ARTIFICIAL INTELLIGENCE

Course Code: AFI 124

Artificial Intelligence A Modern Approach,
Stuart Russel and Peter Norvig

Self Introduction

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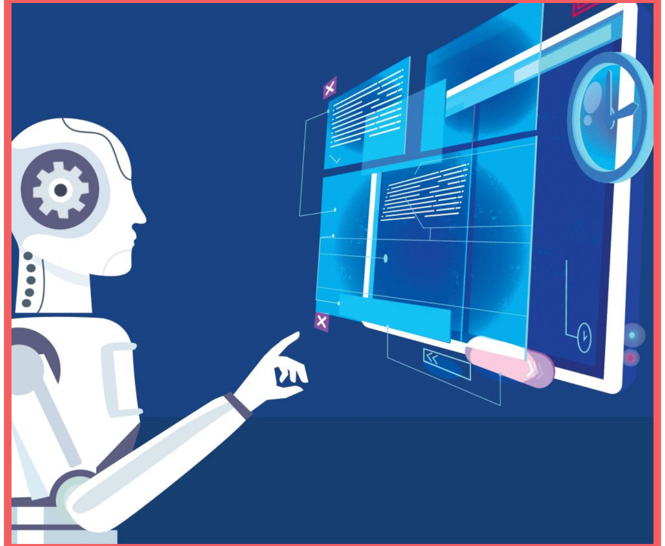
Contents:

Introduction to AI

The field of artificial intelligence, or AI, is concerned with not just understanding but also building intelligent entities.



What is AI?

What is AI?

Artificial Intelligence (AI) is a branch of Science which deals with helping machines finding solutions to complex problems in a more human-like fashion. This generally involves borrowing characteristics from human intelligence, and applying them as algorithms in a computer friendly way.

AI Perspectives

Historically, researchers have pursued several different versions of AI.

Some have defined intelligence in terms of fidelity to *human* performance, while others prefer an abstract, formal definition of intelligence called **rationality**—loosely speaking, doing the "right thing." The subject matter itself also varies: some consider intelligence to be a property of internal *thought processes* and *reasoning*, while others focus on intelligent *behavior*, an external characterization.

AI Perspectives

From these two dimensions—human vs. rational and thought vs. behavior, there are four possible combinations

1. Acting humanly: The Turing test approach
2. Thinking humanly: The cognitive modeling approach
3. Acting rationally: The rational agent approach
4. Thinking rationally: The "laws of thought" approach

(Acting,Thinking)(rationally,humanly)

AI Perspectives: acting humanly

The Turing test, proposed by Alan Turing (1950), was designed as a thought experiment that would sidestep the philosophical vagueness of the question “Can a machine think?” 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.

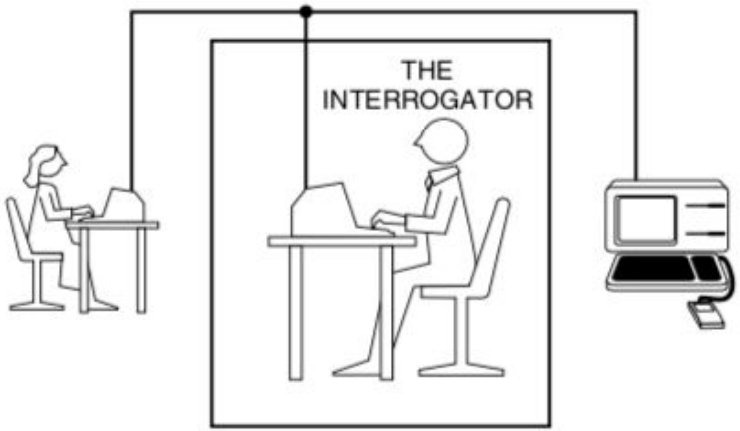


Figure 1.1 The Turing test.

Features of Turing Test:

1. It attempts to give an objective notion of intelligence, i.e., the behavior of a known intelligent being in response to a particular set of questions. This provides a standard for determining intelligence that avoids the inevitable debates over its “true” nature.

2. It prevents us from being sidetracked by such confusing and currently unanswerable questions as whether or not the computer uses the appropriate internal processes or whether or not the machine is actually conscious of its actions.

