Lesson 5: Knowledge Engineering

5.1 Introduction

Knowledge Engineering is the process of imitating how a human expert in a specific domain would act and take decisions. It looks at the metadata (information about a data object that describes characteristics such as content, quality, and format), structure and processes that are the basis of how a decision is made or conclusion reached. Knowledge engineering attempts to take on challenges and solve problems that would usually require a high level of human expertise to solve.

Information and knowledge involved in a knowledge-intensive problem domain, in order to construct a system that can be used for decision making in the problem domain.

5.1.1 Knowledge Engineering Process

The knowledge engineering process include below stages:

1. Knowledge Acquisition- Involves extracting knowledge from various sources.
2. Knowledge Validation- The knowledge is validated and verified until its quality is acceptable. Test cases results are usually shown to the expert to verify the accuracy of the expert system.
3. Knowledge Representation- Designing and implementing programs for holding the knowledge in the form of a knowledge base.
4. Inferencing- Involves the design of a software to enable the computer to make inferences based on the knowledge and specific facts of the problem.
5. Explanation and justification- Designing and implementing programs to explain questions such as how and why.

5.2 Approaches to developing KBS

5.2.1 Expert Systems

Expert systems are among the earliest and most well-known forms of KBS. They mimic the decision-making process of human experts by encoding their knowledge in the form of rules or knowledge bases. Examples include medical diagnosis systems and financial advisory systems.

5.2.2 Rule-Based Systems

These systems use condition-action rules, allowing them to make decisions based on the satisfaction of specific conditions. Rule-based systems are widely used in various applications, including business rule engines and expert systems.

5.2.3 Case-Based Reasoning

In this approach, knowledge is organized into cases, each representing a problem or situation and its solution. New problems are solved by finding and adapting solutions from similar cases.

5.2.4 Ontologies

Ontologies provide a structured way to represent knowledge and domain-specific concepts. They are essential for knowledge engineering in fields like the Semantic Web and natural language processing.

5.3 Production systems & Logical problem solving

a) Production Systems: These are knowledge-based systems that use production rules.

A production rule consists of an antecedent (condition) and a consequent (action).

Production systems follow a match-resolve-execute cycle, where rules that match the current state are executed, leading to problem-solving and decision-making.

b) Logical Problem Solving: KBS often use logic as the foundation for problem-solving.

This involves making deductions, inferences, and decisions based on logical rules and the truth values of propositions.

Propositional and first-order logic are common choices for representing knowledge in a logical form.

5.4 Uncertainty representation

Uncertainty in KBS: Real-world knowledge is often incomplete or imprecise, and this uncertainty needs to be represented.

Techniques like probability theory are used to assign probabilities to different outcomes, while fuzzy logic allows for handling imprecise information.

Bayesian networks are also utilized for modeling and managing uncertainty in KBS.

5.5 Planning agents

Planning in KBS: Planning agents are used to generate sequences of actions to achieve specific goals. They rely on knowledge about the domain, including the available actions, the initial state, and the desired outcomes.

Automated planning systems are used in applications like robotics, scheduling, and logistics.

5.6 Learning agents

Learning in KBS: Learning agents are KBS that improve their performance through experience.

This can be achieved through machine learning techniques like supervised learning, where the system is trained on labeled data, or reinforcement learning, where it learns by interacting with its environment and receiving feedback.

Learning allows KBS to adapt to changing circumstances and improve their decision-making over time.

Lesson 5: Review Questions

1. Explain the skills, professionalism and standards required of a knowledge engineer.
2. Briefly discuss how Knowledge engineering is being used in day to day life and its advantages
3. Explain difference between KE and AI?
4. Explain the following terminologies used in KE;
    a. Domain
    b. Task
    c. Agent