ĐẠI HỌC BÁCH KHOA HÀ NỘI
VIỆN CÔNG NGHỆ THÔNG TIN VÀ TRUYỀN THÔNG

Artificial Intelligence

Lecture 1 - Introduction

School of Information and Communication Technology - HUST

Outline

- What is AI?
- Foundations of AI
- Short history of AI
- Philosophical discussions

What is AI?

Views of AI fall into four categories:

Think like humans	Thinking rationally
Act like humans	Acting rationally

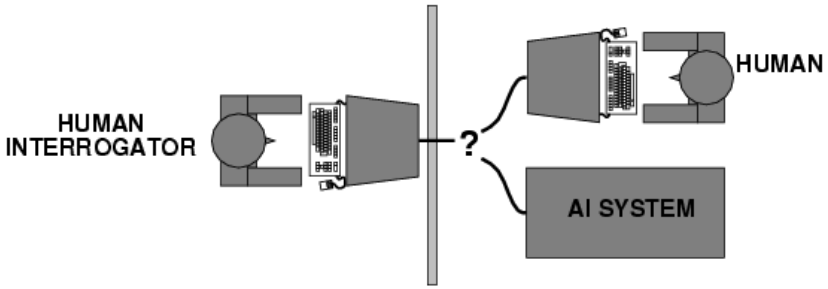
The textbook advocates "acting rationally"

Think like humans

- 1960s "cognitive revolution": information-processing psychology
- Scientific theories of internal activities of the brain
  - What level of abstraction? “Knowledge" or “circuits”?
  - **Cognitive science:** Predicting and testing behavior of human subjects (top-down)
  - This approach now distinct from AI
  - share with AI the following characteristic:
    - The available theories do not explain anything resembling human-level general intelligence

Act like humans

- 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 rationally

- The “Laws of Thought” approach
  - What does it mean to “think rationally”?
  - Normative / prescriptive rather than descriptive
- Logicist tradition:
  - Logic: notation and rules of derivation for thoughts
  - Aristotle: what are correct arguments/thought processes?
    - E.g.: Socrat is a human, human cannot live forever → Socrat human cannot live forever
  - Direct line through mathematics, 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?
  - Logical systems tend to do the wrong thing in the presence of uncertainty

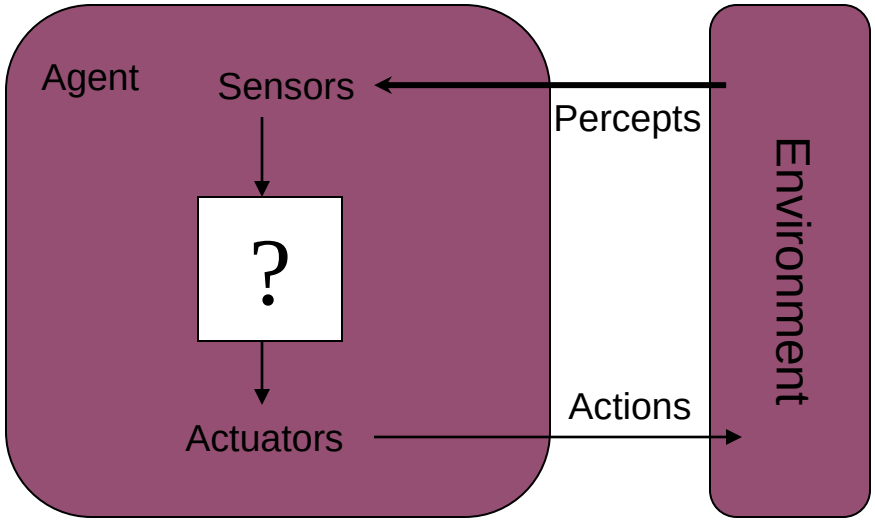
Acting rationally

- 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
  - Thinking can be in the service of rational action
  - Entirely dependent on goals!
  - Irrational ≠ insane, irrationality is sub-optimal action
  - Rational ≠ successful
- Our focus here: rational agents
  - Systems which make the best possible decisions given goals, evidences, and constraints
  - In the real world, usually lots of uncertainty… and lots of complexity
  - Usually, we’re just approximating rationality
- “Computational rationality” a better title for this course

Rational agents

- An **agent** is an entity that perceives and acts
- An agent function maps from percept histories to actions:

$$\mathcal{P}^* \rightarrow \mathcal{A}$$



- For any given class of environments and tasks, we seek the agent (or class of agents) with the best performance
- Computational limitations make perfect rationality unachievable
- So we want the best program for given machine resources

