Unit - 4

Q8.

Q1. Knowledge Representation and Reasoning

- Knowledge Representation is responsible for representing information about the real world so that a computer can understand and utilize this knowledge to solve complex real world problems.

- Knowledge representation is not just storing data into some database, it also enables an intelligent machine to learn from that knowledge and experiences so that it can behave intelligently like a human.

* **Types of knowledge →**
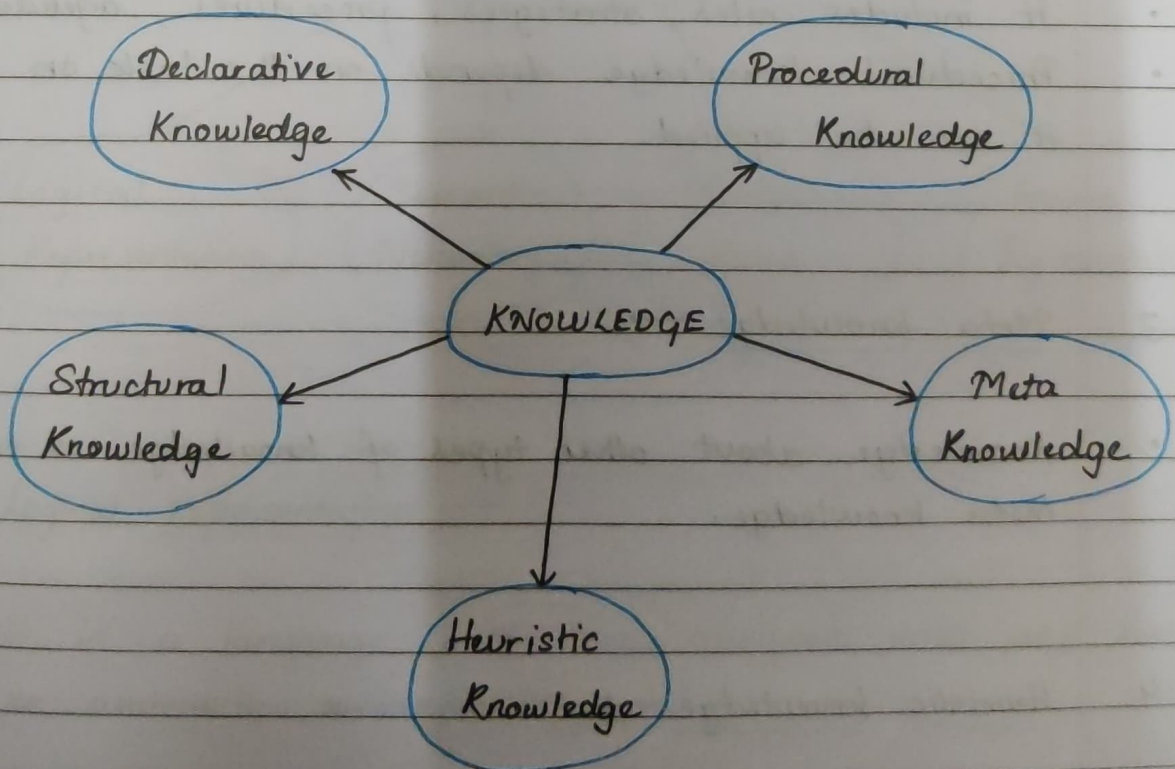
1. Declarative Knowledge →

- Declarative Knowledge is to know about something
- It includes concepts, facts etc.
- It also includes descriptive knowledge
- It is expressed in declarative sentences
- It is simpler than procedural knowledge.

2. Procedural Knowledge →

- It is also known as imperative knowledge
- It is the type of knowledge which involves 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.

