

ARTIFICIAL INTELLIGENCE

CHAPTER 1

Outline

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

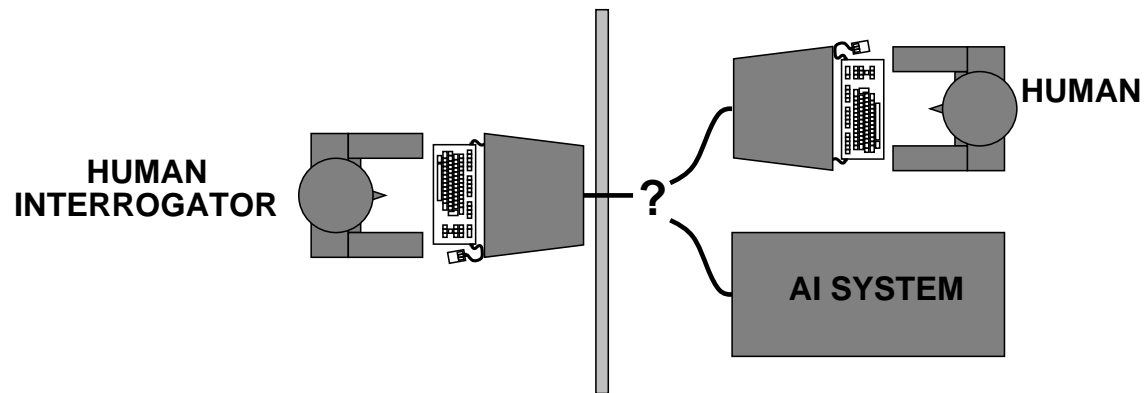
What is AI?

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

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**

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:

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

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

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

→ 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 |

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
- 1988–93 Expert systems industry busts: "AI Winter"
- 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 Robson Street

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 Robson Street
- ◇ Buy a week's worth of groceries on the web

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Which of the following can be done at present?

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- ◇ Buy a week's worth of groceries at Safeway
- ◇ 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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- ◇ Discover and prove a new mathematical theorem
- ◇ 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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- ◇ Give competent legal advice in a specialized area of law
- ◇ Translate spoken English into spoken Swedish in real time

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- ◇ Converse successfully with another person for an hour

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- ◇ Converse successfully with another person for an hour
- ◇ Perform a complex surgical operation

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- ◇ 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

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- ◇ Perform a complex surgical operation
- ◇ Unload any dishwasher and put everything away