Intelligence

Intelligence is the cognitive ability of an individual to learn from experience, to reason well, to remember important information, and to cope with the demands of daily living. Intelligence is not an attribute possessed by humans alone. Many living forms possess intelligence to some extent. At one end are humans, who are able to reason, achieve goals, understand and generate language, perceive and respond to sensory inputs, prove mathematical theorems, play challenging games, synthesize and summarize information, create art and music, and even write histories. Because functioning appropriately and with foresight requires so many different capabilities, depending on the environment, we actually have several ranges of intelligences with no particularly sharp discontinuities in any of them. Many animals and even machines, such as smart cameras are at the other end.

Thinking and intelligence are not same but somehow related to each other. Thinking is the facility to reason, analyze, evaluate, and formulate ideas and concepts. Not every being capable of thinking is intelligent. Intelligence is perhaps affiliated to efficient and effective thinking.

1.1 What is AI?

Artificial Intelligence (AI) means different things to different people. Some believe that AI is synonymous with any form of intelligence achieved by nonliving systems; they maintain that it is not important if this intelligent behavior is not arrived at via the same mechanisms on which humans rely. For others, AI systems must be able to mimic human intelligence. Artifcial intelligence is that activity devoted to making machines intelligent, and intelligence is that quality that enables an entity to function appropriately and with foresight in its environment.

John McCarthy, who coined the term in 1956, defines artificial intelligence as *"the science and engineering of making intelligent machines."*

Other definitions:

- *Artificial Intelligence is the science of making machines do things that would require intelligence if done by man.*
- *Artificial intelligence is the study of how to make computers do things which, at the moment, human do better.*

- *Artificial intelligence, or AI, is the field that studies the synthesis and analysis of computational agents that act intelligently.*
- *An agent is something that acts in an environment – it does something. Agents include worms, dogs, thermostats, airplanes, robots, humans, companies, and countries.*

We are interested in what an agent does; that is, how it acts. We judge an agent by its actions.

An agent acts intelligently when:

- What it does is appropriate for its circumstances and its goals,
- It is flexible to changing environments and changing goals,
- It learns from experience, and
- It makes appropriate choices given its perceptual and computational limitations. An agent typically cannot observe the state of the world directly; it has only a finite memory and it does not have unlimited time to act.

A computational agent is an agent whose decisions about its actions can be explained in terms of computation. That is, the decision can be broken down into primitive operation that can be implemented in a physical device. This computation can take many forms. In humans this computation is carried out in "wetware"; in computers it is carried out in "hardware." Although there are some agents that are arguably not computational, such as the wind and rain eroding a landscape, it is an open question whether all intelligent agents are computational.

The central scientific goal of AI is to understand the principles that make intelligent behavior possible in natural or artificial systems.

AI can be defined along two dimensions. The definitions is based in terms of *dependability to human performance,* and *an ideal performance measure,* called ***rationality***. A system is rational if it does the "right thing," given what it knows.

1.1.1 Acting humanly: The Turing Test approach

The Turing Test, proposed by Alan Turing (Turing, 1950), was designed to provide a satisfactory operational definition of intelligence. Turing defined intelligent behavior as the ability to achieve human-level performance in all cognitive tasks, sufficient to fool an interrogator. Roughly speaking, the test he proposed is that the computer should be interrogated by a human via a teletype, and passes the test if the interrogator cannot tell if there is a computer or a human at the other end. To pass the test, a computer would primarily need to possess the following capabilities:

- **Natural language processing** to enable it to communicate successfully in English (or some other human language);
- **Knowledge representation** to store information provided before or during the interrogation;
- **Automated reasoning** to use the stored information to answer questions and to draw new conclusions;
- **Machine learning** to adapt to new circumstances and to detect and extrapolate patterns.

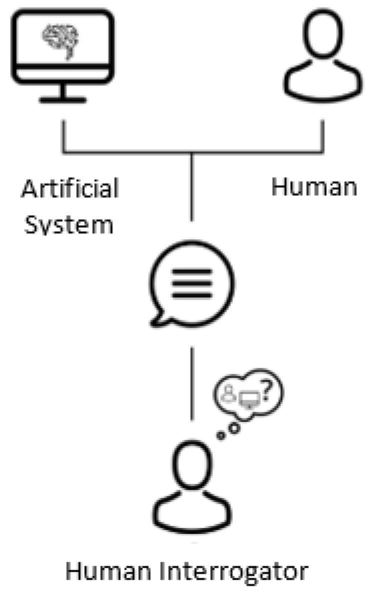

Figure 1. Turing Test Approach

Turing's test deliberately avoided direct physical interaction between the interrogator and the computer, because physical simulation of a person is unnecessary for intelligence. However, the so-called total Turing Test includes a video signal so that the interrogator can test the subject's perceptual abilities, as well as the opportunity for the interrogator to pass physical objects ``through the hatch.'' To pass the total Turing Test, the computer will need:

- Computer vision to perceive objects, and
- Robotics to move them about.

Searle's Criticism: The Chinese Room

John Searle's criticism of the Turing test is more fundamental. Imagine an interrogator who asks questions as expected. This time, however, the question is in Chinese. In a separate room is someone who does not know Chinese, but does have a detailed rulebook. Although the Chinese questions appear as a series of squiggles, the person in the room consults the rulebook, processes the Chinese characters according to the rules, and responds with answers written using Chinese characters.

The interrogator is obtaining syntactically correct and semantically reasonable responses to the questions. Does this mean that the person inside the room knows Chinese? If you answer "No," does the combination of the person and the Chinese rule book know Chinese? No—the person is not learning or understanding Chinese, but is only processing symbols. In the same way, a computer running a program receives, processes, and responds with symbols without learning or understanding what the symbols themselves mean.