3. Meta knowledge →

- Knowledge about other types of knowledge is called meta knowledge.
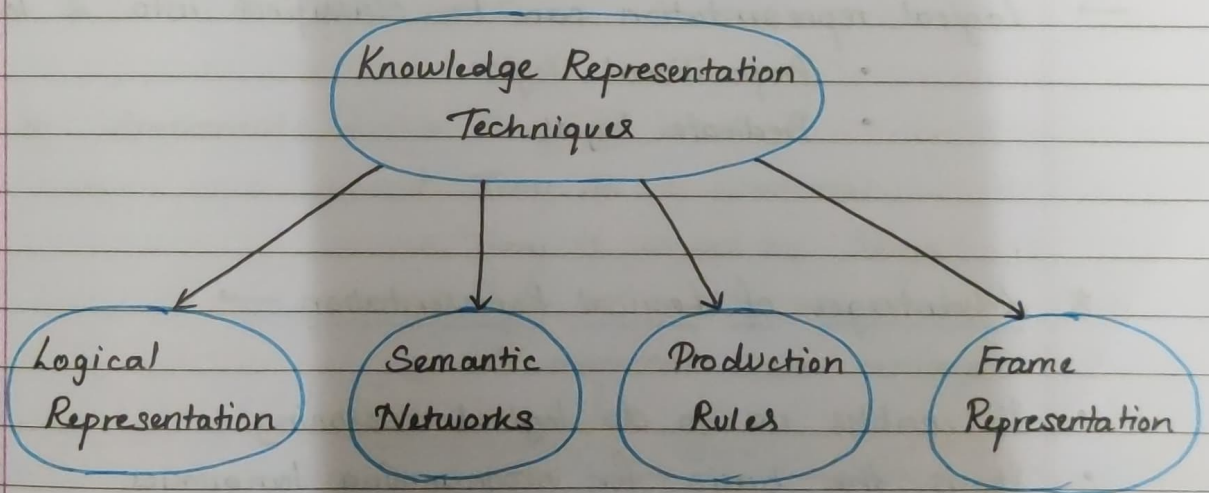
4. Heuristic knowledge →

- Heuristic knowledge represents the knowledge of experts in a field or subject
- It is based on previous experiences, awareness of approaches, and what are good to work, but not guaranteed.

5. **Structural knowledge →**

- It is the basic knowledge for problem-solving
- It describes the relationships between concepts or objects, such as "kind of", "part of" or grouping of something.

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* Techniques of Knowledge Representation →

There are mainly 4 ways of knowledge representation as shown →

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          │ Knowledge Representation │
          │       Techniques         │
          └─────────────────────────┘
         /        │          │         \
        ↓         ↓          ↓           ↓
  ┌──────────┐ ┌─────────┐ ┌──────────┐ ┌──────────────┐
  │ Logical  │ │Semantic │ │Production│ │   Frame      │
  │Representa│ │Networks │ │  Rules   │ │Representation│
  │  tion    │ │         │ │          │ │              │
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- **Logical Representation →**

→ It is a language with some concrete rules and has no ambiguity in representation

→ Logical representation means drawing a conclusion based on various conditions.

→ It consists of a precisely defined syntax and semantics that support the sound inference.

→ Each sentence can be translated into logics using syntax and semantics

It involves the rules by which we interpret the sentences in the logic and assingning meaning to each sentence.

The rules which decide how we can construct legal sentences in a logic and which symbols we can use in knowledge representation

→ Logical representation can be classified into 2 logics →
- Propositional logics
- Predicate logics

★ Advantages of Logical Representation →

- It enables us to do logical reasoning
- It is the basis for programming languages.

★ Disadvantages of Logical Representation →

- It has some restrictions, and can be challenging to work with.
- May not be very natural, inference may not be so efficient.

- _Semantic Network Representation_ →

→ Alternative of predicate logic for knowledge representation.

→ Knowledge is represented in the form of graphical networks where nodes represent the objects and arcs represent the relationship between those objects.

→ Semantic networks are easy to understand and can be easily extended.

