

## Chapter 4

# Knowledge Representation: A Semantic Network Approach

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### ABSTRACT

*Knowledge Representation (KR) is an emerging field of research in AI and Data Mining. Knowledge represented in an effective way guarantees a good retrieval. In this regard, a number of effective approaches have been proposed in the literature and Semantic Networks (SN) are one of them. In SN knowledge is represented in the form of directed graph, where concepts and relationships are appeared at vertices and edges respectively. 'is a' is one of the most frequently used relationship in SN. 'is a' expresses the exact relationship between any pair of objects. But there exists a huge amount of knowledge that cannot be represented by just 'is a', like the knowledge where approximations are involved. To overcome this issue, fuzzy semantic networks (FSN) are proposed in this chapter. In FSN 'is a' is replaced by a fuzzy membership function ' $\mu$ ' having value between  $[0,1]$ . So the relationship between a pair of concepts can be expressed as a certain degree of membership. This chapter focuses on applications of FSN and its significance over the traditional SN.*

### INTRODUCTION

Knowledge Representation (KR) is one of the hottest areas of research in data mining, AI and big data analytics etc. Knowledge represented in an effective way, helps in easy traversal, searching, reasoning, prediction and inferencing. In this regard, a number of approaches, algorithms, techniques and methods have been proposed in the literature and implemented with their own pros and cons.

KR, though not a new concept, however, its usefulness was not felt as necessary as present. KR is becoming a root of almost every Decision Support System (DSS), Expert Systems (ES) and many other intelligent systems. Moreover, it is one of the prominent component of AI paradigm. A number of techniques for KR are proposed in the literature, Semantic Networks are one of the prominent technique among them. Semantic networks were originally proposed by (Quinlin, 1969). In this technique knowledge is represented by directed graph structure, where vertices (nodes) represent the objects (concepts) and

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the edges represent the relationship between them. ‘is a’ is one of the most useful relationship between any pair of objects. However, it does not cover the range of relationship between ‘is a’ and ‘is not a’. To overcome this limitation, Semantic Fuzzy Networks (SFN) are proposed in this chapter. Also their applications and implementation details are provided.

This chapter is organized as follows:

- Basic concepts and definitions are presented in first section
- Section two contains a brief introduction of semantic networks
- Section three contains the introduction of fuzzy semantic network concept
- Section four contains the applications of fuzzy semantic network in general
- Section five contains the application of fuzzy semantic network in various domains

## BACKGROUND

### Semantic Networks

Semantic Networks are one of the oldest and effective-most techniques for KR. A semantic network or net is a graph structure for representing knowledge in patterns of interconnected nodes and arcs. Computer implementations of semantic networks were first developed for artificial intelligence and machine translation, but earlier versions have long been used in philosophy, psychology, and linguistics. The Giant Global Graph of the Semantic Web is a large Semantic Network (Berners-Lee et al. 2001; Hendler & van Harmelen, 2008).

Semantic Networks were initially invented for computers by Richard H. R. et al in 1956 of the Cambridge Language Research Unit (CLRU), for sake of machine translation of natural languages. Semantic Networks were further developed by Klien & Robert in 1963. In subsequent years, remarkable work on semantic nets was done by Allan M. et al., (1969-1970). From 1960 to 1980 the idea of semantic network was related to hyperlink in hypertext. Also many software tools have been developed to implement the semantic networks in that era.

About six most common types of Semantic Network are given in literature by Sowa et al. (1991). Following is their short description:

1. **Definitional Networks:** This is a kind of network in which “is a” relationship is used to create the subtypes. The resulting network, also called a *generalization* or *subsumption* hierarchy, supports the rule of *inheritance* for copying properties defined for a super-type to all of its subtypes. For example, super-type is “Prophet” then its subtypes are “Mohammad,” “Mosa,” etc. moreover, the information in such networks is assumed to be necessarily true.
2. **Assertional Networks:** These are designed to assert propositions. Unlike definitional networks, the information in an assertional network is assumed to be contingently true, unless it is explicitly marked with a modal operator. Some assertional networks have been proposed as models of the *conceptual structures* underlying natural language semantics.
3. **Implicational Networks:** These networks use implication operator as the primary relation for connecting nodes. They may be used to represent patterns of beliefs, causality, or inferences. These networks are intensively used in deductive learning.

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