Chapter 1

INTRODUCTION TO ARTIFICAL INTELLEGENCE

DEFINITION

It is a branch of computer science by which intelligent machines is created which can behave like a human, think like humans, and able to make decisions.

or

According to the father of Artificial Intelligence, John McCarthy, it is "The science and engineering of making intelligent machines, especially intelligent computer programs".

or

Artificial Intelligence is composed of two words Artificial and Intelligence, where Artificial defines "man-made," and intelligence defines "thinking power", hence AI means "a man-made thinking power."

Example:

Google Searching Process – how Google able to search accurate results.

Social Media Newsfeed - how Social Media feed always gives you content based on your interest.

HISTORY OF AI

- In **1950**, **Alan Turing** devised the Turing test. If a machine could carry on a conversation that was indistinguishable from a conversation with a human being, then it was reasonable to say that the machine was thinking.
- **1956 to 1974** is called as the golden era for AI. The **Wabot project** in 1967 built a robot that could measure distances and directions to objects using external receptors, artificial eyes, and ears. And its conversation system allowed it to communicate with a person in Japanese, with an artificial mouth.
- In the **1980s** a form of AI program called **Expert Systems** was adopted by corporations around the world and knowledge became the focus of mainstream AI research.
- A new paradigm called **Intelligent Agents** became widely accepted during the **1990s**. It is a system that perceives its environment and takes actions that maximize its chances of success.
- In the first decades of the **21st century**, access to **large amounts of data, faster computers, and advanced machine learning techniques** was successfully applied to many problems throughout the economy.
- In **2000**, Professor Cynthia Breazeal developed **Kismet**, a robot that could recognize and simulate emotions with its face. It was structured like a human face with eyes, lips, eyelids, and eyebrows.
- In **2009**, Google secretly developed a **driverless car**.
- In **2014**, it passed **Nevada's selfdriving test**

APPLICATIONS OF AI

- **Gaming**
  - AI plays crucial role in strategic games such as chess, poker, tic-tac-toe, etc.,
  - Where machine can think of large number of possible positions based on heuristic knowledge.
- **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.
    - Doctors use clinical expert system to diagnose the patient.
    - Police use computer software that can recognize the face of criminal with the stored portrait made by forensic artist.
- **Speech Recognition**
  - Some intelligent systems are capable of hearing and comprehending the language in terms of sentences and their meanings while a human talk to it.
  - It can handle different accents, slang words, noise in the background, change in human's noise due to cold, etc.
- **Handwriting Recognition**
  - The handwriting recognition software reads the text written on paper by a pen or on screen by a stylus.
  - It can recognize the shapes of the letters and convert it into editable text.
- **Intelligent Robots**
  - Robots are able to perform the tasks given by a human.
  - They have sensors to detect physical data from the real world such as light, heat, temperature, movement, sound, bump, and pressure.
  - They have efficient processors, multiple sensors and huge memory, to exhibit intelligence.
  - In addition, they are capable of learning from their mistakes and they can adapt to the new environment.

Difference between programming with AI and programming without AI

Programming Without AI	Programming With AI
A computer program without AI can answer the specific questions it is meant to solve.	A computer program with AI can answer the generic questions it is meant to solve.
Modification in the program leads to change in its structure.	Can modify even a minute piece of information of program without affecting its structure.
Modification is not quick and easy. It may lead to affecting the program adversely.	Quick and Easy program modification.

COMPONENTS OF INTELLIGENCE

- Learning
- Reasoning
- Linguistic Intelligence
- Perception
- Problem solving

Learning:

- It is the activity of gaining knowledge or skill by studying, practicing, being taught, or experiencing something.
- Learning enhances the awareness of the subjects of the study.
- The ability of learning is possessed by humans, some animals, and AI-enabled systems.

Reasoning:

- It is the set of processes that enables us to provide basis for judgement, making decisions, and prediction.