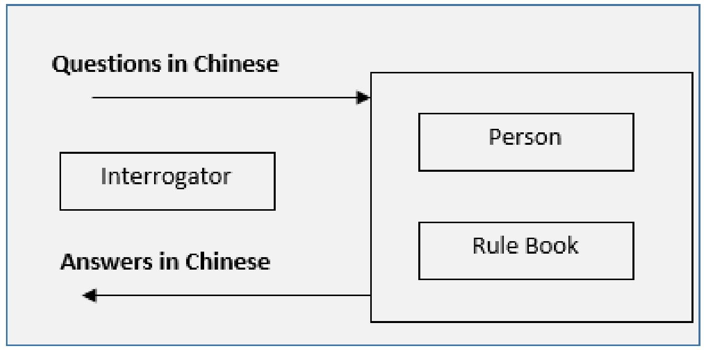

Figure 2. Chinese Room Argument

So, no matter how intelligent-seeming a computer behaves and no matter what programming makes it behave that way, since the symbols it processes are meaningless (lack semantics) to it, it's not really intelligent. It's not actually thinking. Its internal states and processes, being purely syntactic, lack semantics (meaning); so, it doesn't really have intentional (that is, meaningful) mental states.

1.1.2 Thinking humanly: The cognitive modelling approach

When a computer thinks as a human, it performs tasks that require intelligence (as contrasted with rote procedures) from a human to succeed, such as driving a car. If we are going to say that a given program thinks like a human, we must have some way of determining how humans think. We need to get inside the actual workings of human minds. There are three ways to do this:

- **Through introspection:** Detecting and documenting the techniques used to achieve goals by monitoring one's own thought processes.
- **Through psychological experiments:** Observing a person's behavior and adding it to a database of similar behaviors from other persons given a similar set of circumstances, goals, resources, and environmental conditions
- **Through brain Imaging:** observing brain in action through various mechanical means, such as Computerized Axial Tomography (CAT), Positron Emission Tomography (PET), Magnetic Resonance Imaging (MRI), and Magneto encephalography (MEG).

Once we have a sufficiently precise theory of the mind, it becomes possible to express the theory as a computer program. If the program's input/output and timing behavior matches human behavior, that is evidence that some of the program's mechanisms may also be operating in humans. The interdisciplinary field of cognitive science brings together computer models from AI and experimental techniques from psychology to try to construct precise and testable theories of the workings of the human mind.

1.1.3 Thinking rationally: The laws of thought approach

Studying how humans think using some standard enables the creation of guidelines that describe typical human behaviors. A person is considered rational when following these behaviors within certain levels of deviation. A computer that thinks rationally relies on the recorded behaviors to create a guide as to how to interact with an environment based on the data at hand.

The Greek philosopher Aristotle was one of the first to attempt to codify "right thinking", that is, unquestionable reasoning processes. His famous syllogisms provided patterns for argument structures that always gave correct conclusions given correct premises. These laws of thought were supposed to govern the operation of the mind, and initiated the field of logic. The goal of this approach is to solve problems logically, when possible. There are two main obstacles to this approach.

First, it is not easy to take informal knowledge and state it in the formal terms required by logical notation, particularly when the knowledge is less than 100% certain.

Second, there is a big difference between being able to solve a problem "in principle" and doing so in practice. Even problems with just a few dozen facts can exhaust the computational resources of any computer unless it has some guidance as to which reasoning steps to try first.

Although both of these obstacles apply to any attempt to build computational reasoning systems, they appeared first in the logicist tradition because the power of the representation and reasoning systems are well-defined and fairly well understood.

1.1.4 Acting rationally: The rational agent approach

Acting rationally means acting so as to achieve one's goals, given one's beliefs. An agent is just something that perceives and acts. In this approach, AI is viewed as the study and construction of rational agents.

In the "laws of thought" approach to AI, the whole emphasis was on correct inferences. Making correct inferences is sometimes part of being a rational agent, because one way to act rationally is to reason logically to the conclusion that a given action will achieve one's goals, and then to act on that conclusion. On the other hand, correct inference is not all of rationality, because there are often situations where there is no provably correct thing to do, yet something must still be done. There are also ways of acting rationally that cannot be reasonably said to involve inference. For example, pulling one's hand off of a hot stove is a reflex action that is more successful than a slower action taken after careful deliberation.

Studying how humans act in given situations under specific constraints enables you to determine which techniques are both efficient and effective. A computer that acts rationally relies on the recorded actions to interact with an environment based on conditions, environmental factors, and existing data. As with rational thought, rational acts depend on a solution in principle, which may not prove useful in practice. However, rational acts do provide a baseline upon which a computer can begin negotiating the successful completion of a goal.

Following eight definitions can be used to describe these approaches:

	Humanly	Rationally
Thinking	***The Cognitive Modeling Approach*** “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 Laws of Thought Approach*** “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	***The Turing Test Approach*** “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)	***The Rational Agent Approach*** “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)

1.2 Omniscience

Omniscience is the quality or state of being omniscient. If an artificial system is said to be omniscient, it knows everything. In other words, any AI program that knows the exactly what will happen for all its possible actions is omniscient. We need to be careful to distinguish between rationality and omniscience. Rationality maximizes expected performance, while perfection maximizes actual performance. Withdrawing from a requirement of perfection is not just a question of being fair to agents. Our definition of rationality does not require omniscience because the rational choice depends only on the percept sequence till now.

Artificial Intelligence is not concerned with creating a system which knows everything but only act as a human with intelligence and make rational decisions.

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