Deep Learning

Lecture 1

Introduction to Artificial intelligence (AI)

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Class Room

Deep Learning Course – Overview

In this course, we will to understand how **Artificial Intelligence** has evolved into **Deep Learning**, exploring four key milestones that define the foundations of modern intelligent systems:

- **Artificial Intelligence (AI)**
  Understanding how machines can be programmed to think, learn, and make intelligent decisions similar to humans.

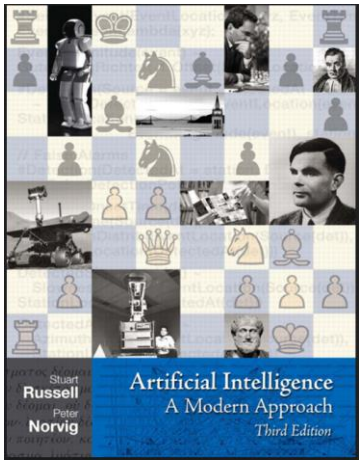
- **Machine Learning (ML)**
  Exploring algorithms that enable computers to learn from data, recognize patterns, and improve performance automatically.

- **Neural Networks (NNs)**
  Studying how artificial neurons connect and process information to mimic the human brain in recognizing complex patterns.

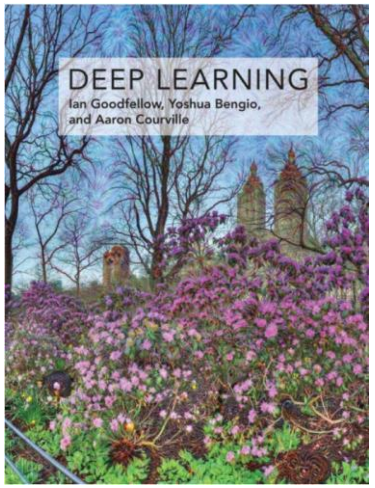
- **Deep Learning (DL)**
  Diving into advanced multi-layer neural networks and their algorithms that power modern applications in:
  Healthcare **Image Recognition** **Speech & Language Processing**

References

- Artificial Intelligence A modern approach , By: Stuart Russell & Peter Norvig, third edition, 2014 , Pearson New International Edition.



- Deep Learning, Ian Goodfellow et al., (MITpress), [https://www.deeplearningbook.org]



General Objective

- To provide students with a solid theoretical and practical foundation in **Deep Learning**, enabling them to understand the underlying principles, architectures, and algorithms of advanced neural networks, and to apply them effectively in solving real-world problems such as **medical image analysis, speech processing, and intelligent decision systems**.

Learning Outcomes

By the end of this lecture, students will be able to:

- **Define** the basic concepts of **Artificial Intelligence**, **Machine Learning**, and **Deep Learning**.
- **Differentiate** between AI, ML, and neural network approaches in intelligent systems.
- **Illustrate** the evolution of learning models from shallow to deep architectures.
- **Recognize** real-world applications of deep learning across healthcare, vision, and language domains.
- **Explain** the motivation behind moving from traditional machine learning to deep learning.

Lecture Contents

- Artificial intelligence (AI) vs. Machine learning (ML)
- What Is Deep Learning?
- What is AI?
- Area of Artificial intelligence
- Branches of AI
- Applications of AI

Artificial intelligence (AI) vs. Machine learning (ML)

- To understand *Deep learning (DL)* , we first need to understand Machine learning (ML) vs. Artificial intelligence (AI).

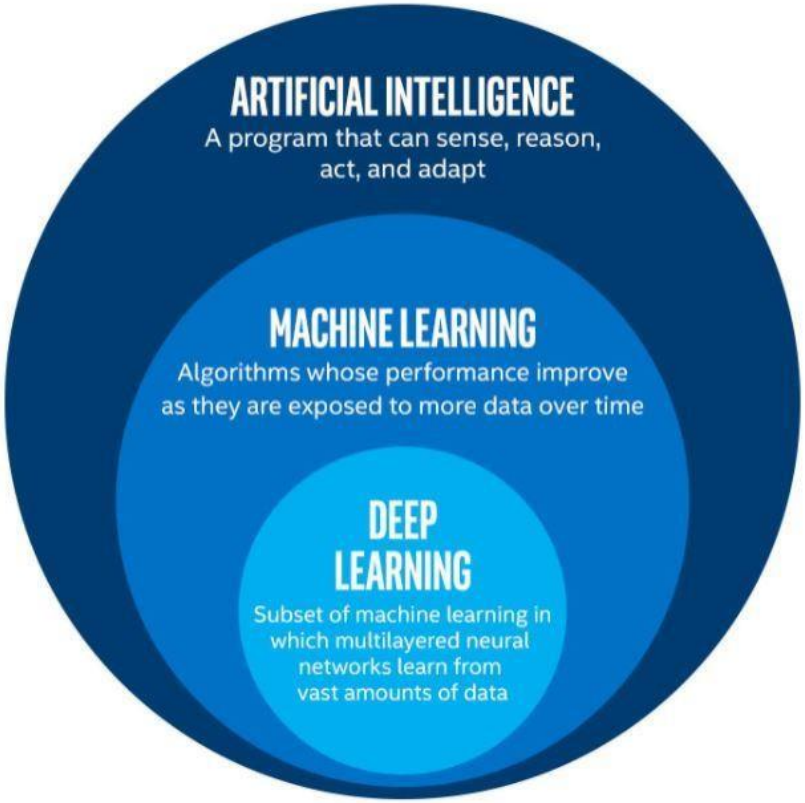
- ***Artificial intelligence (AI)*** is the capability of a machine to imitate intelligent human behavior. It enables the machine to think without any human interventions so that the machine will be able to take its own decision.