Problem Solving:

- It is the process in which one perceives and tries to arrive at a desired solution from a present situation by taking some path, which is blocked by known or unknown hurdles.
- Problem solving also includes decision making, which is the process of selecting the best suitable alternative out of multiple alternatives to reach the desired goal are available.

Perception:

- It is the process of acquiring, interpreting, selecting, and organizing sensory information. Perception presumes sensing.
- In humans, perception is aided by sensory organs.
- In the domain of AI, perception mechanism puts the data acquired by the sensors together in a meaningful manner.

Linguistic Intelligence:

- It is one's ability to use, comprehend, speak, and write the verbal and written language.
- It is important in interpersonal communication.

Spatial Learning:

- It is learning through visual stimuli such as images, colors, maps, etc.
- For Example, A person can create roadmap in mind before actually following the road.

Stimulus-Response Learning

- It is learning to perform a particular behavior when a certain stimulus is present.
- For example, a dog raises its ear on hearing do.

TYPES OF INTELLIGENCE

Linguistic Intelligence:

- It is the ability to speak, recognize and use the mechanism of grammar, semantic and phonology.
- It is an ability to think and express the scenario easily as user understands
- Ex: Novelist, Journalist.

Musical Intelligence:

- It is ability to analyses pitch, rhythm and tone.
- This enables us to recognize, create, reproduce and reflect it on the music.
- Ex: Musician, singers.

Spatial Intelligence:

- It is an ability to think in virtualization this builds the capacity to visualize the things manipulate the images, construct 3D images etc.
- Ex: Graphics, game developer, architect.

Interpersonal Intelligence:

- It is an ability to interact, understand other efficiency.

- The person must have an ability to note and react sensitivity with others depending on mood of another person.
- The person with this type of intelligence will have multiple perspectives on one situation
- Ex: politicians, leader, social worker.

Intrapersonal Intelligence:

- It is the capacity to understand oneself and once thoughts and feelings.
- They are self-motivated and they are very much aware of their own feelings.
- Ex: Spiritual Leader, philosopher.

Kinetic Intelligence/bodily intelligence:

- It is the capacity to manipulate the object by using physical skills this involves timings, perfection.
- Ex: Surgeons or athletes

Logical-mathematical Intelligence:

- It is an ability to calculate quantify and carry out mathematical operations.
- It helps in solving complex problems by a simple technique.
- It is an ability to understand the relationship in the absence of an object
- Ex: Scientist, mathematician etc.

KNOWLEDGE

- Humans are best at understanding, reasoning, and interpreting knowledge.
- Human knows things, which is knowledge and as per their knowledge they perform various actions in the real world.
- But how machines do all these things comes under knowledge representation and reasoning.

Hence we can describe Knowledge representation as following:

- Knowledge representation and reasoning (KR, KRR) is the part of Artificial intelligence which concerned with AI agents thinking and how thinking contributes to intelligent behavior of agents.
- It is responsible for representing information about the real world so that a computer can understand and can utilize this knowledge to solve the complex real world problems such as diagnosis a medical condition or communicating with humans in natural language.
- It a way which describes to represent knowledge in artificial intelligence.
- Knowledge representation is not just storing data into some database, but it also enables an intelligent machine to learn from that knowledge and experiences so that it can behave intelligently like a human.

Thinks need to be represented which is in the form of knowledge,

- **Object**: All the facts about objects in our world domain. E.g., Guitars contains strings, trumpets are brass instruments.
- **Events**: Events are the actions which occur in our world.
- **Performance**: It describe behavior which involves knowledge about how to do things.
- **Meta-knowledge**: It is knowledge about what we know.
- **Facts**: Facts are the truths about the real world and what we represent.
- **Knowledge-Base**: The central component of the knowledge-based agents is the knowledge base. It is represented as KB. The Knowledgebase is a group of the Sentences (Here, sentences are used as a technical term and not identical with the English language).

