Introduction to Artificial Intelligence

Lecture # 1

What is Artificial Intelligence

- Intelligence: "ability to learn, understand and think" (Oxford dictionary).

- AI is the study of how to make computers make things which at the moment people do better.

- Examples: Speech recognition, Smell, Face, Object, Intuition, Inferencing, Learning new skills, Decision making, Abstract thinking.

More Formal Definition of AI

■ AI is a branch of computer science which is concerned with the study and creation of computer systems that exhibit

- some form of intelligence
  OR
- those characteristics which we associate with intelligence in human behavior

Artificial Intelligence

- AI is a broad area consisting of different fields, from machine vision, expert systems to the creation of machines that can "think".

- In order to classify machines as "thinking", it is necessary to define intelligence.

Intelligence

- Intelligence is a property of mind that encompasses many related mental abilities, such as the capabilities to
  - reason
  - plan
  - solve problems
  - think abstractly
  - comprehend ideas and language and
  - learn

What is *Artificial Intelligence?*

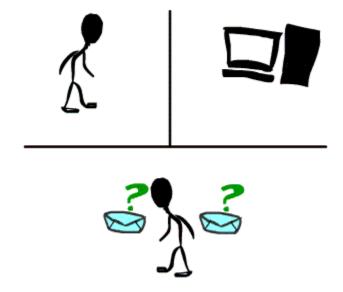| Thinking humanly	Thinking rationally
Acting humanly	Acting rationally

Acting Humanly: The Turing Test

- Predicted that by 2000, a machine might have a 30% chance of fooling a lay person for 5 minutes.

- Anticipated all major arguments against AI in following 50 years.

- Suggested major components of AI: knowledge, reasoning, language, understanding, learning.

Acting Humanly: The Turing Test

- The **Turing Test**, proposed by Alan Turing (Turing, 1950)
- 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.

Turing Test

Turing test

The computer would 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.*

Thinking Humanly

- Thinking humanly means trying to understand and model how the human mind works.
- There are (at least) two possible routes that humans use to find the answer to a question:
  – We reason about it to find the answer. This is called "introspection".
  – We conduct experiments to find the answer, drawing upon scientific techniques to conduct controlled experiments and measure change.

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

Approach is to model how we should think

• The "thinking rationally" approach to AI uses symbolic logic to capture the laws of rational thought as symbols that can be manipulated.

• Reasoning involves manipulating the symbols according to well-defined rules, kind of like algebra.

• The result is an idealized model of human reasoning. This approach is attractive to theorists, i.e., modeling how humans should think and reason in an ideal world.

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.

Strong AI & Weak AI

- According to AI philosophy, AI is considered to be divided in to two major types, namely ***Weak AI*** and ***Strong AI***.

- Weak AI is the thinking focused towards the development of technology capable of carrying out pre-planned moves based on some rules and applying these to achieve a certain goal.

- As opposed to that, Strong AI is developing technology that can think and function similar to humans, not just mimicking human behavior in a certain domain.

Weak AI

- The principle behind Weak AI is simply the fact that machines can be made to act as if they are intelligent.

- For example, when a human player plays chess against a computer, the human player may feel as if the computer is actually making impressive moves. But the chess application is not thinking and planning at all. All the moves it makes are previously fed in to the computer by a human and that is how it is ensured that the software will make the right moves at the right times.

Strong AI

- The principle behind Strong AI is that the machines could be made to think or in other words could represent human minds in the future

- If that is the case, those machines will have the ability to reason, think and do all functions that a human is capable of doing. However, Strong AI, which is in its infant stage, promises a lot due to the recent developments in nanotechnology.

- **Nanobots**, which can help us fight diseases and also make us more intelligent, are being designed.

Characteristics of AI systems

- learn new concepts and tasks

- reason and draw useful conclusions about the world around us
  - remember complicated interrelated facts and draw conclusions from them (inference)

- understand a natural language or perceive and comprehend a visual scene
  - look through cameras and see what's there (vision), to move themselves and objects around in the real world (robotics)

Contd..

- plan sequences of actions to complete a goal

- offer advice based on rules and situations

- may not necessarily imitate human senses and thought processes
  - but indeed, in performing some tasks differently, they may actually exceed human abilities

- capable of performing intelligent tasks effectively and efficiently

- perform tasks that require high levels of intelligence

Human Intelligence VS Artificial Intelligence

Pros

Human Intelligence

- Intuition, Common sense, Judgment, Creativity, Beliefs etc.

- The ability to demonstrate their intelligence by communicating effectively

- Plausible Reasoning and Critical thinking

Artificial Intelligence

- Ability to simulate human behavior and cognitive processes

- Capture and preserve human expertise

- Fast Response. The ability to comprehend large amounts of data quickly.

Human Intelligence VS Artificial Intelligence

Cons

Human Intelligence

- processing of serial nature proceed very slowly in the brain as compared to computers
- Humans are unable to retain large amounts of data in memory.

Artificial Intelligence

- No "common sense"
- Cannot readily deal with "mixed" knowledge
- May have high development costs
- Raise legal and ethical concerns

Advantages of Artificial Intelligence

- **High Accuracy with less errors:** AI machines or systems are prone to less errors and high accuracy as it takes decisions as per pre-experience or information.

- **High-Speed:** AI systems can be of very high-speed and fast-decision making

- **High reliability**: AI machines are highly reliable and can perform the same action multiple times with high accuracy.

