ARTIFICIAL INTELLIGENCE

CHAPTER 1
Outline

◊ What is AI?
◊ A brief history
◊ The state of the art
## What is AI?

<table>
<thead>
<tr>
<th>Systems that think like humans</th>
<th>Systems that think rationally</th>
</tr>
</thead>
<tbody>
<tr>
<td>Systems that act like humans</td>
<td>Systems that act rationally</td>
</tr>
</tbody>
</table>
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
Thinking humanly: Cognitive Science

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) Predicting and testing behavior of human subjects (top-down)
  or 2) Direct identification from neurological data (bottom-up)

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:

\[ f : P^* \rightarrow A \]

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

\[ \rightarrow \text{design best program for given machine resources} \]
AI prehistory

Philosophy
logic, methods of reasoning
mind as physical system
foundations of learning, language, rationality

Mathematics
formal representation and proof
algorithms, computation, (un)decidability, (in)tractability
probability

Psychology
adaptation
phenomena of perception and motor control
experimental techniques (psychophysics, etc.)

Economics
formal theory of rational decisions

Linguistics
knowledge representation
grammar

Neuroscience
plastic physical substrate for mental activity

Control theory
Optimal and adaptive control systems, stability
simple optimal agent designs
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 Al back on the agenda
State of the art

Which of the following can computers do at present?

◊ Play a decent game of chess/checkers/bridge
◊ Drive safely along a curving mountain road
◊ Drive safely in New York city
◊ Buy a week’s worth of groceries on the web
◊ Buy a week’s worth of groceries at the local store
◊ Prove a mathematical theorem
◊ Discover and prove a new mathematical theorem
◊ Design an optimal supersonic aircraft
◊ Write an intentionally funny story
◊ Give competent legal advice in a specialized area of law
◊ Translate spoken English into spoken Spanish in real time
◊ Converse successfully with another person for an hour
◊ Diagnose a tumor in an X-ray image
◊ Perform a complex surgical operation
◊ Unload any dishwasher and put everything away