TYPES OF KNOWLEDGE

Declarative Knowledge:

- Declarative knowledge is to know about something.
- It includes concepts, facts, and objects.
- It is also called descriptive knowledge and expressed in declarative sentences.
- It is simpler than procedural language.

Procedural Knowledge:

- It is also known as imperative knowledge.
- Procedural knowledge is a type of knowledge which is responsible for knowing how to do something.
- It can be directly applied to any task.
- It includes rules, strategies, procedures, agendas, etc.
- Procedural knowledge depends on the task on which it can be applied.

Meta-knowledge:

- Knowledge about the other types of knowledge is called Meta-knowledge.

Heuristic knowledge:

- Heuristic knowledge is representing knowledge of some experts in a filed or subject.
- Heuristic knowledge is rules of thumb based on previous experiences, awareness of approaches, and which are good to work but not guaranteed.

Structural knowledge:

- Structural knowledge is basic knowledge to problem-solving.
- It describes relationships between various concepts such as kind of, part of, and grouping of something.
- It describes the relationship that exists between concepts or objects.

TECHNIQUES FOR KNOWLEDGE REPRESENTATION

There are several techniques of knowledge representation and they are,

- Semantic network representation
- Frame Representation
- Production rules
- Logical representation

Semantic network representation

- In this approach knowledge is represented in the form of graphical network
- Here the nodes are represents objects and they describes their relationship between the object.
- It is easy to understand
- It is easy to extend the knowledge

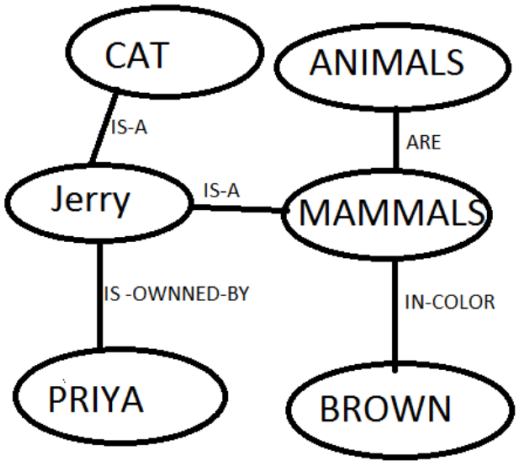
Example

- Jerry is a cat
- Jerry is a mammal
- Jerry is owned by priya
- Jerry is brown in color
- All mammals are animals

In the above example,

- Jerry, cat, priya, brown, animals, mammals are the objects,
- The relationship between the objects are represented by using IS-A,IN-COLOR,IS-OWNED_BY,etc

Relationships as shown below,



- **Frame representation**

- The frame is record like a structure.
- This contains collection of attribute and its value to describe real world entity.
- The frame is a data structure in AI which is a collection of values for single slot.
- This is also called as slot filter knowledge representation

Example:
Priya is a doctor and her age is 30 she lives in Delhi and she is married.

Name	Priya
Profession	Doctor
Age	30
Place	Delhi
Marital status	Married

- **Production Rules**

- It consists of condition, action pair i.e If condition then action.
- The condition contains the production rules if it matches the condition then it performs corresponding action.
- This is also called as recognize act cycle.

Example,

```
if( In bus stand && you have Bus )
        then action(get inside the bus)
if(in BUS && not paid )
        then action (pay the amount)
```

- **Logical Representation**

- The logical representation means drawing the conclusion based on various condition.
- This representation provide the predefined syntax and semantic rules.
- Each sentence can be translated into the logic using syntax and semantics and it is categorized into 2 types,
    1) Propositional logic
    2) Predicate logic

1) Propositional logic

- The declarative statements which are either true or false
- These statements are joined by the connectors like AND(&&),OR(||),Negation(~), Implication (->),Bi conditional (⇓◊)

Example:

P: Jerry is a cat

Q: Jerry is a mammal

p◊Q:if jerry is a cat then jerry is a mammal.

2) Predicate logic

- It is extended form of a propositional logic.
- It is also called as first order predicate logic .
- It contains objects, relations and function.
- It has connectors like for all and there exit's.

