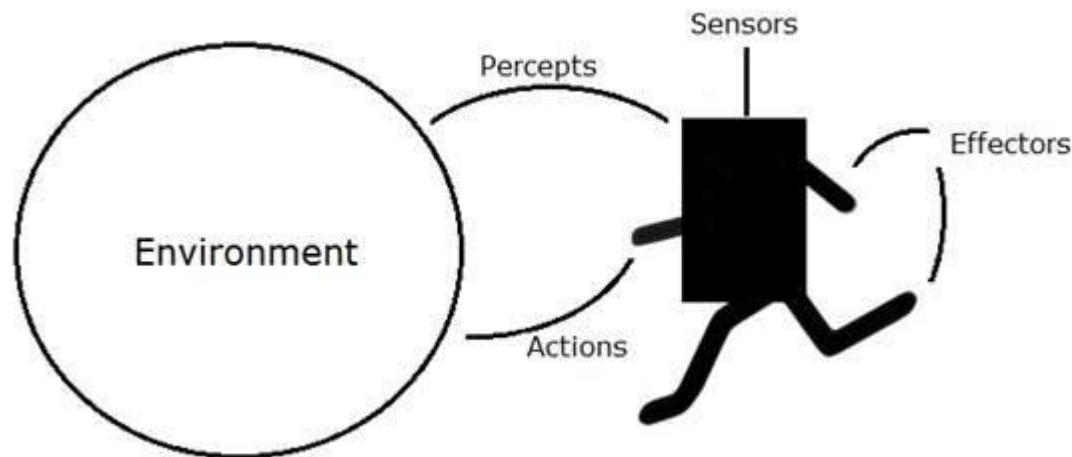


Knowledge Representation Techniques

AI Agent and Environment

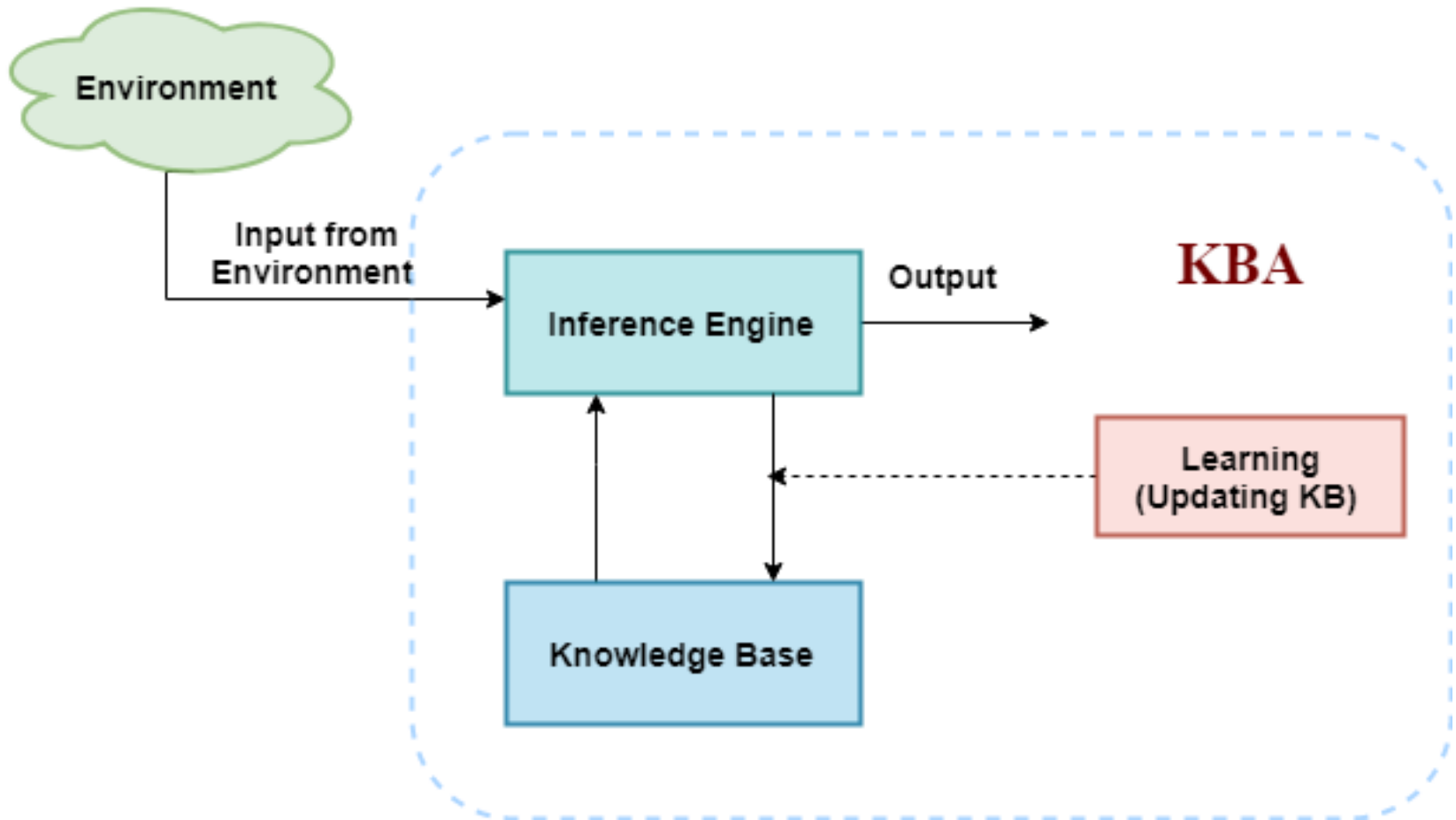
- An **agent** can be anything that perceive its **environment** through sensors, analyses it, takes decisions and act upon that environment through actuators.
- An Agent runs in the cycle of **perceiving, thinking, and acting**.
- An environment is everything in the world which surrounds the agent, but it is not a part of an agent itself. An environment can be described as a situation in which an agent is present.



