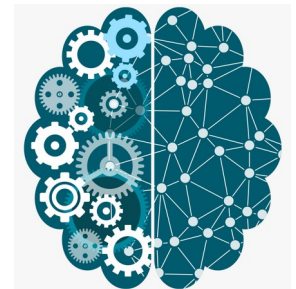


Knowledge Representation in AI

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Introduction

- Human beings are good at understanding, reasoning and interpreting knowledge.
- And using this knowledge, they are able to perform various actions in the real world. But how do machines perform the same?

What is Knowledge Representation?

- Knowledge Representation in AI describes the representation of knowledge.
- Basically, it is a study of how the beliefs, intentions, and judgments of an intelligent agent can be expressed suitably for automated reasoning.
- One of the primary purposes of Knowledge Representation includes modeling intelligent behavior for an agent.

What is Knowledge Representation?

- Knowledge Representation and Reasoning (KR, KRR) represents information from the real world for a computer to understand and then utilize this knowledge to solve complex real-life problems like communicating with human beings in natural language.
- Knowledge representation in AI is not just about storing data in a database, it allows a machine to learn from that knowledge and behave intelligently like a human being.

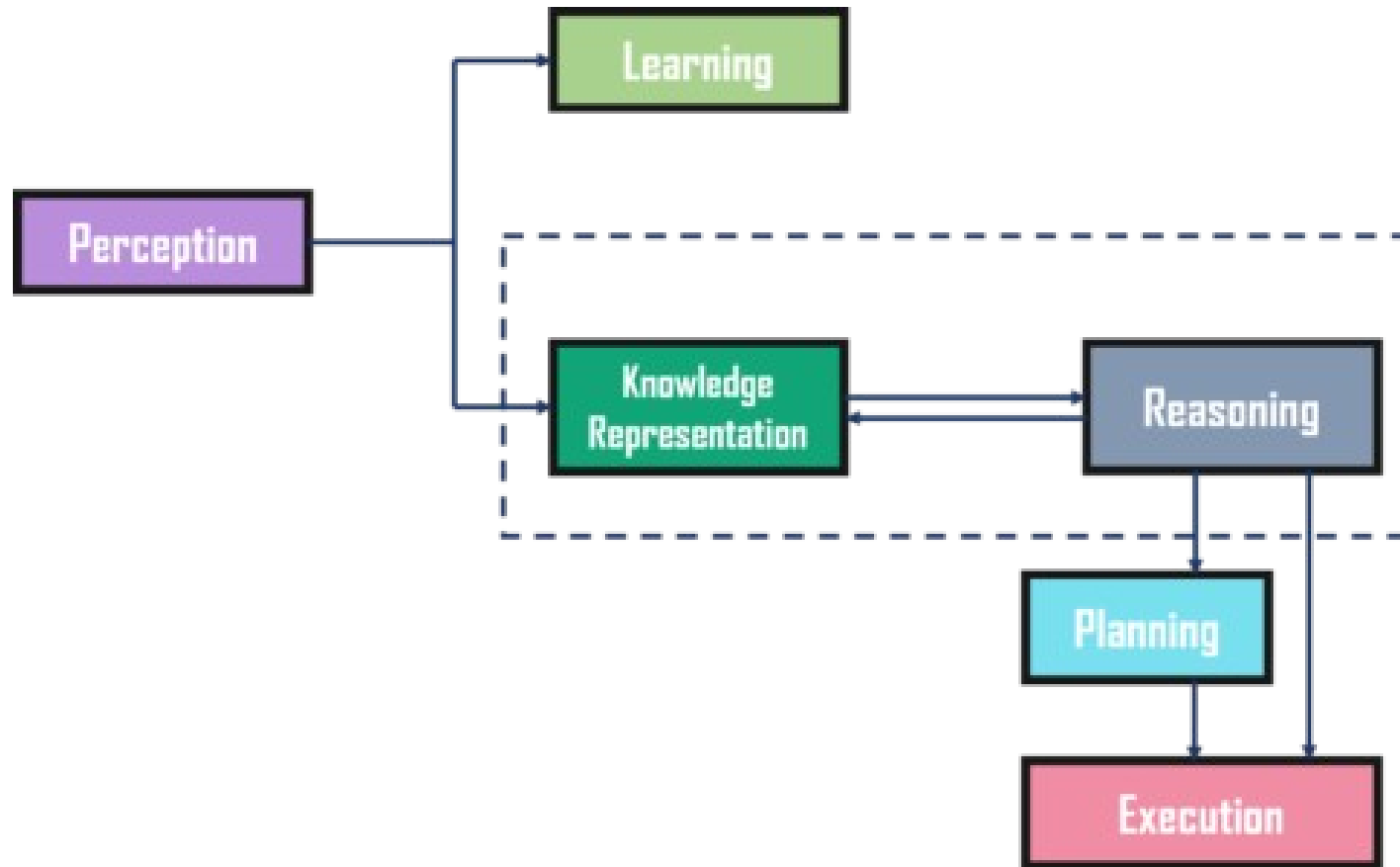
What is Knowledge Representation?

