

FOUNDATIONS OF ARTIFICIAL INTELLIGENCE

WSU, Fall 2016

Introduction: Chapter 1 of [AIMA]

Outline

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

Course overview

- Introduction and Agents (chapters 1,2)
- Search (chapters 3,4,5,6)
- Logic (chapters 7,8,9; will cover partially)
- Planning (chapters 11,12; will cover partially)
- Uncertainty (chapters 13,14)
- Learning (chapters 18,20)
- Natural Language Processing (chapters 22,23; time permitting / partially)

What is AI?

Views of AI fall into four categories:

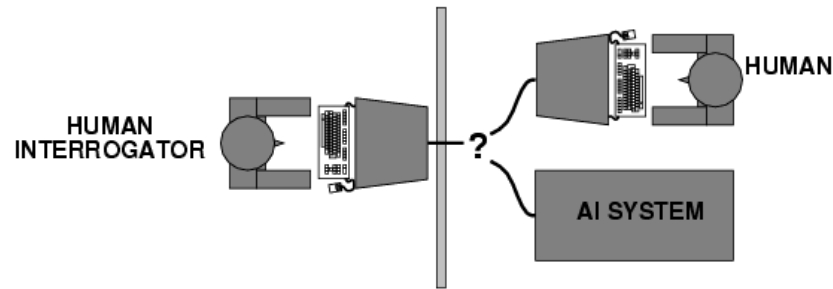
Thinking Humanely	Thinking Rationally
Acting Humanely	Acting Rationally

The ALMA advocates "acting rationally"

- An intelligent agent based view of all of AI

Acting humanly: 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
-

Thinking humanly: cognitive modeling

- 1960s "cognitive revolution":
information-processing psychology
- Requires scientific theories of internal neurological 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 (and Plato before him): what are correct arguments / thought processes?
- Several Greek schools developed various forms of *logic: notation and rules of derivation* for thoughts
 - they may or may not have proceeded to the idea of mechanization
- Direct line through math 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?
3. What thoughts lead to “good outcomes”?

Acting rationally: rational agent

- **Rational** behavior: doing the “right thing”
- The right thing: [usually] that which is expected to maximize goal achievement, given the available information
 - Can you think of situations where a different notion of “most rational thing to do” may be more appropriate?
- Doesn't always necessarily have to 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
- This course is about designing **rational agents**
- Abstractly, an agent is a function from percept (i.e., perception) histories to actions:

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

(some food for thought: why histories, why not individual perceptions?)

- 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** given available resources

AI “prehistory” & origins

- Philosophy Logic, methods of reasoning, mind as physical system foundations of learning, language, rationality
- Mathematics Formal representation and proof, formal models of computation, (un)decidability, (in)tractability, probability
- Economics utility, decision theory, game theory
- Neuroscience physical substrates for mental activity
- Psychology phenomena of perception, sensing & motor control, experimental techniques
- Computer Eng. building fast computers; implementing connectionist machine ideas and paradigms
- Control theory design systems that maximize an objective function over time
- Linguistics knowledge representation, grammars, text mining, reasoning w/ natural language

Abridged history of AI

- 1943 McCulloch & Pitts: Boolean circuit model of brain
 - model of a neuron as a simple arithmetic/logical unit
- 1950 Turing's "Computing Machinery and Intelligence"
 - it was the genius of A. Turing to whom we need to thank of inception of AI (just like with CS in general)
- 1956 Dartmouth meeting: "Artificial Intelligence" adopted
 - John McCarthy coined the term itself
- 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 [CS and hence] AI discover 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 (hmmm...)
- 1988 - Emergence of Distributed AI / multi-agent systems
- 1995 - Emergence of intelligent agents as dominant paradigm

State of the art

- Deep Blue defeated the reigning world chess champion Garry Kasparov in 1997
- **Computer succeeded in beating human champion in checkers much earlier than that, in Go much later**
 - (assuming you know those games) does it surprise you?
- Computer proved a mathematical conjecture (Robbins conjecture) unsolved for decades
- No hands across America (driving autonomously 98% of the time from Pittsburgh to San Diego)
- NASA's on-board autonomous planning program controlled the scheduling of operations for a spacecraft
- `Proverb` solves crossword puzzles better than most humans
- **IBM computer wins Jeopardy against human opponents**