Introduction to Artificial Intelligence

Bùi Tiến Lên

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Contents

What is AI

Intelligence vs. Artificial Intelligence

Concept 1

- **Intelligence** includes the capacity for logic, understanding, learning, reasoning, creativity, and problem solving, etc.
- **Artificial intelligence** (**AI**) attempts not just to understand but also to build intelligent entities.

The field of Artificial Intelligence

- AI is one of the newest fields in science and engineering.
  - Work started in earnest soon after World War II, and the name itself was coined at a conference at Dartmouth College in 1956.
- AI research aims to build intelligent entities that are capable of simulating humans in different aspects.
  - Thinking: learning, planning, knowledge refinement
  - Perception: see, hear, feel, etc.
  - Communication in natural languages
  - Manipulation and moving objects

What is AI

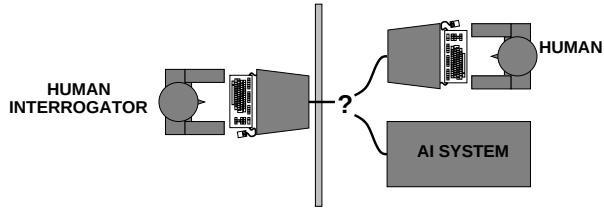
Thinking Humanly	**Thinking rationally**
"The exciting new effort to make computers think ... machines with minds, in the full and literal sense." (Haugeland, 1985) "[The automation of] activities that we associate with human thinking, activities such as decision-making, problem solving, learning ..." (Bellman, 1978)	"The study of mental faculties through the use of computational models." (Charniak and McDermott, 1985) "The study of the computations that make it possible to perceive, reason, and act." (Winston, 1992)
Acting Humanly	**Acting rationally**
"The art of creating machines that perform functions that require intelligence when performed by people." (Kurzweil, 1990) "The study of how to make computers do things at which, at the moment, people are better." (Rich and Knight, 1991)	"Computational Intelligence is the study of the design of intelligent agents." (Poole et al., 1998) "AI ...is concerned with intelligent behavior in artifacts." (Nilsson, 1998)

What is AI (cont.)

Systems that think like humans	Systems that think rationally
Systems that act like humans	**Systems that act rationally**

Acting humanly

- The Turing Test approach
- Turing (1950) "Computing machinery and intelligence"
  - "**Can machines think**?" $\longrightarrow$ "**Can machines behave intelligently**?"
  - Operational test for intelligent behavior: the **Imitation Game**. *A computer passes the test if a human interrogator, after posing some written questions, cannot tell whether the written responses come from a person or from a computer*
- Problem: Turing test is not *reproducible*, *constructive*, or amenable to *mathematical analysis*



Thinking humanly

- The cognitive modeling approach
- Requires scientific theories of internal activities of the brain to get inside the actual workings of human minds
  - What level of abstraction? "**Knowledge**" or "**circuits**"?
- How to validate?
  - Predicting and testing behavior of human subjects (top-down) or
  - Direct identification from neurological data (bottom-up)
- These approaches (**Cognitive Science** and **Cognitive Neuroscience**) are now distinct from AI
  - Share that the available theories but do not explain anything resembling human intelligence.
  - All share a principal direction.

Thinking rationally

- The "laws of thought" approach
- "Right thinking" is irrefutable reasoning processes
- Based on **logic**: *notation* and *rules of derivation* for thoughts; may or may not have proceeded to the idea of mechanization
- Problems:
  - Not all intelligent behavior is mediated by logical deliberation
  - Solving a problem "in principle" is different from solving it in practice

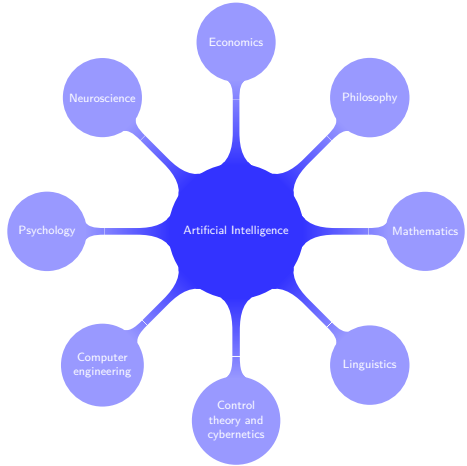
Acting rationally

- The rational agent approach
- **Rational behavior** is doing the **right thing**
  - The **right thing** 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
- An **agent** is an entity that **perceives** and **acts**. Abstractly, an agent is a function from percept histories to actions

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

Foundations of AI

Disciplines to contribute ideas, viewpoints, and techniques to AI



Disciplines to contribute ideas, viewpoints, and techniques to AI (cont.)

Field	Description
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, rational economic agents
Neuroscience	Neurons as information processing units
Psychology	How do people behave, perceive, process information, represent knowledge.
Computer Engineering	Building fast computers
Control theory and cybernetics	Design systems that maximize an objective function over time
Linguistic	Knowledge representation, grammar

History of AI

A brief history of AI

- 1940 – 1950: Early days
  - 1943: McCulloch & Pitts: Boolean circuit model of brain
  - 1950: Turing's "Computing Machinery and Intelligence"
- 1950 – 1970: 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
  - 1965: Robinson's complete algorithm for logical reasoning
- 1970 – 1990: Knowledge-based approaches
  - 1969 – 1980: Early development of knowledge-based systems
  - 1980 – 1988: Expert systems industry booms
  - 1988 – 1993: Expert systems industry busts: "AI Winter"

A brief history of AI (cont.)

- 1990 – 2000: Statistical approaches
  - Resurgence of probability, focus on uncertainty
  - General increase in technical depth
  - Agents and learning systems... "AI Spring"?
- 2000 – present: Where are we now?

State of the Art

State of the Art

- Robotic vehicles
- Speech recognition
- Autonomous planning and scheduling
- Game playing
- Spam fighting
- Logistics planning
- Robotics
- Machine Translation

Course Topics

Solving problems by searching

- **Search** is the fundamental technique of AI.
  - Possible answers, decisions or courses of action are structured into an abstract space, which we then search.
- Search is either "uninformed" or "infomred"
  - **Uninformed**: we move through the space without worrying about what is coming next, but recognizing the answer if we see it
  - **Informed**: we guess what is ahead, and use that information to decide where to look next.
- We may want to search for the first answer that satisfies our goal, or keep searching until we find the best answer.

Knowledge and reasoning

- The second most important concept in AI
- If we are going to act rationally in our environment, then we must have some way of describing that environment and drawing inferences from that representation.
  - How do we describe what we know about the world?
  - How do we describe it concisely?
  - How do we describe it so that we can get hold of the right piece of knowledge when we need it?
  - How do we generate new pieces of knowledge?
  - How do we deal with **uncertain knowledge**?

Machine learning

- If a system is going to act truly appropriately, then it must be able to **change its actions in the light of experience**.
  - How do we generate new facts from old ?
  - How do we generate new concepts ?
  - How do we learn to distinguish different situations in new environments ?

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