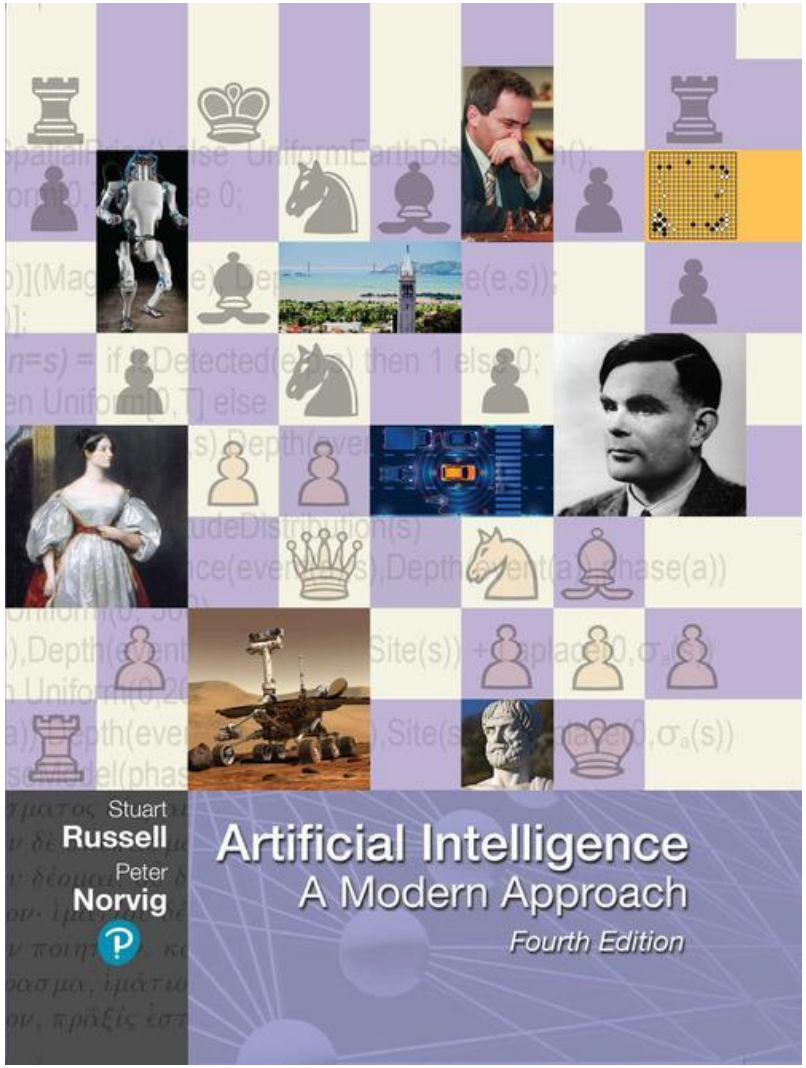
Artificial Intelligence: A Modern Approach

Fourth Edition



Chapter 1

Introduction

Artificial Intelligence

Chapter 1

Outline

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

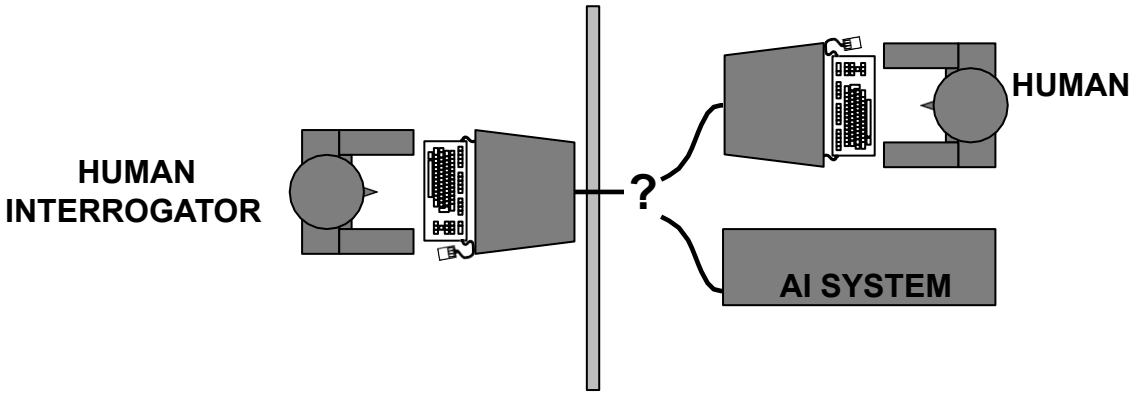
What is AI?

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

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? "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

Philosophy	logic, methods of reasoning mind as physical system
Mathematics	foundations of learning, language, rationality formal representation and proof algorithms, computation, (un)decidability, (in)tractability probability
Psychology	adaptation phenomena of perception and motor
Economics	control experimental techniques
Linguistics	(psychophysics, etc.)
Neuroscience	formal theory of rational decisions knowledge representation grammar plastic physical substrate for mental activity
Control theory	homeostatic systems, stability simple optimal agent

Potted history of AI

1943 McCulloch & Pitts: Boolean circuit model of brain

Turing's "Computing Machinery and Intelligence"

1952–69 Look, Ma, no hands!

Early AI programs, including Samuel's checkers program, Newell & Simon's Logic Theorist, Gelernter's Geometry

1956 Dartmouth meeting: "Artificial Intelligence" adopted

1965 Robinson's complete algorithm for logical reasoning

1966–73 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 in probability; general increase in technical depth

"Nouvelle AI": ALife, GAs, soft computing

1995– Agents, agents, everywhere . . .

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 table tennis
- Drive safely along a curving mountain road
- Drive safely along Telegraph Avenue

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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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- 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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- Converse successfully with another person for an hour

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- Perform a complex surgical operation

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

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Risks and Benefits of AI

"First solve AI, then use AI to solve everything else." Demis Hassabis, CEO of Google DeepMind

Benefits:

- Decrease repetitive work
- Increase production of goods and services
- Accelerate scientific research (disease cures, climate change and resource shortages solutions)

Risks:

- Lethal autonomous weapons
- Surveillance and persuasion
- Biased decision making
- Impact on employment
- Safety-critical applications
- Cybersecurity threats

Risks and Benefits of AI

Development of an artificial superintelligence that surpasses human intelligence may pose a significant risk

Analogous to the "Gorilla problem"
Humans and gorillas evolved from the same species, but humans have more control than other primates.

Thus, we should design AI systems in such a way that they do not end up taking control in the way that Turing suggests they might.