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## A MANUSCRIPT OF KNOWLEDGE REPRESENTATION

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### Abstract

This paper describes the Knowledge representation and how it is used in artificial intelligence systems such as (Expert Systems, Hybrid intelligence systems, Neural networks, etc..) to construct a robust systems without any bugs and issues, it also depicts the knowledge representation categories (Implicit and Explicit) and types (Rules, Ontology, Frames, Semantic Networks and Logic), who is the person that deals with knowledge to analyze (Knowledge Engineer)?, how to build a knowledge base to use in systems? And what are the issues that will face the engineer?

**Keywords:** Artificial intelligence, Knowledge representation , Knowledge base

### Introduction

Artificial intelligence (AI) may be defined as the branch of computer science that is concerned with the automation of intelligent behavior, the principles include the data structures used in knowledge representation (KR), the algorithms needed to apply that knowledge, and the languages and programming techniques used in their implementation [1]. The definition is: There are a number of cognitive tasks that people do easily often, indeed, with no conscious thought at all but that it is extremely hard to program on computers. Archetypal examples are vision, natural language understanding, and real-world reasoning"; Artificial intelligence, is the study of getting computers to carry out these tasks [2].

During the last decade, ontology have become an important means for knowledge interchange and integration. After the vision of the semantic web was broadcasted, ontology became a synonym for the solution to many problems concerning the fact that computers do not understand human language. Ontology is recognized in different research fields and area for knowledge representation and information retrieval and extraction. Ontology is defined as a

conceptualization which means entities and relationships between them. These are implicit or explicit conceptualization for each information base. Ontology provides a means to classify the things, which are exists and also organized in a systematic manner which analyzes the existing things in a structured way. Ontology is a type of knowledge that is used by a knowledge based systems [3]. Section 2 is about Knowledge categories, in section 3 Knowledge representation is discussed, section 4 explains knowledge base and in section 5 an experiment is explained.

### **Knowledge Categories**

There are two types of knowledge that can be used in Artificial Intelligence Systems:

- Implicit, it's often unsuspected and additionally its explication in the form of words, numbers or symbols is not easy and often not even possible [4], implicit knowledge is “know-how” and relates to the process of learning, understanding and applying information. Implicit knowledge constitutes everything that an individual knows, such as their professional insights, judgments, intuition and the special knowledge known by experts. It's also the subjective knowledge found in individual employees and at all levels of an organization (team, department, enterprise-level, etc.) It is complex, hidden, highly individualized, hard to formalize, and hard to share [5].
- Explicit, explicit knowledge must bind a community together in the form of an idea, action, or product symbol. This information must then be turned implicit to bind a greater community to create a trend that will move the idea to greater acceptance through continually attracting new members [6], explicit knowledge is “know-what” and is articulated, codified, and communicated information. Explicit knowledge includes documents, such as case decisions, memoranda, speeches, books, manuals, process diagrams, mathematical expressions and specifications.

### **Knowledge Representation**

It is an area of AI research which is aimed at representing knowledge in symbols to facilitate inference from those knowledge elements, creating new elements of knowledge, whereas knowledge (is a progression from data to information, from information to knowledge and

knowledge to wisdom) and representation ( is a combination of syntax, semantics and reasoning) [7]. Knowledge progression depicts how the data is moved to many phases as shown in Fig. (1)

