K. J. Somaiya College of Engineering, Mumbai-77

Batch: C1	**Roll No.: 16010122323**
Experiment / assignment / tutorial No. 3	
Grade: AA / AB / BB / BC / CC / CD /DD	
Signature of the Staff In-charge with date	

Title: Implementation of Goal based agent architecture using PROLOG.

Objective: To use the concepts of knowledge engineering to design and solve moderate complex problem.

Expected Outcome of Experiment:

Course Outcome	After successful completion of the course students should be able to
CO1	Design AI solution with appropriate choice of agent architecture
CO3	Represent and formulate the knowledge to solve the problems using various reasoning techniques

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Books/ Journals/ Websites referred:

1. **https://www.csupomona.edu/~jrfisher/www/prolog_tutorial/contents.html**
2. **http://www.csupomona.edu/~jrfisher/www/prolog_tutorial/pt_framer.html**
3. **http://www.doc.gold.ac.uk/~mas02gw/prolog_tutorial/prologpages/**
4. **http://classes.soe.ucsc.edu/cmps112/Spring03/languages/prolog/PrologIntro.pdf**
5. **"Prolog: Programming for Artificial Intelligence" by Ivan Bratko, Pearson education Publications**
6. **"Artificial Intelligence: a Modern Approach" by Russel and Norving, Pearson education Publications**
7. **"Artificial Intelligence" By Rich and knight, Tata Mcgraw Hill Publications**

Pre Lab/ Prior Concepts:

Agents, Agent Architecture, Programming with PROLOG

Historical Profile:

Knowledge is vast, uncertain and continuously changing. These properties of knowledge make it difficult to arrive at a result. A murder mystery is a kind of situation which depicts the uncertain nature of knowledge and also emphasizes the need of choosing right clauses from entire knowledgebase to make a decision. He goal based agent architecture and some knowledge engineering can help in solutioning of such problems.

The logical agents are complex but they can reason and learn from the actions and new precepts. They are less like acting and think like humans but more like acting and thinking rational agents.

Knowledge and reasoning play a crucial role in dealing with partially observable environments. A knowledge based agent can combine the general knowledge with current percept to infer the hidden aspects of the current state prior to selecting actions.

New Concepts to be learned:

Knowledge engineering, implementing complex agent architecture, uncertainty in knowledge.

The Knowledge Engineering Process

1. Identify the task
2. Assemble the relevant knowledge
3. Decide on vocabulary of predicates, functions and constants
4. Encode general knowledge about the domain
5. Encode description of specific problem instance
6. Pose queries to the inference procedure and get answers
7. Debug the knowledge base

Algorithm for KB-Agent:

```
function KB-AGENT(percept) returns an action
  static: KB, a knowledge base
          t, a counter, initially 0, indicating time
  TELL(KB, MAKE-PERCEPT-SENTENCE(percept, t))
  action ← ASK(KB, MAKE-ACTION-QUERY(t))
  TELL(KB, MAKE-ACTION-SENTENCE(action, t))
  t ← t + 1
  return action
```

Problem Statement:

In a mysterious case, the renowned author Harlan Thrombey is found dead under suspicious circumstances. Investigators are tasked with identifying the criminal responsible for his death. However, there are multiple suspects with various motives, and the investigation has found crucial evidence at the scene. The suspects are all connected to Harlan in different ways, and each of them has varying alibis and possible motives. To solve the case, we need to identify the criminal based on the following conditions:

1. **Motives: Each suspect has a potential motive for killing Harlan, whether it is money, revenge, control, or another personal reason.**
2. **Evidence: Key evidence, such as fingerprints and poison, has been found at the scene of the crime. One suspect's fingerprints were found on a knife, which was present at the crime scene.**
3. **Alibis: Not all suspects have a solid alibi, meaning some may have been in a position to commit the crime. A solid alibi could involve being with the victim or in a secure location at the time of the murder.**
4. **Connections: The suspects are all related to Harlan in various ways (family members, employees, etc.), and this relationship could play a key role in understanding their motives and opportunity.**