3. It eliminates any bias in favor of living organisms by forcing the interrogator to focus solely on the content of the answers to questions.

AI Perspectives: acting humanly

For Machines to think, we would need:

- natural language processing to communicate successfully in a human language;
- knowledge representation to store what it knows or hears;
- automated reasoning to answer questions and to draw new conclusions;
- machine learning to adapt to new circumstances and to detect and extrapolate patterns.

To pass the total Turing test, a robot will need

- computer vision and speech recognition to perceive the world;
- robotics to manipulate objects and move about.

AI Perspectives: thinking humanly

We can learn about human thought in three ways:

- introspection—trying to catch our own thoughts as they go by;
- psychological experiments—observing a person in action;
- brain imaging—observing the brain in action.

Once we have a sufficiently precise theory of the mind, it becomes possible to express the theory as a computer program.

AI Perspectives: thinking rationally

The Greek philosopher Aristotle was one of the first to attempt to codify “right thinking”, their study initiated the field called logic.

Logicians in the 19th century developed a precise notation for statements about objects in the world and the relations among them.

By 1965, programs could, in principle, solve any solvable problem described in logical notation. The so-called logicist tradition within artificial intelligence hopes to build on such programs to create intelligent systems

The theory of probability fills this gap, allowing rigorous reasoning with uncertain information.

AI Perspectives: acting rationally

Agents: An agent is just something that acts. Computer agents are expected to do more: operate autonomously, perceive their environment, persist over a prolonged time period, adapt to change, and create and pursue goals.

Rational Agents: A rational agent is one that acts so as to achieve the best outcome or, when there is uncertainty, the best expected outcome.

AI has focused on the study and construction of agents that do the right thing. What counts as the right thing is defined by the objective that we provide to the agent. This general paradigm is so pervasive that we might call it the standard model. It prevails not only in AI, but also in control theory, where a controller minimizes a cost function; in operations research, where a policy maximizes a sum of rewards; in statistics, where a decision rule minimizes a loss function; and in economics, where a decision maker maximizes utility or some measure of social welfare.

Foundation of AI

1. Philosophy
2. Mathematics
3. Economics
4. Neuroscience
5. Psycology
6. Computer Engineering
7. Control Theory
8. Linguistic

1. Philosophy

- Can formal rules be used to draw valid conclusions?
- How does the mind arise from a physical brain?
- Where does knowledge come from?
- How does knowledge lead to action?

Aristotle (384–322 BCE) 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, which in principle allowed one to generate conclusions mechanically, given initial premises.

Ramon Llull (c. 1232–1315) devised a system of reasoning published as *Ars Magna* or *The Great Art* (1305). Llull tried to implement his system using an actual mechanical device: a set of paper wheels that could be rotated into different permutations.

Around 1500, Leonardo da Vinci (1452–1519) designed but did not build a mechanical calculator; recent reconstructions have shown the design to be functional. The first known calculating machine was constructed around 1623 by the German scientist Wilhelm Schickard (1592–1635).

1. Philosophy

Blaise Pascal (1623–1662) built the Pascaline in 1642 and wrote that it “produces effects which appear nearer to thought than all the actions of animals.”

Gottfried Wilhelm Leibniz (1646–1716) built a mechanical device intended to carry out operations on concepts rather than numbers, but its scope was rather limited. In his 1651 book *Leviathan*, Thomas Hobbes (1588–1679) suggested the idea of a thinking machine, an “artificial animal” in his words, arguing “For what is the heart but a spring; and the nerves, but so many strings; and the joints, but so many wheels.” He also suggested that reasoning was like numerical computation: “For ‘reason’ ... is nothing but ‘reckoning,’ that is adding and subtracting.”

Aristotle’s algorithm was implemented 2300 years later by Newell and Simon in their **General Problem Solver** program. We would now call it a greedy regression planning system (see Chapter 11). Methods based on logical planning to achieve definite goals dominated the first few decades of theoretical research in AI.

2. Mathematics

- What are the formal rules to draw valid conclusions?
- What can be computed?
- How do we reason with uncertain information?