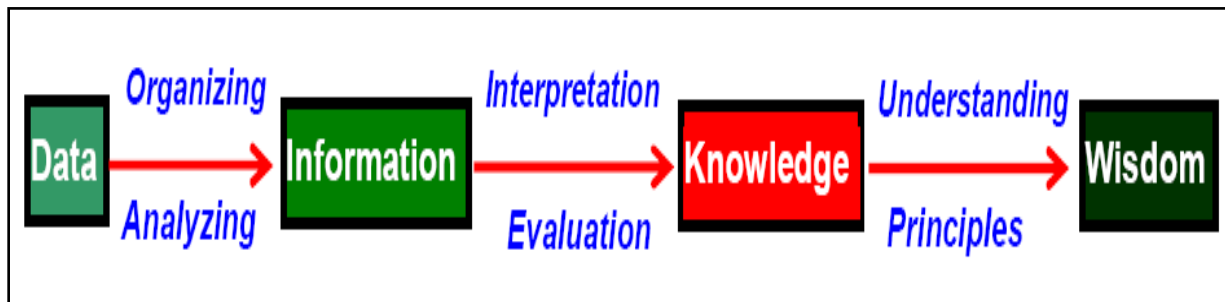


Fig. 1. Knowledge progress

**Data** is viewed as collection of disconnected facts. Example: It is raining.

**Information** emerges when relationships among facts are established and understood; “who”, “what”, “where” and “when”. Example: The temperature dropped 15 degrees and then it started raining.

**Knowledge** emerges when relationships among patterns are identified and understood; "how". Example: If the humidity is very high and the temperature drops substantially, then atmospheres are unlikely to hold the moisture, so it rains.

**Wisdom** is the pinnacle of understanding, uncovers the principles of relationships that describe patterns. "Why". Example: Encompasses understanding of all the interactions that happen between raining, evaporation, air currents, temperature gradients, changes, and raining [8].

Knowledge model tells, that as the degree of “connectedness” and “understanding” increase, we progress from *data* through information and knowledge to wisdom [9], see Fig. (2).

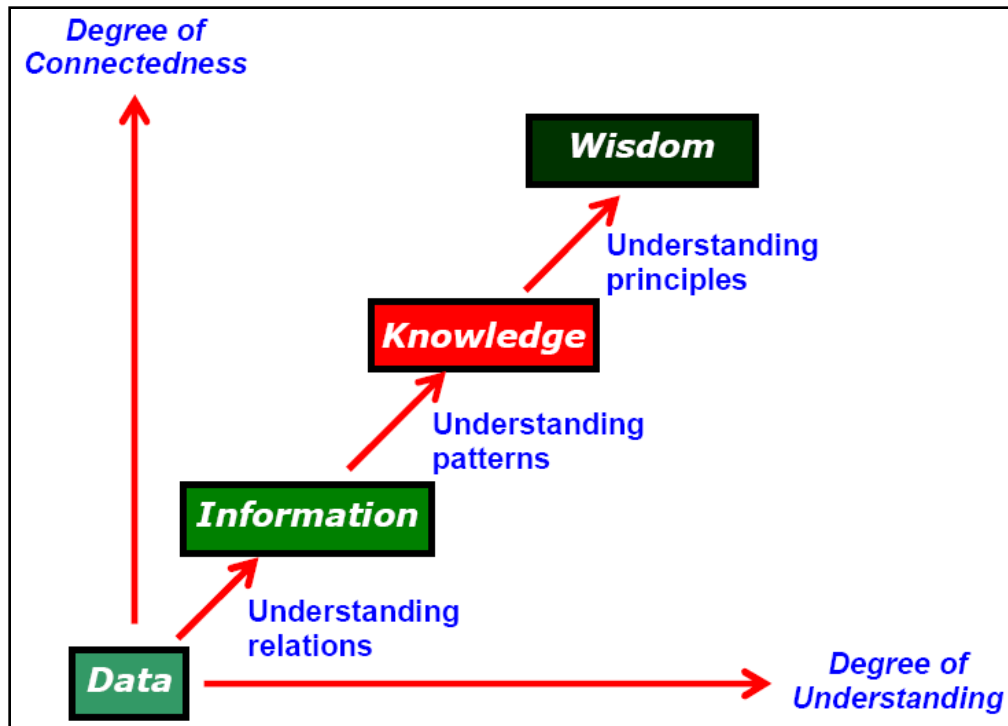


Fig. 2. Knowledge Model

### Knowledge Engineering

Knowledge Representation is the process of designing an expert system (ES). It consists of three stages [7]:

