Artificial Intelligence

Intro (Chapter 1 of AIMA)

Summary

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

What is AI?

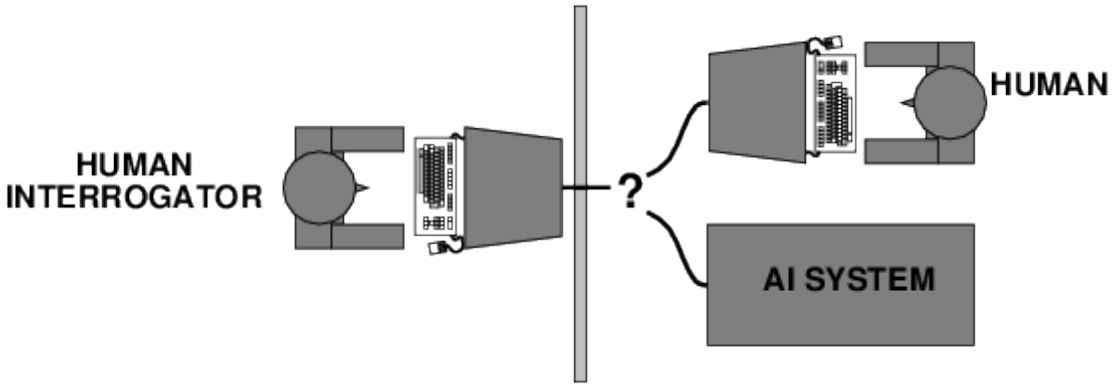
Systems that think like humans	**Systems that think rationally**
Systems that act like humans	**Systems that act rationally**

Acting humanly: The Turing test I

Turing (1950) "Computing machinery and intelligence":

♢ "**Can machines think**?" $\longrightarrow$ "Can machines behave intelligently?"

♢ **Operational** test for intelligent behavior: the Imitation Game



Acting humanly: The Turing test II

♢ Suggested all major components of AI:

- knowledge representation (storing what is known)
- automated reasoning (manipulate facts for inference)
- natural language processing (translate text to knowledge)
- machine learning (adapt to new circumstances)
- (full TT) vision (perceive objects)
- (full TT) robotics (manipulation and gestures)

Problem: Turing test is not **reproducible**, **constructive**, or amenable to **mathematical analysis**

Thinking humanly: Cognitive Science

♢ "cognitive science": merges computer models from AI and empirical methodologies psychology

♢ **Goal**: to construct precise (and testable) theories of human mind

Problems:

1. What level of abstraction? "Knowledge" or "circuits"?
2. How to validate ? i) Predicting and testing behavior of human subjects (top-down); ii) Direct identification from neurological data (bottom-up)

♢ Cognitive Science is now a separate field from AI (though cross-fertilization do exist)

Thinking rationally: Laws of Thought

- Normative (or prescriptive) rather than descriptive
- Aristotele: what are correct arguments/thought processes?
- Direct line through mathematics and philosophy to modern AI

Problems:

1. Translating informal knowledge to logical notation is difficult
2. Huge difference between solving "in principle" and solving in practice.

Acting rationally: Rational Agents

♢ 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

♢ Correct thinking (e.g., inference) does not always result in rational outcome (in some situations no **provable** correct things to do).

Rational agents

- ♢ An agent is an entity that perceives and acts
- ♢ We will focus on designing rational agents

rational agent

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

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

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

Caveat: **computational limitations make perfect rationality unachievable**

→ design best program for given machine resources

AI prehistory I

Philosophy	logic, methods of reasoning
c. 400 B.C.	mind as physical system
	foundations of learning, language,
	rationality
Mathematics	formal representation and proof
c. 800	algorithms, computation,
	(un)decidability, (in)tractability
	probability
Economics	formal theory of rational decisions
1776 (Smith)	
Neuroscience	plastic physical substrate for mental activity
1861 (Broca)	
Aphasia	

AI prehistory II

Psychology	adaptation
1879 (Wundt)	perception and motor control
	experimental techniques
	(psychophysics, etc.)
Control theory	homeostatic systems, stability
1948 (Wiener)	simple optimal agent designs
Linguistics	knowledge representation, grammar
1957 (Chomsky)	

Potted history of AI

1943	McCulloch & Pitts: Boolean circuit model of brain
1950	Turing's **imitation game**:
	"Computing Machinery and Intelligence"
1950s	Early AI programs, e.g., Samuel's checkers program
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
1987–	AI and the scientific method
1995–	**Agents**, agents, everywhere . . .
2001–	Availability of very large data sets
2003–	Human-level AI back on the agenda

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  - Automotive: autonomous or assisted driving, (2015–)

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  - `https://futureoflife.org/ai-activities/`