Artificial Intelligence – Chapter 1

August 23, 2021

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**

Acting humanly: The Turing test

Turing (1950) "Computing machinery and intelligence":

♢ "Can machines think?" $\longrightarrow$ "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? "" or ""?
  - How to validate? Requires
    1. Predicting and testing behavior of human subjects (top-down)
    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 (which 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**?
  3. 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:

    $$f : \mathcal{P}^* \to \mathcal{A}$$

  - 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**

  $\to$ 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	homeostatic systems, stability
	simple optimal agent designs

Brief history of AI

1943	McCulloch & Pitts: Boolean circuit model of brain
1950	Turing's "Computing Machinery and Intelligence"
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
1988–93	Expert systems industry busts: **AI Winter**
1985–95	Neural networks return to popularity
1988–	Resurgence of probability; general increase in technical depth New AI: ALife, GAs, soft computing (Fuzzy Logic)
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

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- ♢ Play a decent game of table tennis
- ♢ Drive safely along a curving mountain road

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- ♢ Play a decent game of bridge

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- ♢ Play a decent game of bridge
- ♢ Discover and prove a new mathematical theorem

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- ♢ Design and execute a research program in molecular biology

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- ♢ Write an intentionally funny story

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- ♢ Give competent legal advice in a specialized area of law

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- ♢ Translate spoken English into spoken Swedish in real time

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- ♢ Perform a complex surgical operation

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- ♢ Give competent legal advice in a specialized area of law
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- ♢ Converse successfully with another person for an hour
- ♢ Perform a complex surgical operation
- ♢ Unload any dishwasher and put everything away

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