Knowledge-Based Agent

- An intelligent agent needs knowledge about the real world for taking decisions and reasoning to act efficiently.
- Knowledge-based agents are those agents who have the capability of
 - maintaining an internal state of knowledge,
 - reason over that knowledge,
 - update their knowledge after observations & take actions.
- These agents can represent the world with some formal representation and act intelligently.
- Knowledge-based agents are composed of two main parts:
 - Knowledge-base and
 - Inference system.

Knowledge-Based Agent



Knowledge Representation Techniques

```
graph TD; A([Knowledge Representation Techniques]) -.- B(Logical Representation); A -.- C(Semantic Networks); A -.- D(Production Rules); A -.- E(Frames Representation);
```

**Logical
Representation**

**Semantic
Networks**

**Production
Rules**

**Frames
Representation**

Production Rules

- Production rules system consist of (**condition, action**) pairs which mean, “If condition then action”.
- 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. And the action part carries out the associated problem-solving steps. This complete process is called a **recognize-act cycle**.
- If there is a new situation (state) generates, then multiple production rules will be fired together, this is called conflict set. In this situation, the agent needs to select a rule from these sets, and it is called a **conflict resolution**.

Production Rules

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).

Production Rules

Advantages of Production rule:

- The production rules are expressed in natural language.
- The production rules are highly modular, so we can easily remove, add or modify an individual rule.

Disadvantages of Production rule:

- Production rule system does not exhibit any learning capabilities, as it does not store the result of the problem for the future uses.
- During the execution of the program, many rules may be active hence rule-based production systems are inefficient.

Propositional Logic

- **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.

Propositional Logic

Syntax:

Syntaxes are the rules which decide how we can construct legal sentences in the logic.

It determines which symbol we can use in knowledge representation.

How to write those symbols.

Defines the sentences in the language

Semantics:

Semantics are the rules by which we can interpret the sentence in the logic.

Semantic also involves assigning a meaning to each sentence.

Defines the “meaning” to sentences

Propositional Logic

Advantages of logical representation:

1. Logical representation enables us to do logical reasoning.
2. Logical representation is the basis for the programming languages.

