation
  - Comprehension
  - Question answering
  - Information extraction
  - Information retrieval, question answering
  - Text classification, spam filtering, etc...

Vision (Perception)

- Object and character recognition
- Scene segmentation
- 3D reconstruction
- Image classification

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

Game Playing

- **Game Playing**
  - 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 big 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.”

Logic

- **Logical systems**
  - Theorem provers
  - NASA fault diagnosis
  - Question answering

- **Methods**
  - Deduction systems
  - Constraint satisfaction
  - Satisfiability solvers (huge advances here!)

Image from Bart Selman, image from IBM's Deep Blue pages

Images from Stanfordracing.org, CMU Robotics, Honda ASIMO sites
Decision Making

- Scheduling, e.g. airline routing, military
- Route planning, e.g. Google Maps
- Medical diagnosis
- Automated help desks
- Fraud detection
- Spam classifiers
- Web search engines
- Movie and book recommendations
- ... Lots more!

What is AI?

The science of making machines that:

<table>
<thead>
<tr>
<th>Think like humans</th>
<th>Think rationally</th>
</tr>
</thead>
<tbody>
<tr>
<td>Act like humans</td>
<td>Act rationally</td>
</tr>
</tbody>
</table>

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
What About the Brain?

- Brains (human minds) are very good at making rational decisions (but not perfect)
- "Brains are to intelligence as wings are to flight"
- Brains aren’t as modular as software
- Lessons learned: prediction and simulation are key to decision making

Course Topics

- Part I: Making Decisions
  - Fast search
  - Constraint satisfaction
  - Adversarial and uncertain search
- Part II: Modeling Uncertainty
  - Bayes’ nets
  - Decision theory
- Part III: Machine learning
  - Perceptron, kernels
- Throughout: Applications
  - Natural language, vision, robotics, games

- Pick up your class account forms now.
- See you Monday.