Objective:

Your task is to use the available facts (motives, evidence, alibis, and connections) to identify the criminal responsible for Harlan Thrombey's death. The criminal will be the suspect who:

- **Has a clear motive for the crime.**
- **Was connected to Harlan.**
- **Has been identified by evidence (such as fingerprints on a weapon).**
- **Does not have a solid alibi at the time of the murder.**

Requirements:

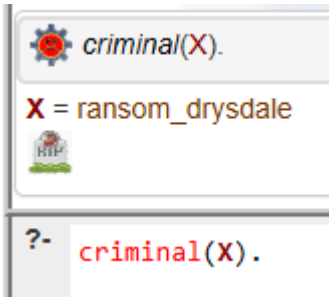
1. **Implement a rule-based system using Prolog to analyze the available facts.**
2. **Derive the criminal based on the conditions mentioned above.**

Example:

Given the facts provided, your program should be able to run the query:

prolog

```
criminal(X).
```



Knowledge Engineering steps applied to chosen problem:

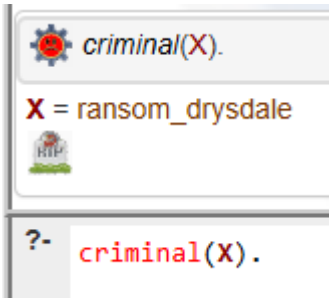
```
% Facts related to the suspects and their motives

motive(marta_cabrera, money).

motive(walt_thrombey, control).

motive(lydia_thrombey, money).

motive(ransom_drysdale, revenge).  % Ransom has a clear motive for
revenge

motive(jacob_thrombey, money).

motive(joanie_thrombey, money).

motive(fran, blackmail).  % Fran was possibly blackmailing someone



% List of witnesses (including additional family members and Fran)

witness(marta_cabrera).

witness(walt_thrombey).

witness(lydia_thrombey).

witness(ransom_drysdale).

witness(jacob_thrombey).
```

```
witness(joanie_thrombey).

witness(fran).



% Evidence found at the scene (including evidence for Fran's death)

evidence(knife, ransom_drysdale).   % Ransom's fingerprint on the
knife

evidence(fingerprint, ransom_drysdale).  % Ransom's fingerprints on
the knife

evidence(venom, fran).   % Poison found in Fran’s system (for her
death)

evidence(venom, harlan).   % Poison found in Harlan’s system (for
Harlan's death)



% Alibis for the suspects (no timeframes)

alibi(marta_cabrera, room_with_harlan).

alibi(walt_thrombey, talking_to_harlan).

alibi(lydia_thrombey, in_her_car).

alibi(jacob_thrombey, in_his_office).

alibi(joanie_thrombey, at_a_spa).



% Suspects

suspect(harlan_thrombey).

suspect(marta_cabrera).

suspect(walt_thrombey).

suspect(lydia_thrombey).

suspect(ransom_drysdale).

suspect(jacob_thrombey).
```

```
suspect(joanie_thrombey).


% Connections of suspects to Harlan
connected_to_harlan(marta_cabrera, nurse).
connected_to_harlan(walt_thrombey, son).
connected_to_harlan(lydia_thrombey, daughter).
connected_to_harlan(ransom_drysdale, grandson).
connected_to_harlan(jacob_thrombey, son).
connected_to_harlan(joanie_thrombey, daughter_in_law).
connected_to_harlan(fran, maid).


% Rule to check if a suspect has a solid alibi
solid_alibi(X) :-
    alibi(X, room_with_harlan),          % Solid if with Harlan
    alibi(X, talking_to_harlan),        % Solid if talking to Harlan
    alibi(X, in_his_office),            % Solid if in their office
    alibi(X, at_a_spa).                 % Solid if at a spa



% Rule to find the criminal based on motive, evidence, alibi, and
connection to the victim
criminal(X) :-
    suspect(X),
     motive(X, _),                      % The suspect must have a
motive
```

```
    evidence(knife, X),                % Only check evidence for
Harlan's murder (knife evidence)

    \+ solid_alibi(X),                % The suspect must not have a
solid alibi

    connected_to_harlan(X, _).              % The suspect must be
connected to the victim (Harlan)
```