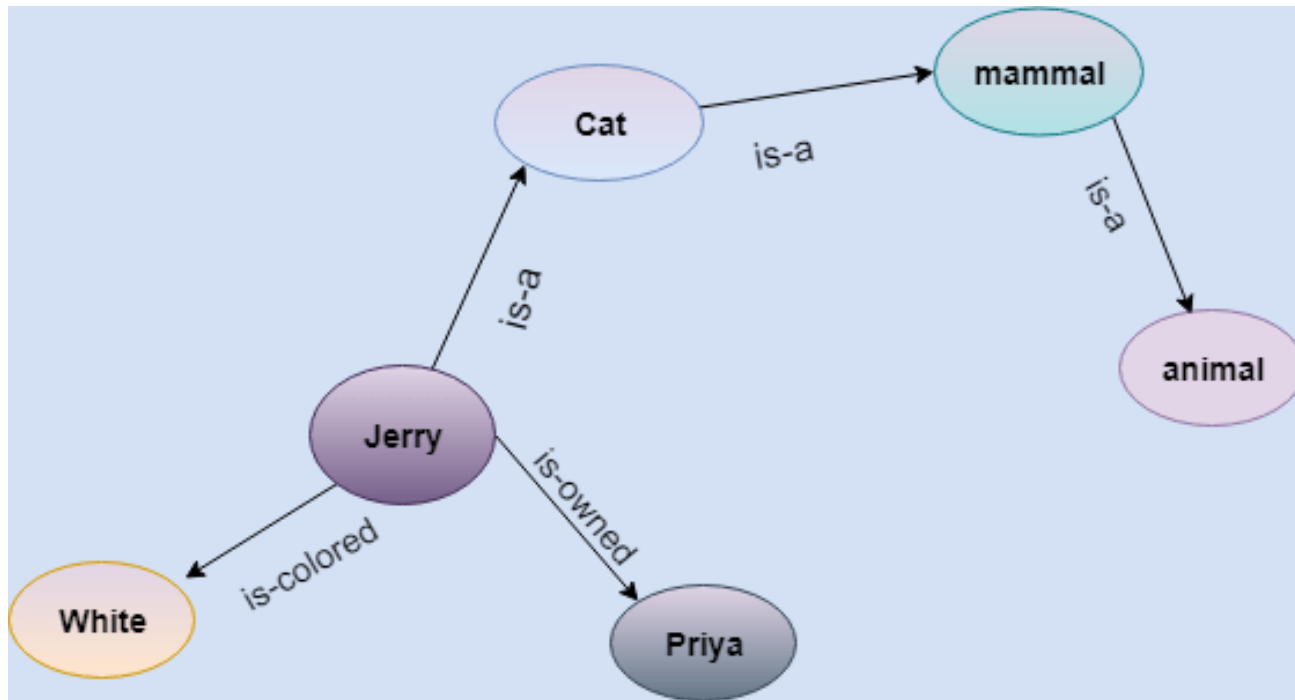
Disadvantages of logical Representation:

1. Logical representations have some restrictions and are challenging to work with.
2. Logical representation technique may not be very natural, and inference may not be so efficient.
3. Not easy to scale.

Semantic Network Representation

- **In Semantic networks**, we can represent our knowledge in the form of graphical networks. 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. Semantic networks are easy to understand and can be easily extended.
- This representation consist of mainly two types of relations:
 - IS-A relation (Inheritance)
 - Kind-of-relation

Semantic Network Representation



In the diagram, the different type of knowledge is represented in the form of nodes and arcs.

Each object is connected with another object by some relation.

Semantic Network Representation

Advantages of Semantic network:

- Semantic networks are a natural representation of knowledge.
- Semantic networks convey meaning in a transparent manner.
- These networks are simple and easily understandable.

Drawbacks in Semantic representation:

- Take more computational time at runtime as we need to traverse the complete network tree to answer some questions.
 - It is possible (worst case scenario) that after traversing the entire tree, we find that the solution does not exist in this network.
- Try to model human-like memory (neurons & links) to store the information, but in practice, it is not possible to build such a vast semantic network.
- These types of representations are inadequate as they do not have any equivalent quantifier, or any standard definition for the link names.