- ***Machine learning (ML):*** Is the practice of using algorithms to analyze data, *learn from that data*, and then make a prediction about new data.

What Is Deep Learning?

- ***Deep learning (DL):*** Is advanced or sophisticated techniques that can be used to implement machine learning.

DL: It teaches computers to do what comes naturally to humans by means of learning by examples.



What is AI?

- Intelligence: “ability to learn, understand and think” (Oxford dictionary)
- The word Intelligence has its roots in the Latin word “Intellegere“ , Therefore intelligence can be depicted as being able to combine different kinds of information by establishing links between them.
- The notion of intelligence does not merely comprise solving problems, but is about being able to make sense out of numerous distinct facts to develop new abstract ideas.
- AI is the study of how to make computers make things which at the moment people do better.
- AI deals with information processing problems and how to identify and solve them.

Area of Artificial intelligence

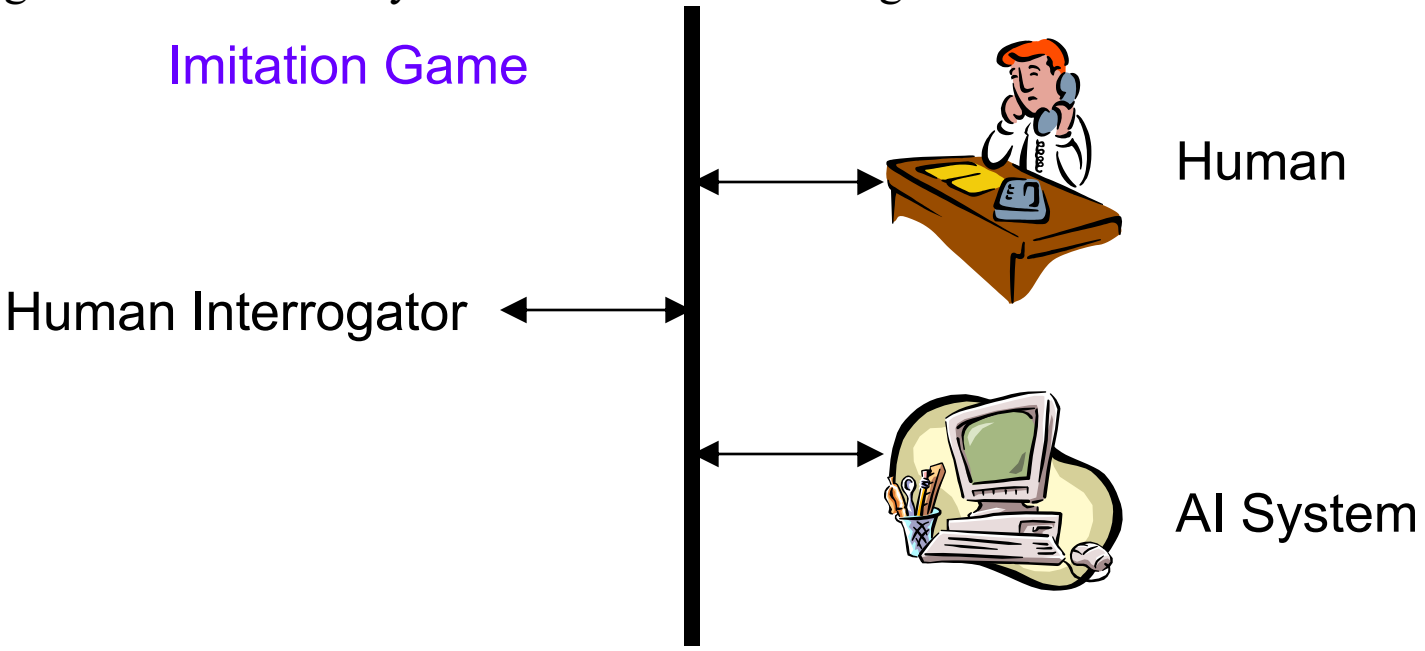
- Getting computers to communicate with us in human languages like English, either by printing on a computer terminal, understanding things we type on a computer terminal, generating speech, or understanding our speech (Natural Language);
- Getting computers to remember complicated interrelated facts, and draw conclusions from them (Inference);
- Getting computers to plan sequences of actions to accomplish goals (Planning);
- Getting computers to offer us advice based on complicated rules for various situations (Expert Systems);
- Getting computers to look through cameras and see what's there (Vision);
- Getting computers to move themselves and objects around in the real world (Robotics).

