Artificial Intelligence

CHAPTER 1: **Introduction to Artificial Intelligence**

Sourav Kumar Giri
Asst. Professor

School of Computer Engineering
KIIT Deemed to be University

Chapter Outline

- What is Artificial Intelligence?
- Foundation
- History of AI
- The state of the art

What is Artificial Intelligence (AI) ?

- The term AI is composed of two terms- Artificial (man-made) and Intelligence (thinking or reasoning power).
- In layman language, AI can be defined as a branch of Computer Science which allows software or machine to act and think like human beings.
- Broadly definitions of AI is centred around four approach-
  - Systems that think like humans
  - Systems that think rationally
  - Systems that act like humans
  - Systems that act rationally

What is Artificial Intelligence (AI) ?

❑ **Systems that think like humans-**

"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)

❑ **Systems that think rationally-**

"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)

What is Artificial Intelligence (AI) ?

❑ **Systems that act like humans-**

"The art of creating machines those 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)

❑ **Systems that act rationally-**

"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)

Acting Humanly: The Turing Test approach

- The Turing Test, proposed by Alan Turing (195O), was designed to provide a satisfactory operational definition of intelligence.
- The computer passes the test if a human interrogator, after posing some written questions, cannot tell whether the written responses come from a person or not.
- 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 information to answer questions and to draw new conclusions.
  - **Machine learning** to adapt to new circumstances and to detect and extrapolate patterns.
  - **Turing's test** deliberately avoided direct physical interaction between the interrogator and the computer, because physical simulation of a person is unnecessary for intelligence. To pass the total Turing Test, the computer will need.
  - **Computer** vision to perceive objects, and
  - **Robotics** to manipulate objects and move about.

Thinking humanly: The cognitive modeling approach

- 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 two ways to do this:
  - **introspection**-trying to catch our own thoughts as they go by-and
  - **psychological experiments**

Thinking rationally: The "laws of thought" approach

- The Greek philosopher Aristotle was one of the first to attempt to codify "**right thinking**".
- Aristotle's syllogisms provided patterns for argument structures that always yielded correct conclusions when given premises are correct. For example-
  - **"Y is a man; all men are mortal; therefore, Y is mortal."**
- These laws of thought were supposed to govern the operation of the mind; their study initiated the field called logic.
- 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.

Acting rationally: The rational agent approach

- An agent is just something that acts. But computer agents are expected to have other attributes that distinguish them from mere "programs," such as operating under autonomous control, perceiving their environment, persisting over a prolonged time period, adapting to change, and being capable of taking on another's goals.
- A rational agent is one that acts so as to achieve the best outcome or, when there is uncertainty, the best expected outcome.

Foundations of AI

Area/ Discipline	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
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

Foundations of AI Contd..

❑ 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?

Foundations of AI Contd..

Aristotle (384–322 B. C.)	**formulated a precise set of laws governing the rational part of the mind**
Ramon Lull (d. 1315)	useful reasoning could actually be carried out by a mechanical artifact
Thomas Hobbes (1588–1679)	Proposed that reasoning was like numerical computation that “we add and subtract in our silent thoughts.”
Leonardo da Vinci (1452–1519)	designed but did not build a mechanical calculator
Wilhelm Schickard (1592–1635)	The first known calculating machine was constructed around
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.
Ren´e Descartes (1596–1650)	Gave the first clear discussion of the distinction between mind and matter and of the problems that arise.
Francis Bacon (1561–1626) **John Locke (1632–1704)** **David Hume (1711–1776)**	principle of induction
Ludwig Wittgenstein (1889–1951) **Rudolf Carnap (1891–1970)**	developed the doctrine of logical positivism
Carnap and Carl Hempel (1905–1997)	attempted to analyze the acquisition of knowledge from experience

Foundations of AI Contd..