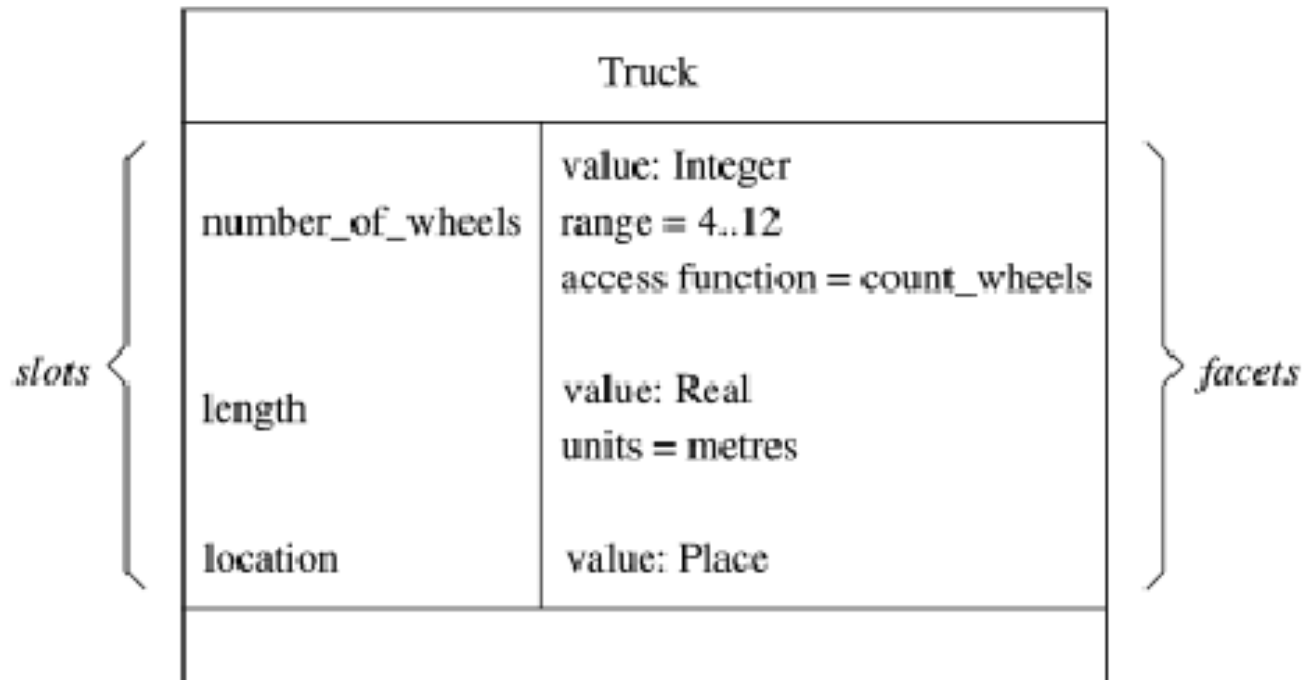
Frame Representation

- A frame is a record like structure which consists of a collection of attributes and its values to describe an entity in the world.
- Frames are more structured form of packaging knowledge,
 - used for representing objects, concepts etc.
- Frames are organized into hierarchies or network of frames.
- Each frame includes two basic element : slots and facets/filter.
- A frame is also known as **slot-filter knowledge representation** in artificial intelligence.

Frame Representation

- A frame may have any number of slots needed for describing object.
 - For example, a student frame may have name, age, address, qualification etc. as slot names.
- Each slot may contain one or more facets (called fillers) which may take many forms such as :
 - **value** (value of the slot),
 - **default** (default value of the slot),
 - **range** (the range of integer or enumerated values, a slot can have),
 - **demons** (procedural attachments such as if_needed, if_deleted, if_added etc.)
 - **other** (may contain rules, other frames, semantic net or any type of other information).

Frame Representation



Frame Representation