Output:



Agent Architecture *(Justify the blocks)*:

Perception Module:

- **Purpose: Ingests and preprocesses the input data (facts about suspects, victim, weapon, motives, and weapon usage).**
- **Justification: It ensures that all available evidence is correctly captured and transformed into a format suitable for reasoning (i.e., Prolog facts).**

Knowledge Base (KB):

- **Purpose: Stores all domain-specific knowledge including the suspects, victim details, weapon facts, and motives.**
- **Justification: Acts as the repository for the structured data which the inference engine uses for deducing the murderer. A well-organized KB is crucial for efficient reasoning.**

Inference Engine:

- **Purpose: Applies logical rules (such as the `committed_murder/1` predicate) to the data in the KB to derive conclusions.**
- Justification: It is the core reasoning component that performs deductions and verifies if a suspect meets the conditions to be considered the murderer.

Decision-Making Module:

- Purpose: Analyzes the outcomes produced by the inference engine to decide on the final conclusion or set of conclusions.

- Justification: This module interprets the logical outcomes in context and may apply additional business rules or heuristics (e.g., handling cases where multiple suspects qualify).

Explanation/Justification Module:

- Purpose: Provides a trace or explanation of how the conclusion was reached (i.e., which rules fired and which facts were used).
- Justification: Enhances transparency and trust in the system by allowing users to understand the reasoning process behind the conclusion.

User Interface / Communication Module:

- Purpose: Allows human users (investigators, analysts, or end-users) to input queries and receive explanations.
- Justification: A user-friendly interface is essential for interacting with the agent and for integrating human insight into the decision-making process.

By integrating these modules, the agent becomes capable of automating the reasoning process involved in the murder investigation while also providing clear explanations and the flexibility to incorporate additional evidence or constraints if needed.

Team Members:

1. **Suhurud**
2. **Vedansh**

Post Lab Objective Questions

1. Which is not a Goal-based agent?

a. Inference
b. Search
c. Planning
d. Conclusion
e. Dynamic search.

Answer: d. conclusion

2. Which were built in such a way that humans had to supply the inputs and interpret the outputs?

a. Agents
b. Sensor
c. AI System
d. Actuators

Answer: c. ai system

Post Lab Subjective Questions

Explain the role of PEAS and task environment in choosing the agent architecture. Justify your answer with an example.

- **Subjective Answer: PEAS (Performance measure, Environment, Actuators, and Sensors) is a framework that helps in designing intelligent agents. It provides a clear outline for understanding what the agent needs to do, what it interacts with, and how it perceives and acts on the environment. The task environment refers to the external conditions under which the agent operates, including factors such as uncertainty, dynamics, and complexity.**
- **The choice of agent architecture is heavily influenced by both PEAS and the task environment. For example, in a self-driving car scenario, the PEAS components might include:**
  - **Performance measure: Safe and efficient navigation**
  - **Environment: Roads, traffic, pedestrians**
  - **Actuators: Steering, brakes, accelerator**
  - **Sensors: Cameras, lidar, radar**
- **The agent architecture needs to be capable of interpreting sensor data (from cameras or lidar), processing it to make decisions (e.g., turning or stopping), and then actuating these decisions (e.g., turning the steering wheel or applying brakes). The task environment of a self-driving car is dynamic and uncertain, requiring an architecture that can handle real-time decision-making and learning from the environment. This is why the choice of agent architecture (e.g., reactive, deliberative, hybrid) is dependent on both the task's PEAS components and the specifics of the environment.**
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