Assignment No: - 3

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Problem Statement

Perform parsing of a family tree using a knowledge base to infer relationships like parent, child, grandparent, and sibling.

Objectives

- To understand knowledge representation in Artificial Intelligence.
- To represent family relationships in the form of a knowledge base.
- To parse the knowledge base and derive new facts (inference).
- To explore the use of logic-based reasoning in AI.

Theory

Knowledge Base in AI

A Knowledge Base (KB) is a collection of facts and rules about the world. It consists of:

1. Facts: Basic statements about objects and relationships.

   - Example: *Parent(John, Mary)* means "John is the parent of Mary".

2. Rules: Logical implications used for inference.

   - Example: $Parent(x, y) \land Parent(y, z) \rightarrow Grandparent(x, z)$.

Knowledge bases are used with reasoning algorithms to derive new knowledge from existing facts.

Family Tree Representation

A family tree is a hierarchical structure representing relationships among family members.

- Entities: Individuals (e.g., John, Mary, David).
- Relations: Parent, Child, Grandparent, Sibling, etc.

Example Facts (KB):

- Parent(John, Mary)
- Parent(Mary, David)

Rules for inference:

- If *Parent(x, y)* then *Child(y, x)*.
- If *Parent(x, y) ∧ Parent(y, z)* then *Grandparent(x, z)*.
- If *Parent(x, y) ∧ Parent(x, z) ∧ y ≠ z* then *Sibling(y, z)*.

Parsing the Family Tree

Parsing means analyzing and deriving relationships using the knowledge base.

Steps:

1. Define initial facts (who is parent of whom).
2. Define inference rules (logic for child, grandparent, sibling).
3. Apply reasoning on KB to infer hidden relationships.
4. Display all derived relationships (e.g., grandparents, siblings).

Methodology

1. Represent family relations in the form of predicates (Parent, Child, Sibling).
2. Store facts in the knowledge base.
3. Apply logical inference rules.
4. Parse the tree to extract relations like:
   - Parent → Child
   - Grandparent → Grandchild
   - Siblings

Advantages

- Easy to represent hierarchical data.
- Supports logical reasoning and inference.
- Scalable to large family trees.

Limitations

- Requires well-defined rules.
- Can become complex for large knowledge bases.
- Inference may be computationally expensive.

Applications

- Genealogy and ancestry tracking.
- Medical domain (genetic inheritance analysis).
- AI systems for reasoning with family or social networks.
- Knowledge-based expert systems.

Example Rule-Based Representation

Facts:

- Parent(John, Mary)
- Parent(Mary, David)
- Parent(John, Alex)

Rules:

1. Parent(x, y) $\rightarrow$ Child(y, x)
2. Parent(x, y) $\land$ Parent(y, z) $\rightarrow$ Grandparent(x, z)
3. Parent(x, y) $\land$ Parent(x, z) $\land$ y $\neq$ z $\rightarrow$ Sibling(y, z)

Inferred Knowledge:

- Child(Mary, John)
- Grandparent(John, David)
- Sibling(Mary, Alex)

Conclusion

Parsing of a family tree using a knowledge base demonstrates how knowledge representation and inference in AI can be used to derive new relationships from existing facts. This approach is widely used in expert systems, genealogy applications, and semantic reasoning engines.