CS3243   FOUNDATIONS OF ARTIFICIAL INTELLIGENCE

AY2004/2005 Semester 2

Introduction: Chapter 1

CS3243

- Course home page: http://www.comp.nus.edu.sg/~cs3243
- IVLE for homework submission and forum communication.
- Textbook: S. Russell and P. Norvig *Artificial Intelligence: A Modern Approach* Prentice Hall, 2003, Second Edition
- Lecturer: Min-Yen Kan (S15 05-05)
- Grading: Programming assignments (20%, 20%), Midterm test (20%), Final exam (40%)
- Class participation can only revise your grade upwards
- Lecture and tutorial attendance is mandatory
- Midterm test (in class, 1 hr) and final exam (2 hrs) are both closed book

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)
- Uncertainty (chapters 13, 14)
- Learning (chapters 18, 20)
- Optional Lectures:
  - Natural Language Processing (chapters 22, 23)
 - Planning and Robotics (chapters 11, 12, 25)

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?" → "Can machines behave intelligently?"
- Operational test for intelligent behavior: the Imitation Game
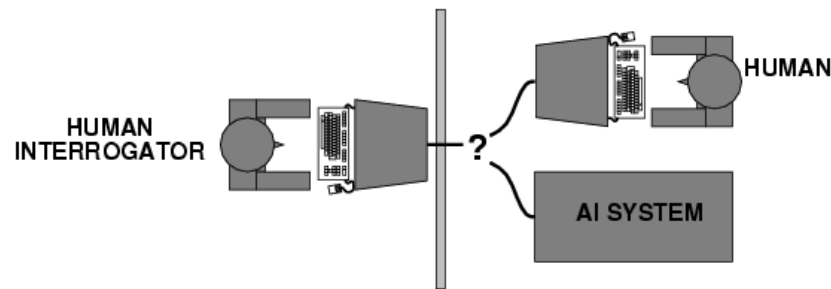
- Predicted that by 2000, a machine might have a 30% chance of fooling a lay person for 5 minutes
- Anticipated all major arguments against AI in following 50 years
- Suggested major components of AI: knowledge, reasoning, language understanding, learning

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:
    1. Not all intelligent behavior is mediated by logical deliberation
    2. 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
- This course is about designing rational agents
- Abstractly, an agent is a function from percept histories to actions:

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

- 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

- 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
- 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) 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