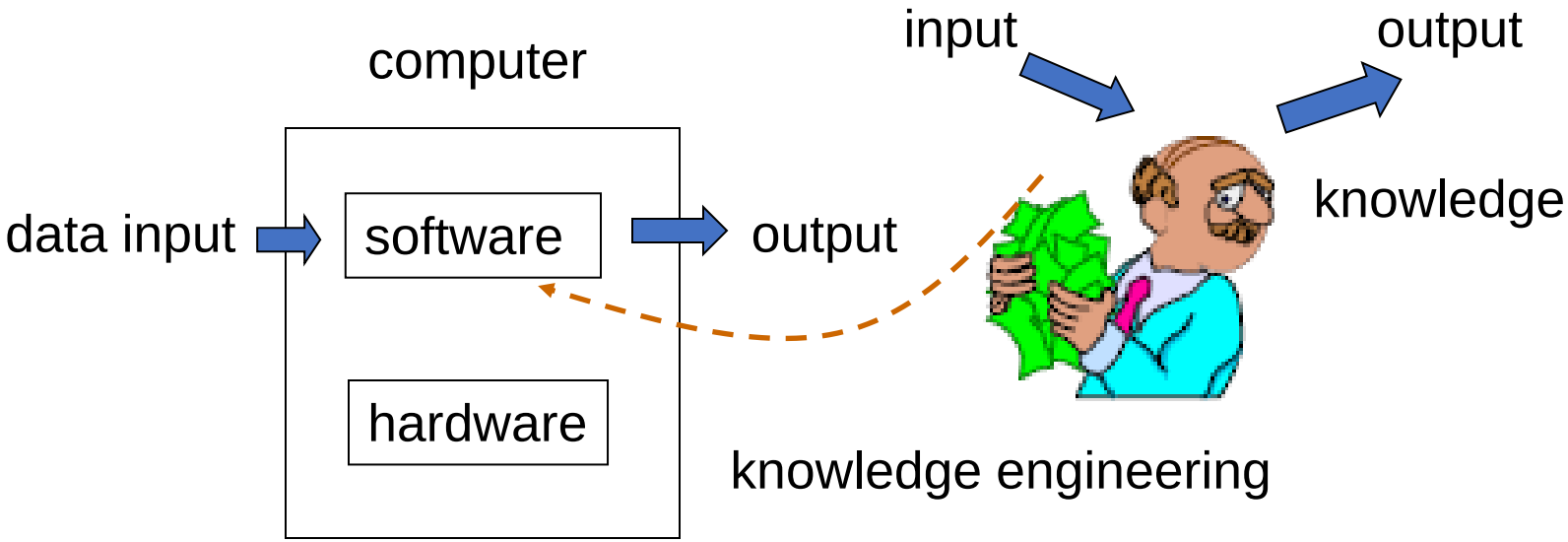
Foundations of AI

- 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

Short history of AI

- 1940-1950: Early days
  - 1943: McCulloch & Pitts: Boolean circuit model of brain
  - 1950: Turing's ``Computing Machinery and Intelligence''
- 1950—70: Excitement: 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
  - 1964: ELIZA
  - 1965: Robinson's complete algorithm for logical reasoning
- 1970—88: Knowledge-based approaches
  - 1969—79: Early development of knowledge-based systems
  - 1980—88: Expert systems industry booms
- 1988—93: Expert systems industry busts: “AI Winter”
- 1988—: Statistical approaches
  - Resurgence of probability, focus on uncertainty
  - General increase in technical depth
  - Agents, agents, everywhere… “AI Spring”?
- 2000—: Where are we now?

Expert system



Expert system = Human Expertise + Inference/Reasoning

Some examples: DENDRAL, MYCIN, PROSPECTOR, MOLGEN, ICAD/ICAM

State of the art

- May, '97: Deep Blue vs. Kasparov
  - First match won against world-champion
  - “Intelligent creative" play
  - 200 million board positions per second!
  - Humans understood 99.9 of Deep Blue's moves
  - Can do about the same now with a big PC cluster
- 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

Philosophical discussions

What Can AI Do?

- Play a decent game of table tennis?
- Drive safely along a curving mountain road?
- Buy a week's worth of groceries on the web?
- Discover and prove a new mathematical theorem?
- Converse successfully with another person for an hour?
- Perform a complex surgical operation?
- Unload a dishwasher and put everything away?
- Translate spoken English into spoken Vietnamese in real time?
- Write an intentionally funny story?

Can machine think?

Some problems with AI

- People might lose their jobs to automation.
- People might have too much (or too little) leisure time.
- People might lose their sense of being unique.
- People might lose some of their privacy rights.
- The use of AI systems might result in a loss of accountability.
- The success of AI might mean the end of the human race.