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Artificial Intelligence

AI is an exciting effort to make computers think and act intelligently.
Definitions vary across dimensions of thought processes, reasoning, and behavior.
Success can be measured by fidelity(loyal) to human performance or rationality (logical decisions).

Systems that think like humans	Systems that think 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." (Chamiak and McDermott, 1985) "The study of the computations that make it possible to perceive, reason, and act." (Winston, 1992)
Systems that act like humans	**Systems that act 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)

Figure 1.1 Some definitions of artificial intelligence, organized into four categories.

Source:Online

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Turing Test

Proposed by Alan Turing (1950)

A test to determine if a machine can exhibit intelligent behavior indistinguishable from a human.

The computer would need to possess the following capabilities:
Natural language processing: to enable it to communicate successfully in English.
Knowledge representation:to store what it knows or hears;
Automated reasoning:to use the stored inforrnation to answer questions and to draw new conclusions;
Machine learning: to adapt to new circumstances and to detect and extrapolate patterns.

The **Total Turing Test** includes video to test perception. To pass, a computer needs
computer vision to see objects and
robotics to handle and move them.

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Approaches to AI

Thinking Humanly: The Cognitive Modeling Approach

Understand human thinking by introspection and psychological experiments.
Develop precise theories of the mind as computer programs.
Example: GPS (General Problem Solver) by Newell and Simon (1961).
Cognitive science combines AI and psychology.

Thinking Rationally: The Laws of Thought Approach

Formalizing the reasoning process through logical and mathematical principles.

An artificial intelligence (AI) agent is a software program that can interact with its environment, collect data, and use the data to perform self-determined tasks to meet predetermined goals.

Acting Humanly: The Turing Test Approach
Creating systems that can perform human-like tasks.

Acting Rationally: The Rational Agent Approach
Designing agents that act to achieve the best outcome based on available information.

The Foundations of Artificial Intelligence

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Philosophy (428 B . c .-present)

Aristotle (384-322 B.C.) was the first to formulate a precise set of laws governing the rational part of the mind. He developed an informal system of syllogisms for proper reasoning

Key Figures and Ideas:

Aristotle (384-322 B.C.):

Formulated laws of rational thought, syllogisms. Aristotle figured out how logical thinking works, like making rules for good reasoning.

Dualism: Descartes (1596-1650):

mind distinct from matter, implications for free will. Descartes thought the mind and body are different things, which affects how we think about free will and our thoughts.

Empiricism (Francis Bacon, John Locke, David Hume):

Knowledge derived from sensory experience. These thinkers believed all knowledge comes from what we see, hear, and experience, not from ideas we're born with.

Logical Positivism (Vienna Circle, Carnap, Russell):

Knowledge rooted in logical theories and observation. This group thought the only meaningful knowledge is based on logic and what we can prove with experiments, not on things we can't test.

Action Theory (Aristotle, John Stuart Mill):

Rationality of action based on goal-directed reasoning. Aristotle and Mill studied how people make decisions based on goals, focusing on why we do things and how we think when choosing actions.

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Mathematics (c. 800-present): Mathematics has contributed significantly to AI through formal logic, algorithms, and probability theory. Formal logic, developed by figures like Boole and Frege, establishes rules for valid reasoning. Algorithms, traced back to Euclid and al-Khowarazmi, define what can be computed, though Gödel's work showed limits to mathematical proof. Probability theory, pioneered by Cardano and advanced by Bayes, addresses reasoning with uncertain information, essential for AI systems tackling real-world uncertainties. These mathematical foundations are critical for developing intelligent behavior in AI.

Neuroscience (1861-present) : Neuroscience explores how the brain processes information through neurons and their complex networks, crucial for memory and learning. Tools like EEG and fMRI provide insights into brain activity, but many fundamental questions remain unanswered, such as how memories form or how the brain adapts after injury. Despite differences, brains and computers both process information uniquely, with brains excelling in parallel processing despite slower neurons compared to fast computer chips.

Computer engineering (1940-present) : Efficient computers evolved from early machines like Babbage's and Jacquard's to today's powerful digital systems, advancing in speed, capacity, and affordability. AI benefits from these innovations, shaping modern computing with new technologies like molecular engineering

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Economics (1776-present): Economics maximizes outcomes through individual choices. Adam Smith initiated this in 1776, focusing on personal gain. Decision theory uses probability and utility for uncertain choices. Game theory examines decisions impacting others. Operations research optimizes sequential decisions from WWII. Herbert Simon's satisficing model emphasizes practical outcomes. These ideas shape economic theory and AI systems.

Control theory helps artifacts like thermostats adjust their behavior automatically using feedback loops, inspired by ancient inventions like water clocks. It focuses on minimizing errors between current and desired states. AI, on the other hand, tackles more complex tasks like language processing and planning, beyond what traditional control theory can manage with its mathematical tools.

Linguistics (1957-present): Language and thought are closely connected. Noam Chomsky showed that language isn't just about repeating what we hear—it involves creativity. This idea changed how we understand how language works.

The History of AI

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From 1943 to 1955, foundational developments in artificial intelligence emerged:
Warren McCulloch and Walter Pitts pioneered artificial neurons capable of computing functions and logical operations;
Donald Hebb introduced Hebbian learning;
Marvin Minsky and Dean Edmonds built the first neural network computer in 1950; and
Alan Turing articulated AI's vision with concepts like the Turing test and machine learning in his 1950 article.

The birth of artificial intelligence in 1956 at Dartmouth College, led by John McCarthy, saw the gathering of key researchers like Marvin Minsky, Claude Shannon, and Allen Newell. They aimed to formalize AI as a separate field focused on replicating human cognitive abilities, distinct from control theory or mathematics, and laying the groundwork for autonomous machine function in dynamic environments.

During the early years of AI (1952-1969), significant milestones were achieved with foundational programs like the General Problem Solver and Arthur Samuel's checkers program. John McCarthy introduced Lisp and envisioned the Advice Taker, advancing knowledge representation and logical reasoning. Despite successes, AI faced challenges in scaling to complex tasks and overcoming computational limitations.

Between 1980 and 1988, artificial intelligence (AI) grew quickly as companies used smart systems to save money. Then, there was a slowdown called the "AI Winter." In the mid-1980s, neural networks made a comeback, competing with traditional AI methods. AI became more scientific, using better methods to learn and make decisions. Intelligent agents also appeared, like internet tools and search engines.

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