Planning and Scheduling: An Introduction to Artificial Intelligence

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Acknowledgements

- These slides refer to Chapter 1 of the textbook:
  S. Russell and P. Norvig:
  Artificial Intelligence: A Modern Approach
  Prentice Hall, 2003, 2nd Edition (or more recent edition)

- These slides are an adaptation of slides by Min-Yen Kan

- The contributions of these authors are gratefully acknowledged.

Outline

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

What is AI?

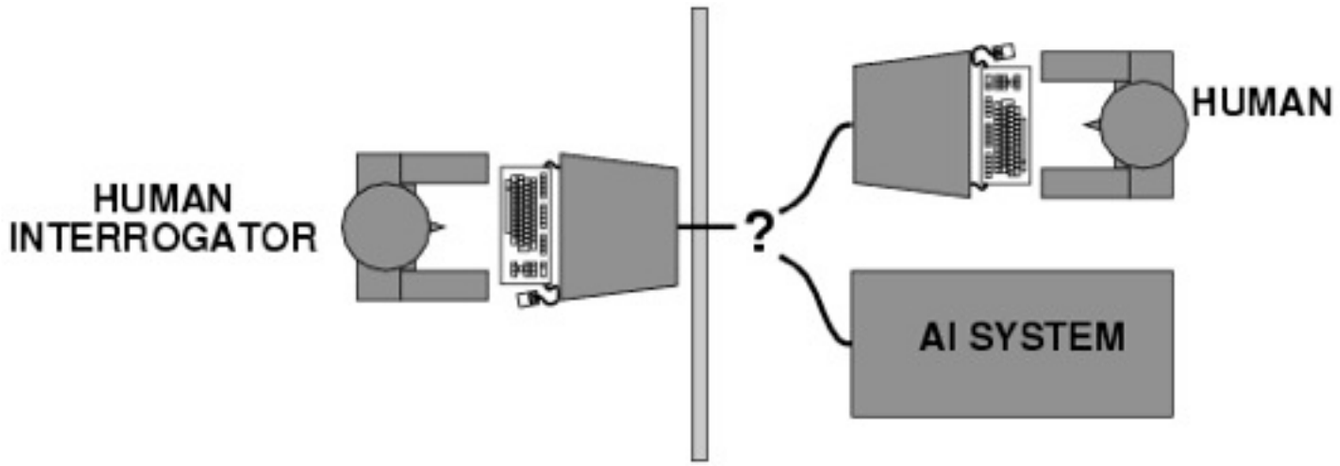
- Views of AI fall into four categories:

Thinking humanly	Thinking rationally
Acting humanly	Acting rationally

- The textbook advocates "acting rationally"

Acting Humanly: 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

Thinking Humanly: Cognitive Modeling

- 1960s "cognitive revolution": information-processing psychology
- Requires scientific theories of internal activities of the brain
- 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

Thinking Rationally: "Laws of Thought"

- 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:
  - Not all intelligent behavior is mediated by logical deliberation
  - What is the purpose of thinking?
  - What thoughts should I have?

Acting Rationally: Rational Agent

- **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

Rational Agents

- An **agent** is an entity that perceives and acts

- Abstractly, an agent is a function from percept histories to actions:
  - [f: P* ==> 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
- Economics — Utility, decision theory
- Neuroscience — Physical substrate for mental activity
- Psychology — Phenomena of perception and motor control, experimental techniques
- Computer Engineering — Building fast computers
- Control Theory — Design systems that maximize an objective function over time
- Linguistics — Knowledge representation, grammar

Abridged History of AI

- 1943 McCulloch & Pitts: Boolean circuit model of brain (cell)
- 1950 Turing's "Computing Machinery and Intelligence"
- 1956 Dartmouth meeting: "Artificial Intelligence" adopted
- 1952-69 Look, Ma, no hands!
- 1950s Early AI programs, including Samuel's checkers program, Newell & Simon's Logic Theorist, Gelernter's Geometry Engine
- 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- AI becomes an industry
- 1986- Neural networks return to popularity
- 1987- AI becomes a science
- 1995- The emergence of intelligent agents

State of the Art

- Deep Blue defeated the reigning world chess champion Garry Kasparov in 1997
- Proved a mathematical conjecture (Robbins conjecture) which was unsolved for decades
- No hands across America (driving autonomously 98% of the time from Pittsburgh to San Diego)
- During the 1991 Gulf War, US forces deployed an AI logistics planning and scheduling program that involved up to 50,000 vehicles, cargo, and people
- NASA's on-board autonomous planning program controlled the scheduling of operations for a spacecraft
- Proverb solves crossword puzzles better than most humans