→ Semantic representation has 2 types of relations mainly →
- "Is-a" relation (inheritance)
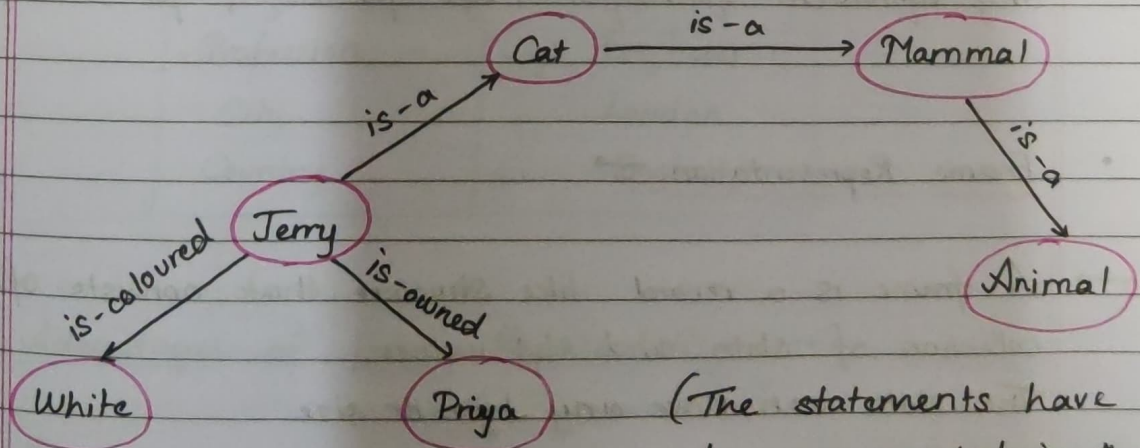- "Kind-of" relation

eg. Statements → a. Jerry is a cat
b. Jerry is a mammal
c. Jerry is owned by Priya
d. Jerry is white coloured
e. All mammals are animals.

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                    Cat ──── is-a ────→ Mammal
                   ↗                        ↘
               is-a                          is-a
                                               ↘
        is-coloured  Jerry                    Animal
              ↙          ↘ is-owned
        White            Priya
```

(The statements have been represented in the form of nodes and arcs above)

→ each object is connected to another object by some relation.

* <u>Advantages of Semantic network</u> →

→ They are a natural representation of knowledge
→ The networks are simple and easily understandable
→ They convey the meaning in a transparent manner

* <u>Drawbacks of semantic network</u> →

- High computational time, as we need to traverse the complete network tree to answer some questions, and in worst case scenario, after traversing the entire tree, we may find that the solution does not exist in the network.
- They try to model human-like memory, but in practice, it is not possible to build such vast semantic networks.
- These networks are not intelligent, they depend on the creator of the system.
- No standard definition for link names.
- The representation is inadequate as it does not have any equivalent quantifier, eg. "for all", "for some", "none" etc.

- <u>Frame Representation</u> →

→ A frame is a record like structure that consists of a collection of slots and slot values.
The slots can have any type or size.

→ The slots have names and values called <u>facets</u>.

→ Facets are the features of the frames.

→ A frame can contain any number of slots and a slot can contain any number of facets. Facets may have any number of values.

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

→ A frame system consists of a collection of frames which is connected. In a frame, the knowledge about an object or event can be stored together in the knowledge base.

eg. Entity → Peter
     Peter is an engineer, 25 y/o, lives in London, England. So the frame representation for this is:

Slots	Filter
Name	Peter
Age	25
Profession	Engineer
City	London
Country	England

★ Advantages of Frame Representation →

• It makes programming easier by grouping the related data
• It is very easy to add slots.
• It is easy to understand and visualize
• It is comparatively flexible and is used by many applicatio -ns in AI.
• It is easy to include default values, search for missing data and values

★ Disadvantages of Frame Representation →

- Inference mechanism is not smoothly processed
- It has a much generalized approach.

- **Production Rules →**

→ Production rules consist of (condition, action) pairs, which mean "if condition then action"

→ It has mainly 3 parts → Set of production rules
                                         Working memory
                                         The recognize - act cycle

→ Agent checks for the condition, if it exists, then the production rule fires and the corresponding action is carried out. This entire process is called recognize - act cycle.

→ The working memory stores description of the current state of problem solving. Rules can write knowledge into the working memory and this knowledge may match and fire other rules

→ In a new situation, multiple rules may fire together and this is called conflict set. Agent must select a rule from the set in this situation, and this is called conflict resolution.

eg. 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 the bus AND unpaid) THEN action (pay charges)
IF (bus arrives at destination) THEN action (get down
from bus)

★ Advantages of Production Rules →

- Expressed in natural language
- Highly modular, so can easily be removed, added or modified.

★ Disadvantages of Production Rules →

- No learning capabilities, it does not store the result of the problem for future uses.
- During program execution, many rules may be active, hence rule-based production systems are inefficient.