ARTIFICIAL INTELLIGENCE

CHAPTER 1
Outline

- Course overview
- What is AI?
- A brief history
- The state of the art
Administrivia

Class home page: http://inst.eecs.berkeley.edu/~cs188 for lecture notes, assignments, exams, grading, office hours, etc. and academic dishonesty policy (DON’T CHEAT!!!)

Assignment 0 (lisp refresher) due 9/8
account forms from 727 Soda.

See syllabus: Chapter 1 for today’s material, Chapter 2 for Thursday.

Code: new AIMA2e version posted locally (see class page)
Lisp/emacs/AIMA tutorial:
Online, or in person 10-12 and 3.30-4.30 on Fri 9/2, 273 Soda
Discussion section this week: Lisp refreshment

Prerequisites: CS 61A, and Math55/CS70

Sections 103 and 104 are primarily intended for non-CS majors
Course overview

♦ intelligent agents
♦ search and game-playing
♦ logical systems
♦ planning systems

♦ uncertainty—probability and decision theory
♦ learning

♦ language
♦ perception
♦ robotics
♦ philosophical issues
## What is AI?

<table>
<thead>
<tr>
<th>Systems that think like humans</th>
<th>Systems that think rationally</th>
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<tr>
<td>Systems that act like humans</td>
<td>Systems that act rationally</td>
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Acting humanly: The Turing test

Turing (1950) “Computing machinery and intelligence”:
◊ “Can machines think?” → “Can machines behave intelligently?”
◊ Operational test for intelligent behavior: the Imitation Game

◊ Predicted that by 2000, a machine might have a 30% chance of fooling a lay person for 5 minutes
◊ Anticipated all major arguments against AI in following 50 years
◊ Suggested major components of AI: knowledge, reasoning, language understanding, learning

Problem: Turing test is not reproducible, constructive, or amenable to mathematical analysis
1960s “cognitive revolution”: information-processing psychology replaced prevailing orthodoxy of behaviorism

Requires scientific theories of internal activities of the brain
   – What level of abstraction? “Knowledge” or “circuits”?  
   – How to validate? Requires
     1) running human subjects (top-down) or 2) brain-stabbing (bottom-up)

Cognitive science is to AI as ornithology is to aerodynamics  
(Drew McDermott, original attribution unknown)

Both approaches (roughly, Cognitive Science and Cognitive Neuroscience) are now distinct from AI

Both share with AI the following characteristic: 
the available theories do not explain (or engender) anything resembling human-level general intelligence
Hence, all three fields share one principal direction!
Thinking rationally: Laws of Thought

**Normative** (or *prescriptive*) rather than **descriptive**

Aristotle: what are correct arguments/thought processes?

Several Greek schools developed various forms of **logic**:

- **notation** and **rules of derivation** for thoughts;
- may or may not have proceeded to the idea of mechanization

Direct line through mathematics and philosophy to modern AI

Problems:

1) Not all intelligent behavior is mediated by logical deliberation

2) **What is the purpose of thinking?** What thoughts **should** I have out of all the thoughts (logical or otherwise) that I **could** have?
Acting rationally

**Rational** behavior: doing the right thing

The right thing: that which is expected to maximize goal achievement, given the available information

Doesn’t necessarily involve thinking—e.g., blinking reflex—but thinking should be in the service of rational action

Aristotle (Nicomachean Ethics):

> Every art and every inquiry, and similarly every action and pursuit, is thought to aim at some good
Rational agents

An agent is an entity that perceives and acts.

This course is about designing rational agents.

Abstractly, an agent is a function from percept histories to actions:

\[ f : \mathcal{P}^* \rightarrow A \]

For any given class of environments and tasks, we seek the agent (or class of agents) with the best performance.

Caveat: computational limitations make perfect rationality unachievable.

→ design best program for given machine resources.
<table>
<thead>
<tr>
<th>Field</th>
<th>Contributions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Philosophy</td>
<td>logic, methods of reasoning</td>
</tr>
<tr>
<td></td>
<td>mind as physical system</td>
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<tr>
<td></td>
<td>foundations of learning, language, rationality</td>
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<tr>
<td>Mathematics</td>
<td>formal representation and proof</td>
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<td></td>
<td>algorithms, computation, (un)decidability, (in)tractability</td>
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<td></td>
<td>probability</td>
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<tr>
<td>Psychology</td>
<td>adaptation</td>
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<td></td>
<td>phenomena of perception and motor control</td>
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<td></td>
<td>experimental techniques (psychophysics, etc.)</td>
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<tr>
<td>Economics</td>
<td>formal theory of rational decisions</td>
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<tr>
<td>Linguistics</td>
<td>knowledge representation</td>
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<td></td>
<td>grammar</td>
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<tr>
<td>Neuroscience</td>
<td>plastic physical substrate for mental activity</td>
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<tr>
<td>Control theory</td>
<td>homeostatic systems, stability</td>
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<td></td>
<td>simple optimal agent designs</td>
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</table>
Potted history of AI