- The different kinds of knowledge that need to be represented in AI include:
 - Objects
 - Events
 - Performance
 - Facts
 - Meta-Knowledge
 - Knowledge-base

Cycle of Knowledge Representation in AI

- Artificial Intelligent Systems usually consist of various components to display their intelligent behavior. Some of these components include:
 - Perception
 - Learning
 - Knowledge Representation & Reasoning
 - Planning
 - Execution

Example:



Knowledge Representation in AI



Logical Representation

- Logical representation is a language with some definite rules which deal with propositions and has no ambiguity in representation.
- It represents a conclusion based on various conditions and lays down some important communication rules.
- Also, it consists of precisely defined syntax and semantics which supports the sound inference.
- Each sentence can be translated into logics using syntax and semantics.

Logical Representation

- Uses formal logic to represent knowledge.
 - Propositional Logic: Involves using statements that can be either true or false.
 - First-Order Logic (Predicate Logic): Extends propositional logic by incorporating objects, properties, and relations.
 - Example:
 - All humans are mortal.
 - Socrates is a human.
 - Therefore, Socrates is mortal.

Logical Representation

Syntax	Semantics
<ul style="list-style-type: none">• It decides how we can construct legal sentences in logic.• It determines which symbol we can use in knowledge representation.• Also, how to write those symbols.	<ul style="list-style-type: none">• Semantics are the rules by which we can interpret the sentence in the logic.• It assigns a meaning to each sentence.

Logical Representation

- Advantages:
 - Logical representation helps to perform logical reasoning.
 - This representation is the basis for the programming languages.
- Disadvantages:
 - Logical representations have some restrictions and are challenging to work with.
 - This technique may not be very natural, and inference may not be very efficient.