What is AI?

Thinking humanly	Thinking rationally
Acting humanly	Acting rationally

Acting Humanly: The Turing Test

- The Turing test measures the performance of an allegedly intelligent machine against that of human being, arguably the best and only standard for intelligent behaviour.
- The interrogator is asked to distinguish the computer from the human on the basis of their answer.
- If the interrogator cannot distinguish the machine from the human, then Turing argue the machine may be assumed to be intelligent.



Thinking Humanly: Cognitive Modelling

- Not content to have a program correctly solving a problem.
- More concerned with comparing its reasoning steps to traces of human solving the same problem.
- Requires testable theories of the workings of the human mind: cognitive science.

Thinking Rationally: Laws of Thought

- Aristotle was one of the first to attempt to codify “right thinking”, i.e., irrefutable reasoning processes.
- Formal logic provides a precise notation and rules for representing and reasoning with all kinds of things in the world.
- Obstacles:
  - Informal knowledge representation.
  - Computational complexity and resources.

Acting Rationally

- Acting so as to achieve one's goals, given one's beliefs.
- Does not necessarily involve thinking.
- Advantages:
  - More general than the "laws of thought" approach.
  - More amenable to scientific development than human-based approaches.

Branches of AI

1. Search : Problem-solving technique that systematically explores a space of problem states.

- There are both alternative and successive stages in the process of problem-solving. There are numerous approaches in the AI branch of searching.
- General approaches to searching are ones such as means-end analysis or iterative deepening.
- Another approach is delineated brute-force or blind search.
- There are many types of search algorithm : Breath first search, Depth first search, Hill Climbing, .. Etc.

2. Logical AI : Logic is being referred to as the science of reasoning with the help of normative formal principles.

- Logical AI involves representing knowledge of an agent's world, its goals and the current situation by sentences in logic.
- There are two interesting logical AI approaches :

A. Fuzzy Logic : It deals with modeling modes of reasoning that are imprecise in the context of rational decision making in uncertain environments. Hence, inferring approximate answers to questions that are based on incomplete knowledge.

B. Non-monotonic logic: It is able to model beliefs of active processes in an environment of incomplete information. Prediction are being revised when new observations are made.

- The development of logical AI is based on the fifth generation computer systems. Computers before were based on a machine language based on the von Neumann machine.
- The fifth generation computer systems formulated a language based on logic and designed hardware "for parallel operations or associative search" to serve for the inference function.

3. Learning :machine learns "whenever it changes its structure, program, or data [...] in such a manner that its expected future performance improves“.

- Tasks by AI systems comprise : "recognition, diagnosis, planning, robot control, prediction, etc.“.
- Rote Learning is the mere memorization of a prior trial-and-error approach.
- Generalization is more difficult to achieve for the situations that are being dealt with were not previously encountered.

4. Representation : Representing knowledge is a central task in AI.

- There are five distinct roles for knowledge representation :
  i. Knowledge representation is a representative inside the reasoner or a stand-in for the things that exist in the world , therefore there are no direct interaction to the real world.
  ii. The knowledge representation is acting as ontological commitments, i.e. restrictions on what we can see in the world and how detailed this perception is.
  iii. The knowledge representation has the role to fragment the reasoning about intelligence, therefore only a part of the insights or beliefs that are prevalent can be captured by the representation.
  iv. The knowledge representation is an efficient computation medium, this incorporates the logical AI perspective to choose an eligible and efficient logic.
  v. The knowledge representation is a medium of human expression.

5. Common-sense knowledge : It is humans knowledge about the structure of the external world. Humans gained this knowledge without any focused effort.

- A human in this context is said to "allow him or her to meet the everyday demands of the physical, spatial, temporal and social environment" and attempt for being at least fair successful.
- Common-sense knowledge is also connected to the field of reasoning, which is being able to make inferences.

6. Pattern Recognition : It is often called the basis of AI programs. Recognizing pattern can be achieved by using memories, by employing symbol processing to derive rules or by making use of neural networks.

- Pattern Recognitions is the foundation of numerous AI applications which will be subsequently depicted such as natural language processing or computer vision.
- Perception is one part of pattern recognition that is gradually enhancing due to new results of the field of neuroscience.

Applications of AI

1. Game Playing
2. Speech Recognition
3. Natural Language Processing
4. Computer Vision
5. Expert System
6. Heuristic Classification
7. Cybernetics and brain simulation
8. Robotics

Thank you…

Any questions??

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