- Knowledge acquisition: The process of obtaining the knowledge from experts (by interviewing and/or observing human experts, reading specific books, etc)
- Knowledge representation: Selecting the most appropriate structures to represent the knowledge (lists, sets, scripts, decision trees, object-attribute value triplets, etc)
- Knowledge validation: Testing that the knowledge of (ES) is correct and complete

Intelligent system designers can use different elements to represent different kinds of knowledge. Knowledge representation (KR) elements could be primitives such as rules, frames, semantic networks and concept maps, ontology, and logic expressions. These primitives might be combined into more complex knowledge elements. Whatever elements they use, designers

must structure the knowledge so that the system can effectively process and it and humans can easily perceive the results [10], as an example Fig. (3) Shows the ontology of a vending machine:

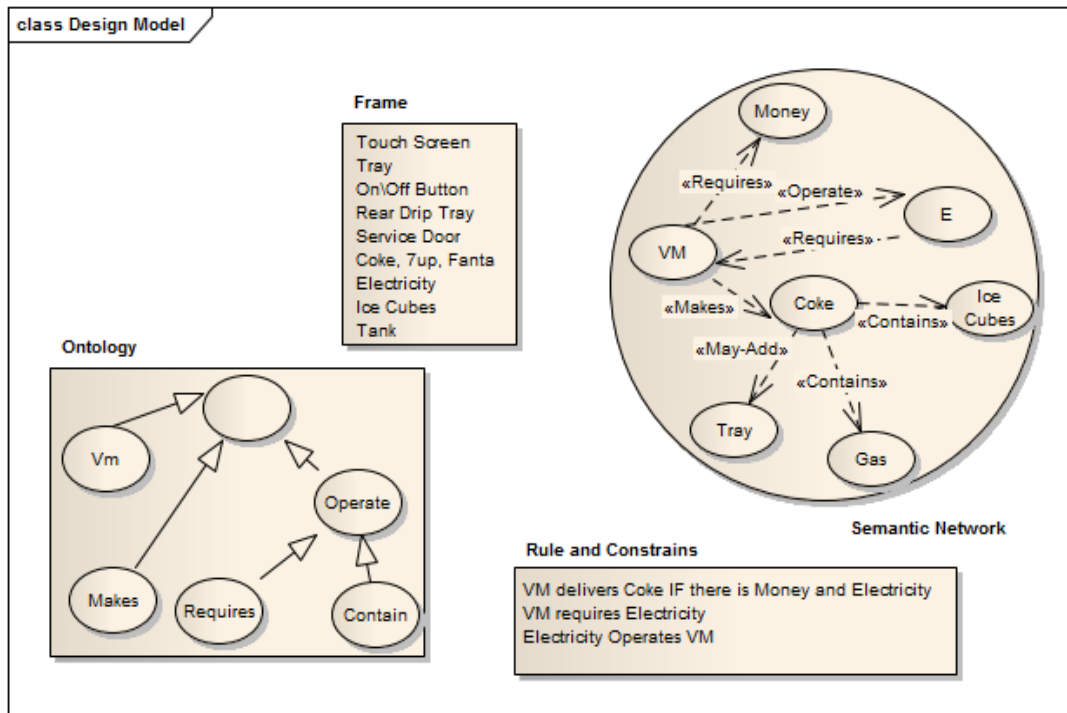


Fig. 3. Vending Machine Ontology

- Rules:** it reflects the notion of consequence. Rules come in the form of IF-THEN such as (IF sky is clear AND temperature is low THEN chance of frost is high) constructs and allow expressing various kinds of complex statements. Rules can be found in logic programming systems, like the language Prolog, in deductive databases or in business rules systems [11]. A major advantage of rule-based KR is its extreme simplicity, which makes it easy to understand the knowledge content. Rules that fire under specific conditions readily demonstrate the reasoning. However, a rule-based KR model can grow very large, incorporating thousands of rules and requiring extra effort and tools to maintain their consistency [10].
- Frames:** Frames represent physical entities, such as objects or persons, or simple concepts via a collection of information, derivation function calls, and output assignments, and can contain descriptions of semantic attributes as well as procedural details. Frames contain two key elements: slots are sets of attributes of the described entity, with special daemons often

included to compute slot values, and facets extend knowledge about an attribute [10]. There are two types of frames, Object frame and Activity frames. Object frames are used to represent the real world entity not limited to physical entity. These frames will act as a data structure activity frame to represent the changes in the world. Activity, precondition and action are reserved word not to be used in specification [7].