❑ Mathematics

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

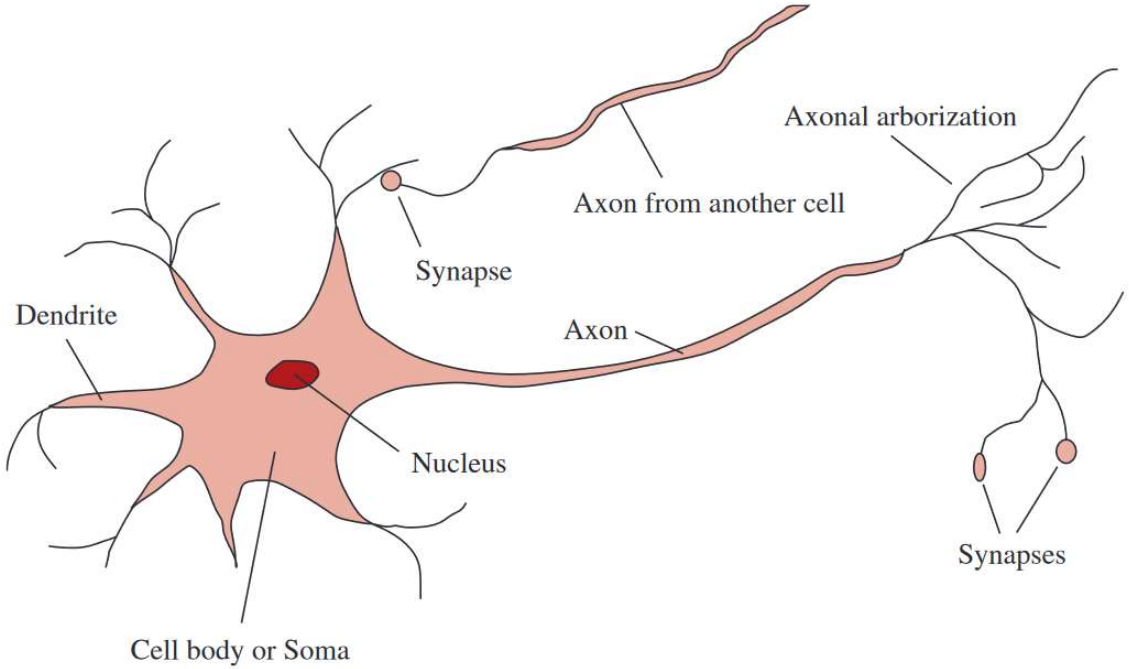
❑ Economics

- How should we make decisions so as to maximize payoff?
- 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?

❑ Neuro science

- How do brains process information?
- Neuroscience is the study of the nervous system, particularly the brain. Although the exact way in which the brain enables thought is one of the great mysteries of science, the fact that it does enable thought has been appreciated for thousands of years because of the evidence that strong blows to the head can lead to mental incapacitation**.**

Foundations of AI Contd..



Structure of Nerve Cell/ neuron:

Soma- cell body that contains a cell nucleus,

dendrites- Branching out from the cell body are a number of fibers,

axon- single long fiber (1cm-1m),

synapses- junction between inter connected neurons

Foundations of AI Contd..

- **Psychology**
  - How do humans and animals think and act?
- **Computer Engineering**
  - How can we build an efficient computer?
- **Control theory and cybernetics**
  - How can artifacts operate under their own control?
- **Linguistics**
  - How does language relate to thought?

History of AI

Year	Invention
1943	McCulloch & Pitts: Boolean circuit model of brain
1950	Turing's "Computing Machinery and Intelligence"
1956	Dartmouth meeting: "Artificial Intelligence" adopted
1952-69	Look, Ma, no hands!
1950	Early AI programs, including Samuel's checkers program, Newell & Simon's Logic Theorist, Gelernter's Geometry Engine
1965	Robinson's complete algorithm for logical reasoning
1966-73	AI discovers computational complexity Neural network research almost disappears
1969-79	Early development of knowledge-based systems
1980	AI becomes an industry
1986	Neural networks return to popularity
1987	AI becomes a science
1995	The emergence of intelligent agents
2001	The availability of very large data sets

