

UNIT III: Artificial Intelligence and Expert System

1. Semantic Nets

Definition

Semantic Nets (Semantic Networks) are a knowledge representation technique used in AI to represent relationships between concepts in the form of a graph consisting of **nodes** (concepts) and **edges** (relations).

- They depict objects, concepts, and their relationships visually.
- Used for **storing structured knowledge** and **reasoning** about it.

Features

- Nodes represent entities or concepts.
- Links (edges) represent relationships like "is-a," "part-of," or "has-property."
- Useful for inheritance of properties.
- Easy to visualize relationships.

Example

- Node "Bird" connected by "is-a" link to "Animal".
 - "Bird" connected by "can" link to "fly".
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2. Frames

Definition

Frames are data structures for representing stereotyped situations, similar to objects in OOP, consisting of **slots** (attributes) and **slot values**.

- Frames organize knowledge about concepts with default values and inheritance.

- Useful for representing real-world objects with attributes and relationships.

Features

- Slots can hold data values, procedures, or pointers to other frames.
- Supports inheritance where child frames inherit from parent frames.
- Frames provide context and defaults for missing information.

Example

A "Car" frame might have slots like:

- Color: red
 - Engine: V6
 - Owner: John
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3. Conceptual Dependency

Definition

Conceptual Dependency (CD) is a theory and representation scheme to express the **meaning of sentences** in natural language processing independent of the words used.

- It uses a fixed set of primitive actions and concepts to represent knowledge.
- Helps in understanding and reasoning about language semantics.

Features

- Uses standardized primitive actions like PTRANS (physical transfer), ATRANS (abstract transfer).
 - Reduces synonymy by abstracting sentence meaning.
 - Facilitates question answering and inference.
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4. Scripts

Definition

Scripts are structured representations of stereotyped sequences of events in particular contexts, used to model **routine activities** and **expectations**.

- Scripts allow AI to predict what happens next or fill in missing information in stories.

Features

- Organized as a series of scenes and actions.
- Includes roles, props, and conditions.
- Helps in natural language understanding and story comprehension.

Example

Restaurant script includes scenes: entering, ordering, eating, paying, leaving.

5. Monotonic Reasoning

Definition

Monotonic reasoning is a form of logical reasoning where **adding new knowledge does not reduce the set of conclusions** previously drawn.

- Once something is derived as true, it remains true even if more information is added.

Features

- Guarantees consistency and soundness.
- Typical in classical logic systems.

Limitations

- Cannot handle situations where new evidence invalidates previous conclusions.
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6. Logical Reasoning

Logical reasoning is the process of deriving conclusions from premises through formal logical methods.

Types of Logical Reasoning:

- Induction
 - Default Reasoning
 - Minimalist Reasoning
 - Statistical Reasoning
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7. Induction

Definition

Inductive reasoning involves generalizing from specific instances to broader rules or conclusions.

- Opposite of deductive reasoning.
- Forms the basis for learning and hypothesis generation.

Features

- Results are probable, not guaranteed.
- Used in machine learning and data mining.

Example

Observing that the sun rises every morning and concluding it will rise tomorrow.

8. Default Reasoning

Definition

Default reasoning allows reasoning with assumptions that hold true **by default**, but can be retracted if contradictory information appears.

- Supports reasoning with incomplete information.

Features

- Enables AI to make plausible conclusions.
- Deals with exceptions flexibly.

Example

"Birds normally fly" is a default assumption, but penguins (exception) do not fly.

9. Minimalist Reasoning

Definition

Minimalist reasoning tries to infer the least amount of information necessary to explain observations or reach conclusions.

- Aims for simplicity and avoiding unnecessary assumptions.

Features

- Focus on parsimony.
 - Avoids overcomplicating models.
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10. Statistical Reasoning

Definition

Statistical reasoning uses probabilistic methods to reason under uncertainty based on frequency and likelihood.

- Involves calculating probabilities to make informed guesses.
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11. Bayes' Theorem

Definition

Bayes' Theorem provides a mathematical formula to update the probability of a hypothesis based on new evidence.

- : Probability of hypothesis given evidence .
- : Probability of evidence given hypothesis.
- : Prior probability of hypothesis.
- : Probability of evidence.

Importance

- Foundation of Bayesian inference and probabilistic AI.
- Used in spam filtering, medical diagnosis, etc.

12. Certainty Factors

Definition

Certainty Factors (CF) are used in expert systems to represent the degree of belief in a hypothesis, based on uncertain or incomplete evidence.

- CF ranges between -1 (false) and +1 (true).
- Helps combine evidence from multiple rules.

13. Dempster-Shafer Theory

Definition

A general framework for reasoning with uncertainty that allows combining evidence from different sources and calculating belief levels.

- Extends Bayesian reasoning by allowing belief intervals instead of precise probabilities.

Features

- Uses **belief functions** and **plausibility functions**.
 - Handles ignorance explicitly.
 - Useful in sensor fusion, fault diagnosis.
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14. Fuzzy Logic

Definition

Fuzzy Logic is a form of multi-valued logic that deals with reasoning that is approximate rather than fixed and exact.

- Handles **vague or imprecise information**.
- Unlike binary logic (true/false), fuzzy logic variables have a degree of truth ranging between 0 and 1.

Features

- Uses **membership functions** to define fuzzy sets.
- Enables reasoning with linguistic terms like “hot,” “cold,” “high,” “low.”
- Widely used in control systems, decision-making, and AI.

Example

Temperature could be “somewhat hot” with membership 0.7 and “cool” with membership 0.3.
