

Semiotics for Ontologies and Knowledge Representation

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Abstract. The Semantic Web implies the comprehensive use of the main semiotic postulates on the Web. One of the most important facts about human understanding comes from the area of linguistics and semiotics. The semiotic techniques, such as syntagm and paradigm are explained through the examples in learning environment, in the context of logical understanding and knowledge representation on the Web.

1 Introduction

In this paper, we discuss some of the basic semiotic principles and techniques, such as the notion of sign, connotation and denotation, syntagm and paradigm. Logical understanding, meaning creation, and knowledge representation is explained by using semiotic techniques on the Web

2 Technological Advances on the Web

Efficiency of learning process on the Web implies a certain level of intelligence, which will transform the Web into an intelligent entity. Hence, the term of Web Intelligence (WI) appears. WI explores the fundamental and practical impacts of [1]:

- Artificial Intelligence (AI) - knowledge representation, planning, knowledge discovery, data mining, intelligent agents, social network intelligence, and
- Advanced Information Technology (IT) - wireless networks, ubiquitous devices, social networks, wisdom Web, data/knowledge grids.

Nowadays, the vision of the future Web, called the Semantic Web, is near its own realization. The Semantic Web represents a new way of knowledge organization on the Web in the form of decentralized vocabularies [2] - called ontologies. On the intelligent Web, Web agents will be able to create new and to use existing meta-knowledge from ontologies, to resolve their conflicts by themselves, to plan future processes and discover new processes that arise between the existing Web ontologies.

3 Semiotic Principles

People recognize patterns of information and organize them to generate meaning. Collections of these organized patterns form the languages for human communication. Considering the fact that everything can be a sign [3], that is becoming alive by getting the meaning, we would try to explain some of the basic semiotic postulates in the Semantic Web and learning mechanisms.

3.1 A Sign

A sign is anything that can be used to express a meaning. As traditionally analyzed (by Saussurean 'dyadic' diagram of the sign [3]), the sign consists of two parts:

- A signifier - the form in which the sign appears,
- A signified - the concept (mental content) represented by the signifier.

In other words, the sign is a recognizable combination of a signifier with a particular signified. The standard interpretation of the sign is usually given by a semantic function, which assigns an abstract syntax sign to a point in some domain, as well as the variables of the sign to their meaning.

Unlike the syntax, which represents the way to recognize signs, as well as the formal or structural relations among signs, semantics on the Web can be defined as a comprehension of the intended meanings of the signs on the Web [4]. It is a way to construct the meaning as a semantic value, produced through the marked terms and knowledge that comes from the Web ontologies.

Languages that can be used for modeling ontologies are well known as Semantic Web languages, based on XML, but with a notable level of semantics, which enable the correct interpretation of the contents of marked knowledge. Nowadays, important Semantic Web languages include RDF (Resource Definition Framework), RDFS (RDF Schema), and OWL (Web Ontology Language). Based on a sign explanation, there are certain relations between the signs (symbols) in human understanding generally, as well as on the Web. These relations can be opposition, correlations and different logical relations among the signs. According to this fact, there are a syntagm, paradigm, sememe, connotation, denotation, and many more.

3.2 Connotation/Denotation

Connotation and denotation are not two separate things/signs. They are two aspects/elements of a sign, and the connotative meanings of a word exist together with the denotative meanings [3] [5].

- Connotation represents the various social overtones, cultural implications, or emotional meanings associated with a sign.
- Denotation represents the explicit or referential meaning of a sign. Denotation refers to the literal meaning of a word, the 'dictionary definition.'

For example, the name 'Hollywood' *connotes* such things as glitz, glamour, tinsel, celebrity, and dreams of stardom. In the same time, the name 'Hollywood' *denotes* an

area of Los Angeles, worldwide known as the center of the American movie industry.

3.3 Syntagms/Paradigms

Apart from connotation/denotation mechanism, there are other semiotic principles that form the comprehension of the different kinds of communication on the Web. Because the meaning arises from the differences between signifiers, there are two kinds of these differences: *syntagmatic* and *paradigmatic*. Both paradigmatic and syntagmatic relations determine the ‘value’ of a sign. Syntagms and paradigms provide a structural context within which signs make sense [3] [6].

- Syntagm represents a combination of ‘this-*and*-this-*and*-this’ things/signs in a sentence. A syntagm is an orderly combination of interacting signifiers forming a meaningful whole within a text. In language, a sentence is a syntagm of words. Syntagms can contain other syntagms. Syntagms are created by linking signifiers from paradigm sets, which may be required by rule system (grammar).
- Paradigm represents a selection of ‘this-*or*-this-*or*-this’ things/signs. It is a set of associated signifiers/signifies, which are all members of some defining category, but they are significantly different from each other. In natural language, there are grammatical paradigms, such as verbs or nouns, homophones or synonyms.

An example of using syntagm and paradigm principles for meaning creation and knowledge representation in the field of e-learning will be explained in Sec. 4.

4 An Example of Using the Semiotic Principles on the Web

In order to explain the roles of the main semiotic principles in meaning creation for e-learning, we start from an environment that has mechanisms for creation, communication, and interpretation of signs and symbols by using intelligent pedagogical agents. Intelligent pedagogical agents have a role to facilitate learning process, to simplify making decisions in preparing and finding existing learning materials, and to facilitate real understanding descriptions and contents of those materials. In according to these possibilities, we have to explain research on Learning objects (LOs). LOs represent a part of the IEEE Learning Technology Standard Committee (LTSC), and it is defined as any digital resource that can be reused to support learning, education or training [7]. An LO consists of two parts:

- Content (different learning materials described using ontology-based annotations),
- Descriptive metadata (described by using IEEE LO Metadata (LOM) standard).

Intelligent pedagogical agents help a learner to find an appropriate LO, and their semantically marked contents regarding the course that is being learnt. Fig. 1 shows the way how the real semantic comprehension between pedagogical agents and LOs, as well as ontologies, will be achieved. We try to explain how a pedagogical agent searches for LOs and creates educational materials by using some of explained semiotic principles in e-learning environment. For example, syntagmatic and paradigmatic dimensions are often presented as ‘axes’, where the horizontal axis is the syntagmatic

and the vertical axis is the paradigmatic. The combination of ‘this-and-this-and-this’ and the selection of ‘this-or-this-or-this’ of semantically marked notions represents the syntagm and paradigm. The example of syntagm and paradigm principles for meaning creation is shown in Fig. 2.

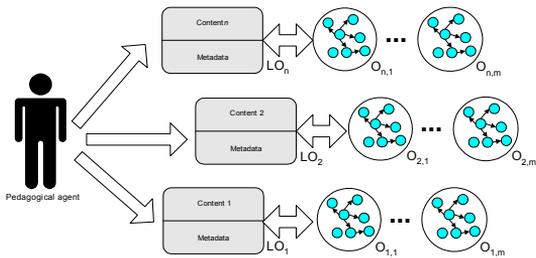


Fig. 1. E-Learning environment and ontologies

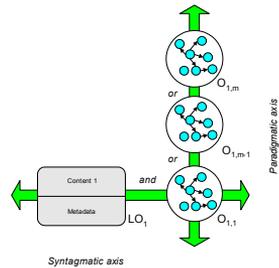


Fig. 2. Meaning creation

5 Conclusion

The Semantic Web concept comprises the main semiotic paradigms, and semiotics gets a global perspective on the Web where all levels of system, as well as the knowledge on the Web can be treated semiotically. In addition, we can notice that semiotics contributes to the vital aspects of the future Web, and has the potential to affect the AI and education community.

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