- **Semantic Networks and Concept Maps:** Knowledge is often best understood as a set of related concepts. A semantic network is a directed graph consisting of nodes which represent concepts connected by edges which represent semantic relations between those concepts. There's no standard set of relations between concepts in semantic networks [10], they are the declarative knowledge representation techniques and Script [12]; Semantic networks are closely related to another form of knowledge representation called frame systems. In fact, frame systems and semantic networks can be identical in their expressiveness but use different representation metaphors. While the semantic network metaphor is that of a graph with concept nodes linked by relation arcs, the frame metaphor draws concepts as boxes, i.e. frames, and relations as slots inside frames that can be filled by other frames. Thus, in the frame metaphor the graph turns into nested boxes [11], where Concept maps are similar to semantic networks, but they label the links between nodes in very different ways. They are considered more powerful than semantic networks because they can represent fairly complex concepts for example, a hierarchy of concepts with each node constituting a separate concept. Concept maps are useful when designers want to use an intelligent system to adopt a constructivist view of learning [10].
- **Ontology:** Ontology inherit the basic concepts provided by rules, frames, semantic networks, and concept maps. They explicitly represent domain concepts, objects, and the relationships among those concepts and objects to form the basic structure around which knowledge can be built [10]. In the last decades, the use of ontology in information systems has become more and more popular in various research fields, such as web technologies, database integration, multi agent systems, and Natural Language Processing [13]. Fundamentally, ontology are used to improve communication between people and/or computers, by describing the intended meaning of “things” in a formal and unambiguous

way, ontology enhance the ability of both humans and computers to interoperate seamlessly and consequently facilitate the development of semantic (and more intelligent) software applications [13].

- **Logic:** To achieve the precise semantics necessary for computational purposes, intelligent system designers often use logic to formalize KR. Moreover, logic is relevant to reasoning (inferring new knowledge from existing knowledge), which in turn is relevant to entailment and deduction. The most prominent logical formalism used for KR is first-order logic. FOL helps to:
  1. Describe a knowledge domain as consisting of objects, and
  2. Construct logical formulas around those objects.

Similar to semantic networks, statements in natural language can be expressed with logic formulas describing facts about objects using predicate and functional symbols [10].

Implicit knowledge can be represented through the use of Neural Networks which is created and adapted by the learning algorithm; the optimal represent depends on the weights between nodes.

The following are the issues to be considered regarding the knowledge representation [7]:

- Grain Size – Resolution Detail
- Scope
- Modularity
- Understandability
- Explicit Vs. Implicit Knowledge
- Procedural vs. Declarative knowledge

### **Knowledge Base:**

In recent years, several large-scale knowledge bases (KBs) have been constructed, including academic projects such as YAGO, NELL, DBpedia, and Elementary/ Deep- Dive, as well as commercial projects, such as those by Microsoft, Google, Facebook, Walmart, and others. These

knowledge repositories store millions of facts about the world, such as information about people, places and things (generically referred to as entities) [14].

Knowledge base stores enterprise knowledge with mappings to ontology through a structure process. There are matching relationships between the two, and for knowledge in the knowledge base there exists corresponding semantics in the ontology base. User information base stores related user information, include: I. personal information provided by users; II. Information collected via analysis on user access paths, search quests and so on. There are primarily two functions of user information base. Firstly, it helps to improve search efficiency by leveraging on user preference to filter search results and improve search accuracy. Secondly, to push for knowledge based on user interests [5]. *Knowledge-based systems* have a computational model of some domain of interest in which symbols serve as surrogates for real world domain artifacts, such as physical objects, events, relationships, etc [11]. The designers noted that the most difficult aspect in constructing intelligence systems is initiating its knowledge base, this process usually done by the knowledge engineer who contributes with other specialist of the problem domain to acquire more information about the problem.