The idea of **formal logic** can be traced back to the philosophers of ancient Greece, India, and China, but its mathematical development really began with the work of George Boole (1815–1864), who worked out the details of propositional, or Boolean, logic (Boole, 1847).

In 1879, Gottlob Frege (1848–1925) extended Boole's logic to include objects and relations, creating the first-order logic that is used today.

Gerolamo Cardano (1501–1576) first framed the idea of probability, describing it in terms of the possible outcomes of gambling events.

In 1654, Blaise Pascal (1623–1662), in a letter to Pierre Fermat (1601– 1665), showed how to predict the future of an unfinished gambling game and assign average payoffs to the gamblers

3. Economics

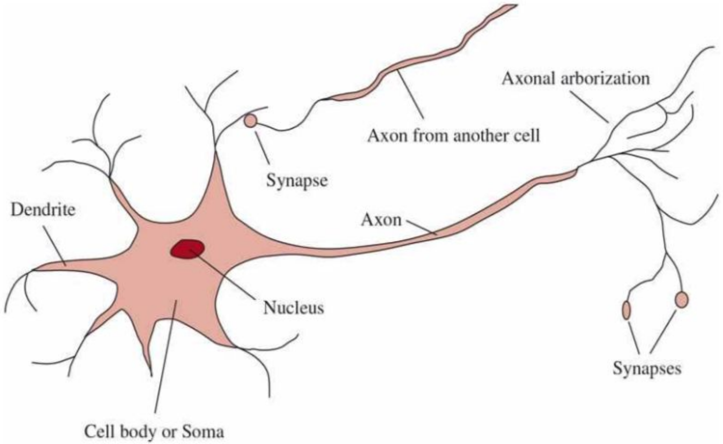
- How should we make decisions in accordance with our preferences?
- How should we do this when others may not go along?
- How should we do this when the payoff may be far in the future?

The science of economics originated in 1776, when Adam Smith (1723–1790) published *An Inquiry into the Nature and Causes of the Wealth of Nations*.

Léon Walras (pronounced "Valrasse") (1834–1910) gave utility theory a more general foundation in terms of preferences between gambles on any outcomes (not just monetary outcomes). The theory was improved by Ramsey (1931) and later by John von Neumann and Oskar Morgenstern in their book *The Theory of Games and Economic Behavior* (1944). Economics is no longer the study of money; rather it is the study of desires and preferences.

Economists, with some exceptions, did not address the third question listed above: how to make rational decisions when payoffs from actions are not immediate but instead result from several actions taken *in sequence*.

Figure 1.1



4. Neuroscience

- How do brains process information?

Neuroscience is the study of the nervous system, particularly the brain.

Paul Broca's (1824–1880) investigation of aphasia (speech deficit) in brain-damaged patients in 1861 initiated the study of the brain's functional organization by identifying a localized area in the left hemisphere—now called Broca's area—that is responsible for speech production.

By that time, it was known that the brain consisted largely of nerve cells, or **neurons**, but it was not until 1873 that Camillo Golgi (1843–1926) developed a staining technique allowing the observation of individual neurons (see Figure 1.1).

This technique was used by Santiago Ramon y Cajal (1852–1934) in his pioneering studies of neuronal organization. It is now widely accepted that cognitive functions result from the electrochemical operation of these structures. That is, *a collection of simple cells can lead to thought, action, and consciousness.* In the pithy words of John Searle (1992), *brains cause minds*.

5. Psychology

- How do humans and animals think and act?

The origins of scientific psychology are usually traced to the work of the German physicist Hermann von Helmholtz (1821–1894) and his student Wilhelm Wundt (1832–1920).

In 1879, Wundt opened the first laboratory of experimental psychology, at the University of Leipzig.

Cognitive psychology, which views the brain as an information-processing device, can be traced back at least to the works of William James (1842–1910). Helmholtz also insisted that perception involved a form of unconscious logical inference. The cognitive viewpoint was largely eclipsed by behaviorism in the United States, but at Cambridge's Applied Psychology Unit, directed by Frederic Bartlett (1886–1969), cognitive modeling was able to flourish.

6. Computer Engineering

- How can we build an efficient computer?