TYPES OF AI

Weak AI or Narrow AI:

- Narrow AI is a type of AI which is able to perform a dedicated task with intelligence.
- The most common and currently available AI is Narrow AI in the world of Artificial Intelligence.
- Narrow AI cannot perform beyond its field or limitations, as it is only trained for one specific task. Hence it is also termed as weak AI.
- Narrow AI can fail in unpredictable ways if it goes beyond its limits.
- Apple Siri is a good example of Narrow AI, but it operates with a limited pre-defined range of functions.
- IBM's Watson supercomputer also comes under Narrow AI, as it uses an Expert system approach combined with Machine learning and natural language processing.
- Some Examples of Narrow AI are playing chess, purchasing suggestions on e-commerce site, self-driving cars, speech recognition, and image recognition.

General AI:

- General AI is a type of intelligence which could perform any intellectual task with efficiency like a human.
- The idea behind the general AI to make such a system which could be smarter and think like a human by its own.
- Currently, there is no such system exist which could come under general AI and can perform any task as perfect as a human.
- The worldwide researchers are now focused on developing machines with General AI.
- As systems with general AI are still under research and it will take lots of efforts and time to develop such systems.

Super AI:

- Super AI is a level of Intelligence of Systems at which machines could surpass human intelligence, and can perform any task better than human with cognitive properties.

- It is an outcome of general AI.
- Some key characteristics of strong AI include capability include the ability to think, to reason, solve the puzzle, make judgments, plan, learn, and communicate by its own.
- Super AI is still a hypothetical concept of Artificial Intelligence.
- Development of such systems in real is still world changing task.

TASK DOMAINS OF AI

Formal Task (rules and regulations)

- This task having fixed rules and logics to be applied.
- It includes developing Games
- It includes developing mathematical applications, theorem -proving, mathematical calculations.

Mundane task or Ordinary task

- These are the common things that humans do every day.
- It includes perception, vision, and speech reorganization.
- It includes language processing like understanding the language, language translation.
- It includes common sense, reasoning and planning.

Expert Task

- These are the task that are done by same domain experts
- It contains the task like fault finding, manufacturing, monitoring etc.
- It is used in mission planning for under water vehicles, mat labs etc.
- It contains task in the field of scientific analysis, financial analysis, medical diagnosis

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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.

Philosophy of AI

While exploiting the power of the computer systems, the curiosity of human, lead him to wonder, "Can a machine think and behave like humans do?" Thus, the development of AI started with the intention of creating similar intelligence in machines that we find and regard high in humans.

RESEARCH AREAS OF AI

1. Expert System

- It is a computer system that simulates the decision-making ability of a human expert.
- it is used to solve the complex problem by using a previous knowledge.
- It is used the knowledge stored in the knowledge bas to solve the problem
- It can advice the user and provides explanation to the user about how to solve the problem.
- It is mainly used in a medical field.
- Ex : procto, mycin

2. Natural Language Processing

- It is the branch of AI that deals with interaction between the computer and the humans using natural language.
- The objective of NLP is to read, understand and make a sense of human language
- Ex: it is used in language translation application -Google translator

3. Fuzzy logic

- It is the method of reasoning that resembles the human reasoning capacity.
- The approach of fuzzy logic imitates the way of decision making in humans that involves all intermediate possible values between yes and no.
- It provides flexibility for reasoning.
- It is used in aerospace field for altitude control.

4. Neural network

- A computing system made up of simple and highly inner connected processing elements which process the information by external input.
- It is inspired by biological neural network which resembles animal brain.
- It is used in prediction or fore casting
- It is used in business analysis

5. Robotics

- It is the branch of AI and engineering that involves conception, design, manufacture and operation of robots.

- It deals with study of creating intelligent and efficient machines.
- It is used in industries for cutting, welding, drilling etc.
- It is used in military, medical field, entertainment.

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