### **Experiment**

Using Knowledge representation in neural expert system to construct “Windows 7 Troubleshooting” software, we represented the two categories of knowledge; explicit, with the use of expert systems artificial techniques and implicit, using neural networks as a knowledge base. Table 1 shows the integration of expert systems and neural networks and gives the neural expert system capabilities.

TABLE I. NEURAL EXPERT SYSTEMS REFERENCES



	Expert system	Neural network	Neural expert system
Knowledge representation	★	●	★
Uncertainty tolerance	●	★	★
Imprecision tolerance	●	★	★
Adaptability	●	★	★
Learning ability	●	★	★
Explanation ability	★	●	★
Maintainability	●	★	★
The terms used for grading are: ★ Good , ● Bad			

A neural expert system as shown in Fig. 4 explains the basic structure. Unlike a rule-based expert system, the knowledge base in the neural expert system is represented by a trained neural network [15] [16].

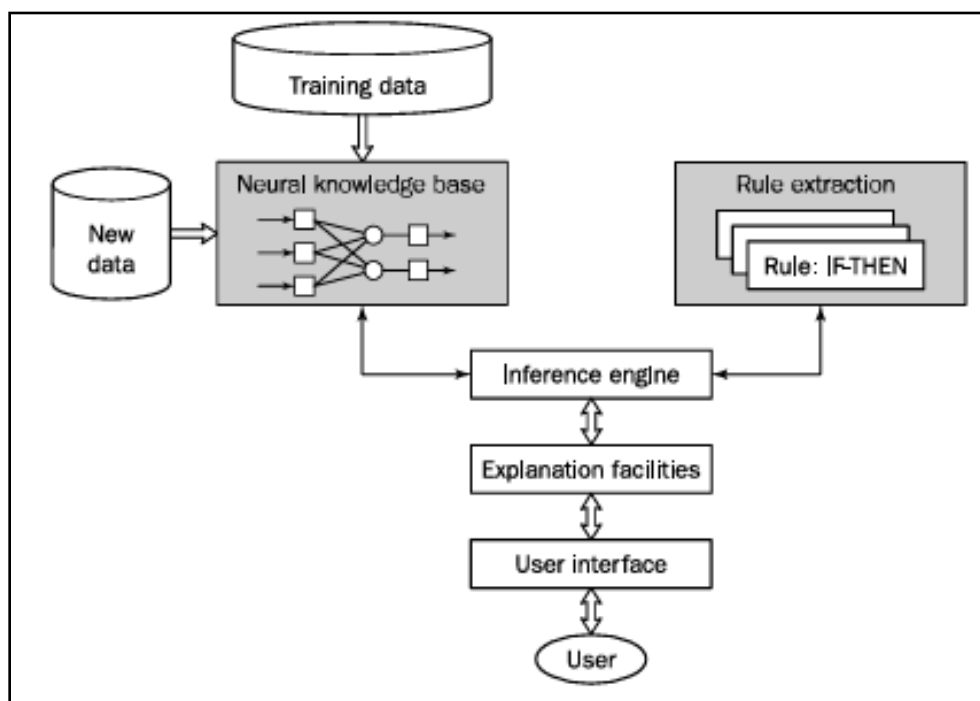


Fig. 4. Basic structure of a neural expert system

## Conclusion

The conclusion is that knowledge can be represented explicitly in five basic elements ( Frames, Ontologies, Semantic Networks, Logic and Rules) and in some complex cases we can combine more than an element to represent our knowledge, implicit knowledge can be represented using Artificial Neural Networks (Back propagation, Radial Basis Function and recurrent networks) with optimal weights. The authors concluded in their paper according to the experiment mentioned, when using neural expert system the perfect representation is the explicit and implicit.

## Recommendations

1. Knowledge representation is so important for work, we recommend to use in any field to gain accurate results.
2. Our recommendation is to apply the hybrid method of knowledge representation (implicit & explicit), which has a valuable ability to construct a robust system.

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