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**Assignment 3**

**Problem Statement:** Perform Parsing of Family Tree Using Knowledge Base

**1. Introduction**

A **Family Tree** represents relationships among individuals, such as parents, children, siblings, and grandparents. In Artificial Intelligence, this structure can be modeled and reasoned about using a **Knowledge Base (KB)** — a collection of facts and rules that describe relationships in logical form.

By representing family relationships as **facts** (e.g., *father(John, Mary)*) and **rules** (e.g., *grandfather(X, Y) :- father(X, Z), father(Z, Y)*), we can use **inference mechanisms** to deduce new knowledge, such as finding grandparents, siblings, or cousins.

This experiment demonstrates how to parse and infer family relationships using a knowledge-based system, showing the power of logic-based reasoning in AI.

**2. Objective**

The main objectives of this experiment are:

* To represent family relationships using **facts** and **rules** in a **Knowledge Base**.
* To perform **parsing and reasoning** on the family data to derive new relationships.
* To implement logical inference to find relations such as **grandfather, grandmother, siblings, cousins, etc.**
* To understand how a **Knowledge Representation System (KRS)** works in reasoning tasks.

**3. Theory**

**3.1 Knowledge Representation**

**Knowledge Representation (KR)** is a method used in AI to store and organize information in a way that computers can process it to perform reasoning.  
In this experiment, we use a **declarative representation**, where we define **facts** (known truths) and **rules** (logical relationships between facts).

**Example of Facts:**

father(John, Mary)

mother(Linda, Mary)

father(John, Alex)

mother(Linda, Alex)

**Example of Rules:**

sibling(X, Y) :- father(Z, X), father(Z, Y), X ≠ Y.

grandfather(X, Y) :- father(X, Z), father(Z, Y).

Here:

* father(John, Mary) means John is the father of Mary.
* sibling(X, Y) rule defines that X and Y are siblings if they share the same father and are not the same person.

**3.2 Parsing of Family Tree**

Parsing involves analyzing input data (family relationships) and converting them into a structured form that can be processed by a computer.  
The **Family Tree** is parsed by identifying and storing relationships such as father, mother, child, and spouse in the knowledge base.

The relationships can be expressed as:

* **Father relation:** father(X, Y) → X is the father of Y
* **Mother relation:** mother(X, Y) → X is the mother of Y
* **Parent relation:** parent(X, Y) → X is the parent of Y
* **Grandparent relation:** grandparent(X, Y) → X is the parent of Y’s parent
* **Sibling relation:** sibling(X, Y) → X and Y share the same parents
* **Cousin relation:** cousin(X, Y) → parents of X and Y are siblings

By applying these rules, the system can **infer** indirect relationships not explicitly stored.

**3.3 Inference Mechanism**

An **Inference Engine** is used to draw logical conclusions from known facts and rules in the Knowledge Base.  
Two common reasoning strategies are:

1. **Forward Chaining:**  
   Starts with known facts and applies inference rules to extract more data until the goal is reached.  
   Example: If we know John is the father of Alex, and Alex is the father of Sam, we can infer John is the grandfather of Sam.
2. **Backward Chaining:**  
   Starts with a goal (query) and works backward to determine which facts support it.  
   Example: To check if John is the grandfather of Sam, the system verifies if there exists a chain of father relationships linking them.

**3.4 Example Knowledge Base**

**Facts:**

father(john, mary)

father(john, alex)

mother(linda, mary)

mother(linda, alex)

father(alex, sophia)

**Rules:**

sibling(X, Y) :- father(Z, X), father(Z, Y), X ≠ Y.

grandfather(X, Y) :- father(X, Z), father(Z, Y).

grandmother(X, Y) :- mother(X, Z), father(Z, Y).

parent(X, Y) :- father(X, Y).

parent(X, Y) :- mother(X, Y).

**Query Examples:**

* Find siblings: sibling(mary, alex)
* Find grandfather: grandfather(john, sophia)

The inference engine will evaluate these rules and return logical results based on the knowledge base.

**4. Conclusion**

In this experiment, we successfully **parsed and represented a family tree** using a **Knowledge Base** consisting of facts and inference rules.  
By applying logical reasoning (forward or backward chaining), we derived new relationships such as siblings and grandparents that were not explicitly stored.

This experiment illustrates the strength of **Knowledge Representation and Reasoning (KRR)** in Artificial Intelligence — enabling machines to infer, deduce, and represent human-like understanding of relationships.  
Such approaches are widely used in **expert systems**, **semantic networks**, and **AI chatbots** to model and reason about real-world knowledge.