

Revised by Hankui Zhuo, March 1, 2019

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

Both approaches (roughly, Cognitive Science and Cognitive Neuroscience) are now distinct from AI

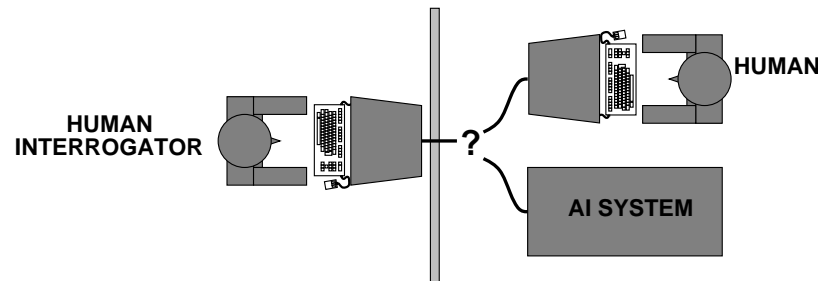
Both share with AI the following characteristic:

**the available theories do not explain (or engender)
anything resembling human-level general intelligence**

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



- ◇ Suggested major components of AI: knowledge, reasoning, language understanding, learning

Thinking rationally: Laws of Thought

- ◇ Normative (or prescriptive) rather than descriptive
- ◇ Reasoning / strong AI

Example:

$A \vee B \rightarrow C$ is true

A is true

Can we have C is true?

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: ALife, GAs, soft computing
- 1995– Agents, agents, everywhere . . .
- 2003– Human-level AI back on the agenda
- 2010– Cloud computing, big data, deep learning, AlphaGo

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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

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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 Telegraph Avenue

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Which of the following can be done at present?

- ◇ Play a decent game of table tennis
- ◇ Drive safely along a curving mountain road
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- ◇ Buy a week's worth of groceries on the web

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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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- ◇ 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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- ◇ Perform a complex surgical operation

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- ◇ 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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End of Chapter 1

Thanks & Questions!