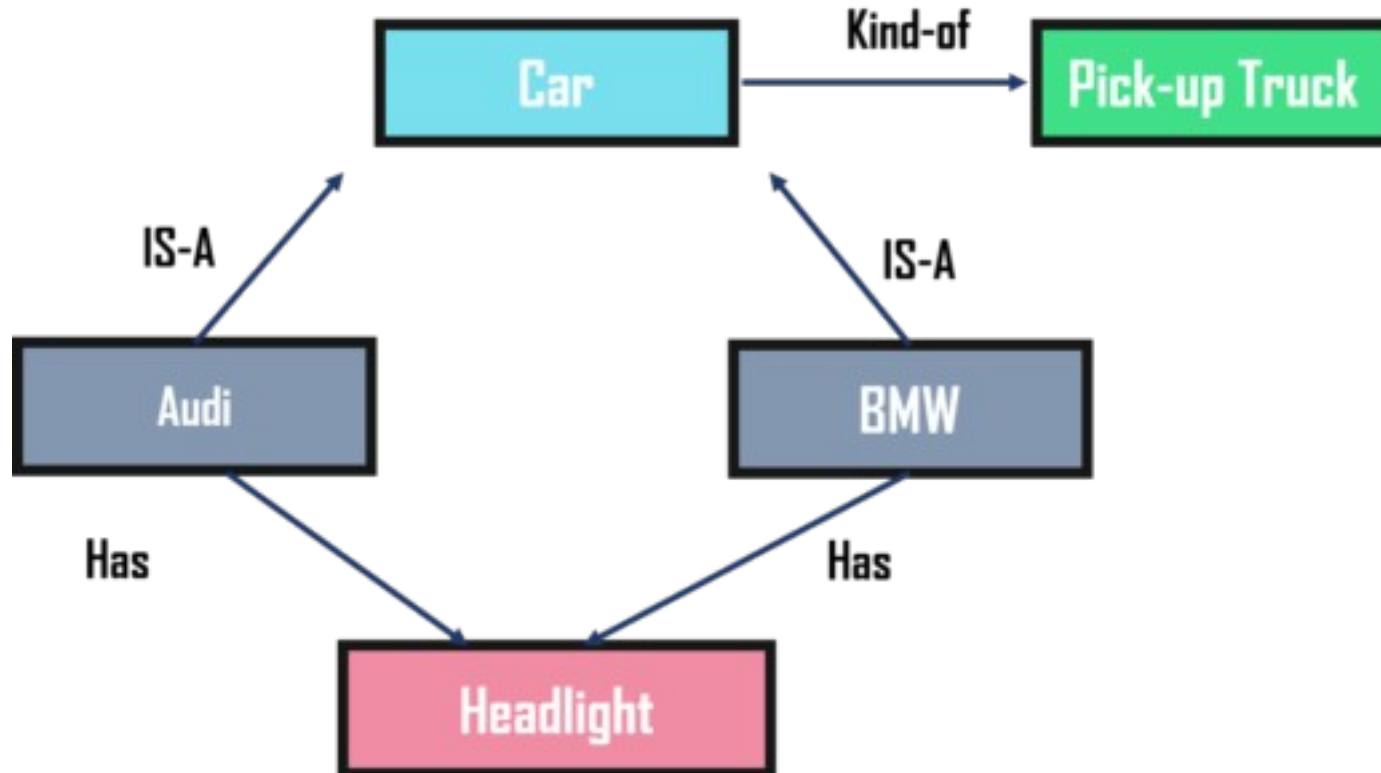
Semantic Network Representation

- Semantic networks work as an alternative of predicate logic for knowledge representation. In Semantic networks, you can represent your knowledge in the form of graphical networks.
- This network consists of nodes representing objects and arcs which describe the relationship between those objects. Also, it categorizes the object in different forms and links those objects.
- This representation consist of two types of relations:
 - IS-A relation (Inheritance)
 - Kind-of-relation

Semantic Network Representation

- Uses a graph of nodes and edges to represent concepts and their relationships.
 - Nodes: Represent objects or concepts.
 - Edges: Represent relationships between nodes.
 - Example:
 - (Human) --is a--> (Mammal)
 - (Mammal) --has a--> (Heart)
 - (Human) --has a--> (Heart)

Semantic Network Representation



Semantic Network Representation

- Advantages:
 - Semantic networks are a natural representation of knowledge.
 - Also, it conveys meaning in a transparent manner.
 - These networks are simple and easy to understand.
- Disadvantages:
 - Semantic networks take more computational time at runtime.
 - Also, these are inadequate as they do not have any equivalent quantifiers.
 - These networks are not intelligent and depend on the creator of the system.

Frame Representation

- A frame is a record like structure that consists of a collection of attributes and values to describe an entity in the world.
- These are the AI data structure that divides knowledge into substructures by representing stereotypes situations.
- Basically, it consists of a collection of slots and slot values of any type and size.
- Slots have names and values which are called facets.

Frame Representation

- Structures for representing stereotyped situations.
- Consist of slots (attributes) and fillers (values).
- Allow for the organization of knowledge into hierarchies.
- Example:
 - Frame: Human
 - Slots:
 - Name: (Type: String)
 - Age: (Type: Integer)
 - Occupation: (Type: String)

Frame Representation

- Advantages:
 - It makes the programming easier by grouping the related data.
 - Frame representation is easy to understand and visualize.
 - It is very easy to add slots for new attributes and relations.
 - Also, it is easy to include default data and search for missing values.
- Disadvantages:
 - In frame system inference, the mechanism cannot be easily processed.
 - The inference mechanism cannot be smoothly proceeded by frame representation.
 - It has a very generalized approach.

Production Rules

- In production rules, agent checks for the condition and if the condition exists then production rule fires and corresponding action is carried out.
- The condition part of the rule determines which rule may be applied to a problem. Whereas, the action part carries out the associated problem-solving steps. This complete process is called a recognize-act cycle.
- The production rules system consists of three main parts:
 - The set of production rules
 - Working Memory
 - The recognize-act-cycle

Production Rules

- Uses condition-action pairs for knowledge representation.
- Often used in expert systems.
- Example:
 - IF it is raining THEN take an umbrella.
 - IF the light is red THEN stop.

Production Rules

- Advantages:
 - The production rules are expressed in natural language.
 - The production rules are highly modular and can be easily removed or modified.
- Disadvantages:
 - It does not exhibit any learning capabilities and does not store the result of the problem for future uses.
 - During the execution of the program, many rules may be active. Thus, rule-based production systems are inefficient.

Ontology

- A formal representation of knowledge as a set of concepts within a domain and the relationships between those concepts.
- Used to model complex systems and their interrelationships.
 - Example:
 - Ontology: Medical
 - Concepts:
 - - Disease
 - - Symptom
 - - Treatment
 - Relationships:
 - - Disease hasSymptom Symptom
 - - Disease treatedBy Treatment

Bayesian Networks

- A probabilistic graphical model representing a set of variables and their conditional dependencies using a directed acyclic graph (DAG).
- Useful for reasoning under uncertainty.
- Example:
 - Node: Rain
 - Node: Sprinkler
 - Node: WetGrass
 - Arrows:
 - Rain -> WetGrass
 - Sprinkler -> WetGrass

Thank you

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