1943  McCulloch & Pitts: Boolean circuit model of brain
1950  Turing’s “Computing Machinery and Intelligence”
1952–69  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
1966–74  AI discovers computational complexity
  Neural network research almost disappears
1969–79  Early development of knowledge-based systems
1980–88  Expert systems industry booms
1985–95  Neural networks return to popularity
1988–  Resurgence of probability; general increase in technical depth
  “Nouvelle AI”: ALife, GAs, soft computing
1995–  Agents, agents, everywhere . . .
2003–  Human-level AI back on the agenda
State of the art

Which of the following can be done at present?

◊ Play a decent game of table tennis
State of the art

Which of the following can be done at present?

◊ Play a decent game of table tennis
◊ Drive safely along a curving mountain road
State of the art

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
State of the art

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
State of the art

Which of the following can be done at present?

♦ Play a decent game of table tennis
♦ Drive safely along a curving mountain road
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♦ Buy a week’s worth of groceries on the web
♦ Buy a week’s worth of groceries at Berkeley Bowl
State of the art

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♦ Drive safely along a curving mountain road
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♦ Buy a week’s worth of groceries on the web
♦ Buy a week’s worth of groceries at Berkeley Bowl
♦ Play a decent game of bridge
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♦ Drive safely along a curving mountain road
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♦ Buy a week’s worth of groceries on the web
♦ Buy a week’s worth of groceries at Berkeley Bowl
♦ Play a decent game of bridge
♦ Discover and prove a new mathematical theorem
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◊ 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
◊ Play a decent game of bridge
◊ Discover and prove a new mathematical theorem
◊ Design and execute a research program in molecular biology
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
- Play a decent game of bridge
- Discover and prove a new mathematical theorem
- Design and execute a research program in molecular biology
- Write an intentionally funny story
State of the art

Which of the following can be done at present?

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♦ 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
♦ Play a decent game of bridge
♦ Discover and prove a new mathematical theorem
♦ Design and execute a research program in molecular biology
♦ Write an intentionally funny story
♦ Give competent legal advice in a specialized area of law
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◊ Discover and prove a new mathematical theorem
◊ Design and execute a research program in molecular biology
◊ Write an intentionally funny story
◊ Give competent legal advice in a specialized area of law
◊ Translate spoken English into spoken Swedish in real time
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♦ Discover and prove a new mathematical theorem
♦ Design and execute a research program in molecular biology
♦ Write an intentionally funny story
♦ Give competent legal advice in a specialized area of law
♦ Translate spoken English into spoken Swedish in real time
♦ Converse successfully with another person for an hour
State of the art

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♦ Discover and prove a new mathematical theorem
♦ Design and execute a research program in molecular biology
♦ Write an intentionally funny story
♦ Give competent legal advice in a specialized area of law
♦ Translate spoken English into spoken Swedish in real time
♦ Converse successfully with another person for an hour
♦ Perform a complex surgical operation
State of the art

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♦ 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
♦ Play a decent game of bridge
♦ Discover and prove a new mathematical theorem
♦ Design and execute a research program in molecular biology
♦ Write an intentionally funny story
♦ Give competent legal advice in a specialized area of law
♦ Translate spoken English into spoken Swedish in real time
♦ Converse successfully with another person for an hour
♦ Perform a complex surgical operation
♦ Unload any dishwasher and put everything away
State of the art

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♦ 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
♦ Play a decent game of bridge
♦ Discover and prove a new mathematical theorem
♦ Design and execute a research program in molecular biology
♦ Write an intentionally funny story
♦ Give competent legal advice in a specialized area of law
♦ Translate spoken English into spoken Swedish in real time
♦ Converse successfully with another person for an hour
♦ Perform a complex surgical operation
♦ Unload any dishwasher and put everything away
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 threatened to hit Irving if he didn’t tell him where some honey was. 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.

etc.
Hard questions

Will machines surpass human intelligence? Should they?

What will we do with superintelligent machines?

Do such machines have conscious existence? Rights?

Should we replace the human race with superhuman machines?

Can human minds exist indefinitely within machines?