Knowledge Representation

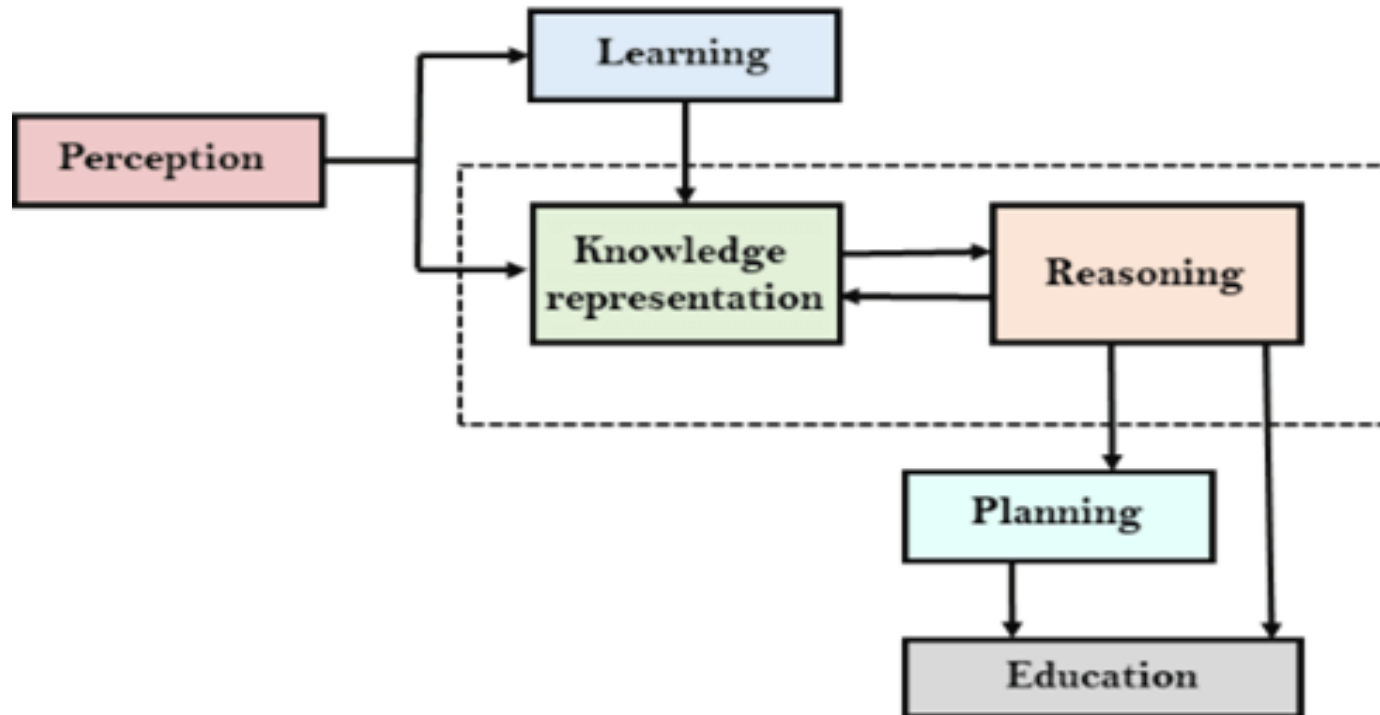# What is knowledge representation?

- Knowledge is cognizance or understanding expanded by experiences of facts, data, and circumstances.

- Humans are best at understanding, reasoning, and interpreting knowledge. **But how machines will be able to do all these comes under knowledge representation and reasoning**.

Following are the types of knowledge in artificial intelligence:

- **Declarative Knowledge**
- **Procedural Knowledge**
- **Meta-knowledge**
- **Heuristic knowledge**
- **Structural knowledge**

AI Knowledge Cycle

Approaches to Knowledge Representation

1. Simple Relational Knowledge:

- It is the simplest way of storing facts which uses the relational method, and each fact about a set of the object is set out systematically in columns.

- This approach of knowledge representation is famous in database systems where the relationship between different entities is represented.

- This approach has little opportunity for inference.

- **Example:**

Player	Weight	Age
Player1	65	23
Player2	58	18
Player3	75	24

2. Inheritable knowledge:

- In the inheritable knowledge approach, all data must be stored into a hierarchy of classes.
- All classes should be arranged in a generalized form or a hierarchal manner.
- In this approach, we apply inheritance property.
- Elements inherit values from other members of a class.
- This approach contains inheritable knowledge which shows a relation between instance and class, and it is called instance relation.
- Every individual frame can represent the collection of attributes and its value.
- In this approach, objects and values are represented in Boxed nodes.
- We use Arrows which point from objects to their values.

Example:
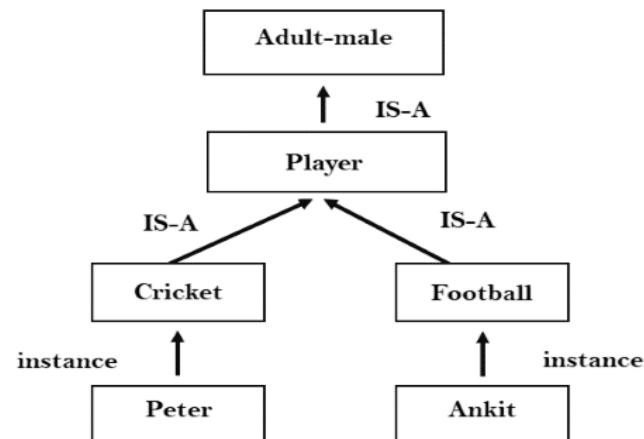
3. Inferential knowledge:

- Inferential knowledge approach represents knowledge in the form of formal logics.
- This approach can be used to derive more facts.
- It guaranteed correctness.
- **Example:** Let's suppose there are two statements:
  - Marcus is a man
  - All men are mortal
    Then it can represent as;

    man(Marcus)
    ∀x :man (x)→mortal (x)

4. Procedural knowledge:

- Procedural knowledge approach uses small programs and codes which describes how to do specific things, and how to proceed.
- In this approach, one important rule is used which is **If-Then rule**.
- In this knowledge, we can use various coding languages such as **LISP language** and **Prolog language**.
- We can easily represent heuristic or domain-specific knowledge using this approach.
- But it is not necessary that we can represent all cases in this approach.