The first *operational* computer was the electromechanical Heath Robinson,9 built in 1943 by Alan Turing's team for a single purpose: deciphering German messages.
In 1943, the same group developed the Colossus, a powerful general-purpose machine based on vacuum tubes.
The first operational *programmable* computer was the Z-3, the invention of Konrad Zuse in Germany in 1941. The first *electronic* computer, the ABC, was assembled by John Atanasoff and his student Clifford Berry between 1940 and 1942 at Iowa State University.

We are just beginning to see hardware tuned for AI applications, such as the graphics processing unit (GPU), tensor processing unit (TPU), and wafer scale engine (WSE). From the 1960s to about 2012, the amount of computing power used to train top machine learning applications followed Moore's law. A machine learning model that took a full day to train in 2014 takes only two minutes in 2018 (Ying *et al*., 2018). Although it is not yet practical, **quantum computing** holds out the promise of far greater accelerations for some important subclasses of AI algorithms.

7. Control Theory

- How can artifacts operate under their own control?

Ktesibios of Alexandria (c. 250 BCE) built the first self-controlling machine: a water clock with a regulator that maintained a constant flow rate.

Modern control theory, especially the branch known as stochastic optimal control, has as its goal the design of systems that maximize a **cost function** over time.

This roughly matches the standard model of AI: designing systems that behave optimally. Why, then, are AI and control theory two different fields, despite the close connections among their founders? The answer lies in the close coupling between the mathematical techniques that were familiar to the participants and the corresponding sets of problems that were encompassed in each world view. Calculus and matrix algebra, the tools of control theory, lend themselves to systems that are describable by fixed sets of continuous variables, whereas AI was founded in part as a way to escape from these perceived limitations. The tools of logical inference and computation allowed AI researchers to consider problems such as language, vision, and symbolic planning that fell completely outside the control theorist's purview.

8. Linguistics

- How does language relate to thought?

In 1957, B. F. Skinner published *Verbal Behavior*.

the linguist Noam Chomsky, who had just published a book on his own theory, *Syntactic Structures*.

Modern linguistics and AI, then, were “born” at about the same time, and grew up together, intersecting in a hybrid field called **computational linguistics** or **natural language processing**. The problem of understanding language turned out to be considerably more complex than it seemed in 1957. Understanding language requires an understanding of the subject matter and context, not just an understanding of the structure of sentences. This might seem obvious, but it was not widely appreciated until the 1960s. Much of the early work in **knowledge representation** (the study of how to put knowledge into a form that a computer can reason with) was tied to language and informed by research in linguistics, which was connected in turn to decades of work on the philosophical analysis of language.

History of AI

1. The inception of artificial intelligence (1943–1956)
2. Early enthusiasm, great expectations (1952–1969)
3. A dose of reality (1966–1973)
4. Expert systems (1969–1986)
5. The return of neural networks (1986–present)
6. Probabilistic reasoning and machine learning (1987– present)
7. Big data (2001–present)
8. Deep learning (2011–present)

The State of the Art

1. ROBOTIC VEHICLES(self driving cars)
2. MACHINE TRANSLATION(google)
3. SPEECH RECOGNITION(alexa,siri,cortana)
4. RECOMMENDATIONS(amazon,youtube,netflix)
5. GAME PLAYING(chess)
6. IMAGE UNDERSTANDING(captioning)
7. MEDICINE(diagnosis)

Risks and Benefits of AI

1. LETHAL AUTONOMOUS WEAPONS
2. SURVEILLANCE AND PERSUASION
3. BIASED DECISION MAKING
4. IMPACT ON EMPLOYMENT
5. SAFETY-CRITICAL APPLICATIONS
6. CYBERSECURITY

Github

Create an account

Create a New Project

From Website:

- Create a Note file as Readme.md
- Commit the readme file to the project

From local System:

- Clone the project
- Create a Note file as Readme.md
- Push the readme file to the project

Assignment

Book: Stuart Russel and Peter Norvig, Artificial Intelligence A Modern Approach, Pearson Reference

Assignment: Create a <topic>.md file of the topics studied from the book and push the code.

Take Away:

- Learning
- Documenting Projects
- Handson github
- Structuring Projects