- **Useful for risky areas:** AI machines can be helpful in situations such as defusing a bomb, exploring the ocean floor, where to employ a human can be risky.

- **Digital Assistant:** AI can be very useful to provide digital assistant to the users such as AI technology is currently used by various E-commerce websites to show the products as per customer requirement.
- **Useful as a public utility:** AI can be very useful for public utilities such as a self-driving car which can make our journey safer and hassle-free, facial recognition for security purpose, Natural language processing to communicate with the human in human-language, etc.

Goals of AI

- **To Create Expert Systems** – The systems which exhibit intelligent behavior, learn, demonstrate, explain, and advice its users.

- **To Implement Human Intelligence in Machines** – Creating systems that understand, think, learn, and behave like humans.

Applications of AI

- **Gaming** – AI plays crucial role in strategic games such as chess, poker, tic-tac-toe, etc

- **Natural Language Processing** – It is possible to interact with the computer that understands natural language spoken by humans.

- **Expert Systems** – There are some applications which integrate machine, software, and special information to impart reasoning and advising. They provide explanation and advice to the users.

- **Vision Systems** – These systems understand, interpret, and comprehend visual input on the computer. For example,
  - A spying aero plane takes photographs, which are used to figure out spatial information or map of the areas.

Applications of AI

- **Speech Recognition** – Some intelligent systems are capable of hearing and comprehending the language in terms of sentences and their meanings while a human talks to it.

- **Handwriting Recognition** – The handwriting recognition software reads the text written on paper by a pen or on screen by a stylus.

- **Intelligent Robots** – Robots are able to perform the tasks given by a human.

Applications of AI

- **AI in Healthcare**

- **AI in Data Security**

- **AI in Social Media**

- **AI in Travel & Transport**

- **AI in Entertainment**

- **AI in E-commerce**

- **AI in education**

Task Domains of AI

Artificial Intelligence can be used to solve real-world problems by implementing the following processes/ techniques:
- Machine Learning
- Neural Networks
- Robotics
- Expert Systems
- Fuzzy Logic
- Natural Language Processing

1. Expert Systems:

- Expert Systems is an Artificial Intelligence (AI-based) system that learns and imitates a human being's decision-making ability.
- Expert Systems does not use conventional programming to solve complex problems but instead uses logical notations to achieve such an aim.
- It is mainly used in the medical field to operate medical facilities and detect virus infections. It is also used in the banking sector for loan and investment analysis.

2. Robotics:

- This is a very interesting branch of Artificial Intelligence that focuses on the design and development of robots. Robotics deals with the designing, constructing, and operating of robots by incorporating both science and engineering techniques.
- The aim of deploying robots is to help humans with tedious and bulky tasks. These tasks involve the control of computer systems, information transformation and manufacturing of automobiles. It is used by NASA to move heavy objects in space.

3. Machine Learning:

- Machine Learning is a highly demanding branch of Artificial Intelligence. It is the science that enables machines and computer systems to process, analyze and interpret data with the aim of providing solutions for real-life challenges.
- Computer systems can learn and take actions on their own due to the level of sufficient data provided through Machine Learning. The algorithm is set up in such a way that machines can predict outcomes based on past occurrences.
- Machine Learning algorithms and techniques help in training a model with data presented which will then predict and adjust to future outcomes.

4. Neural Network

- Neural Network is a branch of Artificial Intelligence associated with the use of Neurology to incorporate cognitive science in helping computer systems and machines to execute tasks. It is known as "*Deep Learning*" because it involves making use of artificial brain neurons to solve complex problems.
- Neural Network helps machines process how the human brain operates. This branch of AI also involves implementing mathematical functions and statistical techniques to solve real-world problems. It is used in fields such as risk analysis, market research, fraud detection, forecasting, and stock exchange prediction.

5. Fuzzy Logic:

- This branch of AI is the technique of modifying and representing uncertain information by analyzing the degree to which the hypothesis is true. Fuzzy Logic helps to offer a certain level of reasoning flexibility when faced with uncertainties.
- This might sound a bit complex but it is simply a case of using standard logic to determine if a concept exhibits a degree of truth. For instance, standard logic is 1.0 if a concept is TRUE and 0.0 if a concept is FALSE. However, there are cases where a concept can either be partially true or partially false.

6. Natural Language Processing:

- Communicating with someone who doesn't understand your language can be very challenging and the same can be said of humans trying to communicate with a computer system. A computer will find it difficult to interpret words because it only understands the language of binary digits. This challenge has led to the development of Natural Language Processing in computer science.

AI techniques

AI techniques are methods that can be used to develop and create computer programs commonly viewed as forms of artificial intelligence.

- (Expert Systems) Rule-based
- Fuzzy Logic
- Neural Networks
- Genetic Algorithm

Note: Above techniques will be discussed in detail later.

Task Domains of AI

- Mundane Tasks:
  - Perception
    - Vision
    - Speech
  - Natural Languages
    - Understanding
    - Generation
    - Translation
  - Common sense reasoning
  - Robot Control

Contd..

- Formal Tasks
  - Games : chess, checkers etc.
  - Mathematics: Geometry, logic, Proving properties of programs
- Expert Tasks:
  - Engineering (Design, Fault finding, Manufacturing planning)
  - Scientific Analysis
  - Medical Diagnosis
  - Financial Analysis