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Knowledge Representation Approaches in Artificial Intelligence

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Abstract: ***Knowledge representation (KR) is the study of how knowledge and facts about the world can be represented, and what kinds of reasoning can be done with that knowledge. It is a medium for pragmatically efficient computation, and the computational environment in which thinking is accomplished. The knowledge representation is used to solve the problems encountered in artificial intelligence. KR is a field of artificial intelligence that focuses on designing computer representations that capture information about the world that can be used to solve complex problems. Knowledge representation techniques support the representation of knowledge in a structured form which is suitable for computer processing. Today's knowledge representation system requires to design a general system which is applicable to represent declarative as well as procedural knowledge.***

Keyword: artificial intelligence, knowledge, knowledge representation, relational knowledge, Inheritable knowledge

1. Introduction

Artificial intelligence (AI) is accomplished by studying how human brain thinks and how humans learn, decide, and work while trying to solve a problem, and then using the outcomes of this study as a basis of developing intelligent software and systems. Knowledge representation and reasoning is the area of AI concerned with how knowledge can be represented symbolically and manipulated in an automated way by reasoning programs. Knowledge representation is the study of – how knowledge and facts about the world can be represented, and – what kinds of reasoning can be done with that knowledge. The architecture of Knowledge Representation system is capable to integrate different type of knowledge. The object of knowledge representation is to express knowledge in computer-tractable form, such that it can be used to help intelligent system perform well. Key aspects of knowledge representation languages is syntax, semantics and computational aspect. Many knowledge representation technique rely on some variant of logic like propositional logic, first order logic and temporal logic. It is a fragmentary theory of intelligent reasoning, expressed in terms of three components i.e. the representation's fundamental conception of intelligent reasoning, the set of inferences the representation sanctions; and the set of inferences it recommends. Knowledge representation is most desirable area of research to make the system intelligent. This paper discusses a kind of knowledge to represent in AI, categories of knowledge representation schemes, properties **of** knowledge representation, and different approaches to knowledge representation.

2. Kind of Knowledge to Represent in AI

Knowledge representation and knowledge engineering are central to AI research. Many of the problems machines are expected to solve will require extensive knowledge about the world. AI need to represent objects, properties, categories and relations between objects; situations, events, states and time; causes and effects and knowledge about knowledge. Ontology indicates a representation of "what exists" which includes the set of objects, relations, concepts and so on that the machine knows about. AI supports following type of knowledge to be represented.

- Objects: It represents facts about knowledge in our world domain like guitars have strings.
- Events: It represent the actions that occur like playing guitar.
- Performance: It represents behavior which involves knowledge about how to do things.
- Meta-knowledge: It is knowledge about what we know. It includes facts and representation of facts.

3. Categories of Knowledge Representation Schemes

According to Mylopoulos and Levesque (1984) knowledge representation schemes are categorized into the following four categories:

1) **Logical Representation Scheme :** This class of representation uses expressions in formal logic to represent a knowledge base. Inference rules and proof procedures apply this knowledge to problem solving. First order predicate calculus is the most widely used logical representation scheme, and PROLOG is an ideal programming language for implementing logical representation schemes.
2) **Procedural Representation Scheme:** Procedural scheme represents knowledge as a set of instructions for solving a problem. In a rule-based system, for example, an if then rule may be interpreted as a procedure for searching a goal in a problem domain: to arrive at the conclusion, solve the premises in order. Production systems are examples of a procedural representation scheme.
3) **Network Representation Scheme:** Network representation captures knowledge as a graph in which the nodes represent objects or concepts in the problem domain and the arcs represent relations or associations between them. Examples of network representations include semantic network, conceptual dependencies and conceptual graphs.
4) **Structured Representation Scheme:** Structured representation languages extend networks by allowing each node to be a complex data structure consisting of named slots with attached values. These values may be

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simple numeric or complex data, such as pointers to other frames, or even procedures.

Properties of Knowledge Representation (KR)
A good system for the representation of knowledge in a particular domain should possess the following four properties:

1) **Representational Accuracy:** The ability to represent all kind of required knowledge.
2) **Inferential Adequacy:** The ability to manipulate the representational structures to produce new knowledge corresponding to existing structure.
3) **Inferential Efficiency:** The ability to direct the inferential knowledge mechanism into the most productive directions by storing appropriate guides.
4) **Acquisitional Efficiency-** The ability to acquire the new knowledge easily using automatic methods. The simplest case involves direct insertion by a person of new knowledge into the database.

4. Approaches to Knowledge Representation

There are four approaches to knowledge representation as discussed below:

i. Simple Relational Knowledge: It is the simplest way of storing facts which uses the relational method, and each fact about a set of the object is set out systematically in columns. This approach of knowledge representation is famous in database systems where the relationship between different entities is represented and has little opportunity for inference.

Table 1: Simple Relational Knowledge Representation.

Player	Weight	Age
Player1	65	23
Player2	58	18
Player3	75	24

ii. Inheritable Knowledge: In the inheritable knowledge approach, all data must be stored into a hierarchy of classes. All classes should be arranged in a generalized form or a hierarchal manner. In this approach, we apply inheritance property and elements inherit values from other members of a class. This approach contains inheritable knowledge which shows a relation between instance and class, and it is called instance relation. Every individual frame can represent the collection of attributes and its value. Objects and values are represented in boxed nodes and use arrows which point from objects to their values.

Example of Inheritable Knowledge:

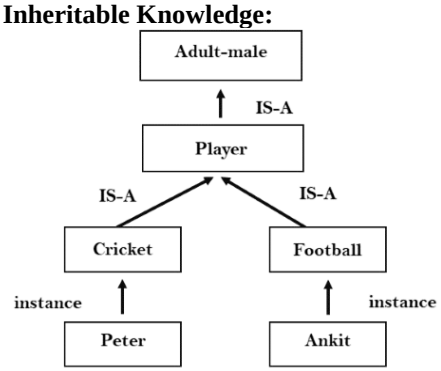

Figure 1: Inheritable Knowledge

iii. Inferential Knowledge: Inferential knowledge approach represents knowledge in the form of formal logics where properties are inherited from more general concepts. This knowledge generates new information from the given information. This new information does not require further data gathering from source, but does require analysis of the given information to generate new knowledge. This approach can be used to derive more facts. For example let's suppose there are two statements:

Marcus is a man
All men are mortal

Then it can represent as:
man(Marcus)
∀x = man (x) ----> mortal (x)s

iv. Procedural Knowledge: Procedural knowledge approach uses small programs and codes which describes how to do specific things, and how to proceed. It uses If-Then rule which can be used to represent heuristic or domain-specific knowledge. It uses small programs that know how to do specific things and how to proceed. For example, a parser in a natural language understand that has the knowledge that a noun phrase may contain articles, adjectives and nouns. It is represented by calls to routines that know how to process articles, adjectives and nouns.

5. Conclusion

Goal of knowledge representation is that **k**nowledge representation techniques should be rich enough to express the knowledge needed to solve the problem and it should be as close to the problem as possible like compact, natural and maintainable and amenable to efficient computation . The ease with which a problem can be solved depends upon knowledge representation scheme. The effective representation of domain knowledge is considered to be the keystone to the success of AI programs .To construct an intelligent computer system, a primary consideration is to represent large amounts of knowledge that allows effective use and efficiently organizing information to facilitate making the recommended inferences. Granularity of knowledge representation can effect its usefulness, that is, how detailed the knowledge need to be represented. This will depend on the application and the function to which the knowledge will be considered and utilized.

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