Requirements for knowledge Representation system

- **Representational Accuracy:** Ability to represent all kind of required knowledge.

- **Inferential Adequacy:** Ability to manipulate the representational structures to produce new knowledge corresponding to existing structure.

- **Inferential Efficiency:** Ability to direct the inferential knowledge appliance into the most productive orders by storing suitable guides.

- **Acquisitional Efficiency-** The ability to obtain the new knowledge easily using instinctive methods.

Techniques of Knowledge Representation

1. Logical Representation

2. Semantic Network Representation

3. Frame Representation

4. Production Rules

1. Logical Representation

There are two type of logical representation:

- Propositional Logics
- Predicate logics

Logical representation is a language with some concrete rules which deals with propositions and has no ambiguity in representation. Logical representation means drawing a conclusion based on various conditions. This representation lays down some important communication rules. It consists of precisely defined syntax and semantics which supports the sound inference. Each sentence can be translated into logics using syntax and semantics.

- Syntax determines which symbol we can use in knowledge representation.
- Semantics are the rules by which we can interpret the sentence in the logic.

2. Semantic Network Representation

- It is alternative of predicate logic for knowledge representation.
- In Semantic net we represent knowledge in graphical network form.
- This network consists of nodes representing objects and arcs which describe the relationship between those objects. Semantic networks can categorize the object in different forms and can also link those objects.
- This representation consists of mainly two types of relations:
1. IS-A relation (Inheritance)
2. Kind-of-relation

Example:

Statements:
- Jerry is a cat.
- Jerry is a mammal
- Jerry is owned by Priya.
- Jerry is brown colored.
- All Mammals are animal.
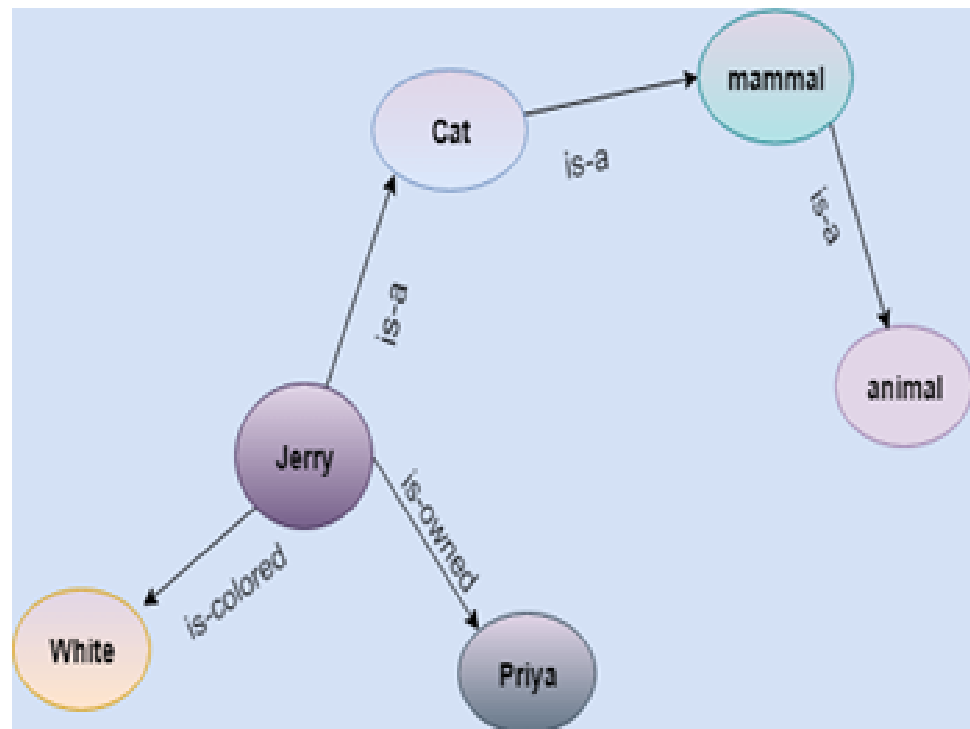
3. Frame Representation

- The structure of frame is like record which contains collection of attributes and its values to describe an entity in the world. Frames are the AI data structure which divides knowledge into substructures by representing stereotypes situations. It consists of a collection of slots and slot values. These slots may be of any type and sizes. Slots have names and values which are called facets.

- A frame is also known as **slot-filter knowledge representation** in artificial intelligence.

        Example: Frame for a book

Slots	Filters
Title	Artificial Intelligence
Genre	Computer Science
Author	Peter Norvig
Edition	Third Edition
Year	1996
Page	1152

4. Production Rules

It is based on pair of (**condition, action**) that is "If condition then action".

It has mainly three parts:

- Set of production rules
- Working Memory
- The recognize-act-cycle

Condition part - Determines which rule may be applied to a problem

Action part - Carries out the associated problem-solving steps.

This complete process is known as recognize-act cycle.

Example:

IF (at bus stop AND bus arrives) THEN action (get into the bus)

IF (on the bus AND paid AND empty seat) THEN action (sit down).

IF (on bus AND unpaid) THEN action (pay charges).

IF (bus arrives at destination) THEN action (get down from the bus).