Artificial Intelligence

Chapter 1

Outline

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

What is AI?

Systems that think like humans | Systems that think rationally
Systems that act like humans | Systems that act rationally

Thinking humanly: Cognitive Science

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!

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

Diamond 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

CAPTCHA

Completely Automated Public Turing test to tell Computers and Humans Apart

Thinking humanly: Cognitive Science

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**

→ design best program for given machine resources

AI prehistory

<table>
<thead>
<tr>
<th>Year</th>
<th>Event</th>
</tr>
</thead>
<tbody>
<tr>
<td>1943</td>
<td>McCulloch &amp; Pitts: Boolean circuit model of brain</td>
</tr>
<tr>
<td>1950</td>
<td>Turing’s “Computing Machinery and Intelligence”</td>
</tr>
<tr>
<td>1952–69</td>
<td>Look, Ma, no hands!</td>
</tr>
<tr>
<td>1950s</td>
<td>Early AI programs, including Samuel’s checkers program, Newell &amp; Simon’s Logic Theorist, Gelernter’s Geometry Engine</td>
</tr>
<tr>
<td>1956</td>
<td>Dartmouth meeting: “Artificial Intelligence” adopted</td>
</tr>
<tr>
<td>1965</td>
<td>Robinson’s complete algorithm for logical reasoning</td>
</tr>
<tr>
<td>1966–74</td>
<td>AI discovers computational complexity</td>
</tr>
<tr>
<td>1969–79</td>
<td>Early development of knowledge-based systems</td>
</tr>
<tr>
<td>1980–88</td>
<td>Expert systems industry booms</td>
</tr>
<tr>
<td>1985–95</td>
<td>Neural networks return to popularity</td>
</tr>
<tr>
<td>1988–</td>
<td>Resurgence of probability; general increase in technical depth “Nouvelle AI”: ALife, GAs, soft computing</td>
</tr>
<tr>
<td>1995–</td>
<td>Agents, agents, everywhere . . .</td>
</tr>
<tr>
<td>2003–</td>
<td>Human-level AI back on the agenda</td>
</tr>
</tbody>
</table>

State of the art

Which of the following can be done at present?

◇ Play a decent game of table tennis
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 Robson Street
◊ Buy a week’s worth of groceries on the web
◊ Buy a week’s worth of groceries at Safeway
◊ Play a decent game of bridge
◊ Discover and prove a new mathematical theorem
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 Robson Street
♦ Buy a week’s worth of groceries on the web
♦ Buy a week’s worth of groceries at Safeway
♦ 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
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 Robson Street
- Buy a week’s worth of groceries on the web
- Buy a week’s worth of groceries at Safeway
- 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