Applications of AI- The state of the Art

❑ Robotic vehicles

- A driverless robotic car named S TANLEY sped through the rough terrain of the Mojave dessert at 22 mph, finishing the 132-mile course first to win the 2005 DARPA Grand Challenge.
- S TANLEY is a Volkswagen Touareg outfitted with cameras, radar, and laser rangefinders to sense the environment and onboard software to command the steering, braking, and acceleration (Thrun, 2006).
- The following year CMU's BOSS won the Urban Challenge, safely driving in traffic through the streets of a closed Air Force base, obeying traffic rules and avoiding pedestrians and other vehicles.

Applications of AI- The state of the Art

- **Speech recognition**
  - A traveler calling United Airlines to book a flight can have the entire conversation guided by an automated speech recognition and dialog management system.
- **Autonomous planning and scheduling:**
  - A hundred million miles from Earth, NASA's emote Agent program became the first on-board autonomous planning program to control the scheduling of operations for a spacecraft (Jonsson *et al.,* 2000).
  - REMOTE A GENT generated plans from high-level goals specified from the ground and monitored the execution of those plans- detecting, diagnosing, and recovering from problems as they occurred.
  - Successor program MAPGEN (Al-Chang *et al.,* 2004) plans the daily operations for NASA's Mars Exploration Rovers, and MEXAR2 (Cesta et al., 2007) did mission planning—both logistics and science planning—for the European Space Agency's Mars Express mission in 2008

Applications of AI- The state of the Art

- **Game playing:**
  - IBM's D EEP B LUE became the first computer program to defeat the world champion in a chess match when it bested Garry Kasparov by a score of 3.5 to 2.5 in an exhibition match (Goodman and Keene, 1997).
  - Kasparov said that he felt a "new kind of intelligence" across the board from him. Newsweek magazine described the match as "The brain's last stand."
  - The value of IBM's stock increased by $18 billion. Human champions studied Kasparov's loss and were able to draw a few matches in subsequent years, but the most recent human-computer matches have been won convincingly by the computer.

Applications of AI- The state of the Art

- **Spam fighting**
  - Each day, learning algorithms classify over a billion messages as spam, saving the recipient from having to waste time deleting what, for many users, could comprise 80% or 90% of all messages, if not classified away by algorithms.
  - As the spammers are continually updating their tactics, it is difficult for a static programmed approach to keep up, and learning algorithms work best (Sahami et al., 1998; Goodman and Heckerman, 2004).
- **Robotics**
  - The iRobot Corporation has sold over two million Roomba robotic vacuum cleaners for home use. The company also deploys the more rugged PackBot to Iraq and Afghanistan, where it is used to handle hazardous materials, clear explosives, and identify the location of snipers.

Applications of AI- The state of the Art

- **Logistics planning:**
  - During the Persian Gulf crisis of 1991, U.S. forces deployed a Dynamic Analysis and Replanning Tool, DART (Cross and Walker, 1994), to do automated logistics planning and scheduling for transportation. This involved up to 50,000 vehicles, cargo, and people at a time, and had to account for starting points, destinations, routes, and conflict resolution among all parameters. The AI planning techniques generated in hours a plan that would have taken weeks with older methods. The Defense Advanced Research Project Agency (DARPA) stated that this single application more than paid back DARPA's 30-year investment in AI.

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Applications of AI- The state of the Art

- **Machine Translation**
  - A computer program automatically translates from Arabic to English, allowing an English speaker to see the headline “Ardogan Confirms That Turkey Would Not Accept Any Pressure, Urging Them to Recognize Cyprus.” The program uses a statistical model built from examples of Arabic-to-English translations and from examples of English text totaling two trillion words (Brants et al., 2007). None of the computer scientists on the team speak Arabic, but they do understand statistics and machine learning algorithms.
- **And many more …**

END OF CHAPTER 1