Cognitive Interactions in the Semantic Web

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ABSTRACT
The advancement of a Semantic Web both entails and promotes new collaborative practices in Web content management, e.g. for e-business applications. These practices involve cognitive interactions which must be taken into account in the aims of the Semantic Web, and encouraged by using and completing its standards, with a Knowledge Engineering approach.

General Terms : Human Factors.

Keywords : Cognitive Interactions, Topic Maps.

1. INTRODUCTION
Although the Semantic Web (WS) initially aims give to software agents an intelligent use of the Web, this ability entails domains of knowledge being described by human agents, who can be either specialists in the domain (building ontologies) or authors, even active readers, of documents (creating meta-data without pre-existent ontologies).

Even if the Semantic Web often assigns information retrieval tasks to automatic agents [1], a significant part of the corpora (catalogues, documents …) is first conceived for human readers. It would be useful that such attempts at the semantic structuring benefits not only to software agent but also to improvement peoples' navigation practices on the Web.

So we think that both the design and the exploitation of semantic representations must be adapted to these practices, and have to be involved in the field of WS research, including it within the field of Knowledge Engineering [3]. We especially include, initial design of representations, maintenance and the continuous capitalization (as knowledge evolves) and the evaluation of the relevance of the results of queries. All these activities based on cognitive interactions are critical, in order to design the services exploiting the potentialities of the Semantic Web in an industrial scale.

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2. THE EXEMPLE OF A "KNOWLEDGE-BASED MARKETPLACE"
The e-MarketPlace system that we develop and experiment at the Tech-CICO Laboratory, illustrates the interest of cognitive interactions based on Semantic Web standards. Basically, e-MarketPlaces catalogues proceed from a twofold problem of modelling information and knowledge from multiple points of view and from multiple experts [4]. Buyers and sellers each bring complementary expertise and cooperate to "co-construct" the catalogues. Due to this, we built a cooperation model entitled "Knowledge-Based Marketplace" (KBM). KBMs could bring a dimension of generated and shared knowledge, stimulating new types of economic exchanges and product innovation. Our approach consists of operating a KBM on an example, based on an e-MarketPlace case in a precise domain (for selling training services to the computer community) [2].

An advantage provided by a KBM could be to give tools adapted to the user, in order to deal with the very large quantity and variability of concepts and properties used to describe competing products. In addition, concepts corresponding to products (i.e. the « learning module » concept in our example of KBM) are involved in several processes and roles, and used by numerous agents carrying an unlimited variety of points of view. The success of the agents (i.e., for a buyer: finding the best product) depends largely on the integration of many ontological systems or on sharing problems, taking into account the taxonomies and the vocabulary that agents use within different contexts. These aspects were studied by several authors especially in the field of Electronic Commerce [10][5][11].

These works and many others ones in the fields of Knowledge Engineering, [13], Computer Supported Cooperative Work [12] and information systems, contribute indirectly to highlight a central characteristic of the KBM model : most e-MarketPlaces are open systems, which do accept (even research) a plurality of beliefs and naming practices aiming at the resources in play, including their identifying and qualifying properties.

This is the reason why we chose to tackle KBM problem with the Semantic Web approach, including a cooperation paradigm, using the Topic Map standard as a formalism of representation. These experiments soon need a semi-formal level of modeling, with the help of a knowledge representation language (based on Topic Map) that we are developing.

3. COMPUTATIONNAL SEMANTIC VERSUS COGNITIVE SEMANTIC, TWO PATHS IN SEMANTIC WEB

3.1 Cots and benefits of the two approaches

Two opposite approaches of the Semantic Web can be distinguished. The first one could be characterized as « computational » because it basically aims to automate information retrieval by exploiting software agents. Due to this fact, the knowledge models which represent the contents of documents or more generally the domain of knowledge have to be expressed in a formal language (OntoKnowledge [6], Protege2000 [7], COMMA [8]…). This language has to be capable of logical inferences and powerful processing.

For the second one, that we identify as «cognitively semantic», formalization of contents -even if it allows partial automate several tasks- aims to increase the Web's intelligibility for human users involved in navigation practices and content enhancement practices. Such practices involve human-machine interactions but also interactions between humans through the asynchronous medium provided by the Web. We call « cognitive » those interactions which underline heuristic and interpretative dimensions tied to these activities. In this case, issues of indexation have to be given preference over issues of inferences. Knowledge representations of such approaches, even syntactically formal, will appear to be weaker in an objective of symbolical calculus realized by intelligent software agents.

Each of these approaches can reveal benefits and disadvantages. On the one hand, computational semantic allows valid inferences to be perform according to several logical criteria and allows highly precise information to be retrieved in an automatically manner. The first consequences of this are in the high costs generated by information deployment and maintenance. Furthermore, even if information offered can appear to be absolutely non-ambiguous, these kinds of representation are not meaningful for someone who is not competent in computer sciences or in logical . Finally, these representations can be considered as poorer concerning the width of covered domains and the sciences variability of contents which can be brought to the user involved in a session of interactive navigation.

On the other hand, a cognitively semantic Web can't usually achieve valid logical inferences automatically. Although partially automated searches can be performed, labels and notions are meaningful only within the context of a human-machine dialog, driven by a human being, who is the only one person who can attest the « cognitive validity » of information he decides to keep. Nevertheless, this kind of representation can be characterized as being a "low cost", easier to upgrade and more meaningful for non-specialists. It allows a higher number of documents to be included more frequently and more easily and seems to be more meaningful because of the associations it makes appear.

3.2 The contexts which this two approaches trigger

There are advantages and disadvantages in different contexts of use. As shown in the table below, ontologies and semantic-network representations towards logical or object-oriented languages are more fitted to representations of documents which have intangible contents –and which therefore justify investment in terms of modeling- or which contain formated data, as these can be found in databases. Such representations will also be used for "closed" and consensual domains of knowledge (for example in medicine, anatomy, …) where expertise can be considered as the reference. From the users' point of view, these representations fit well defined needs which can be expressed as precise and non-ambiguous queries.

Nevertheless, in order to process evolutionary documents covering "open domains" of knowledge and addressing different points of view, another type of representation will appear to be more suitable. These models can be characterized as less formal, more cognitive than computational, that is to say more meaningful and more flexible from the users' point of view.

Such an approach seems to be in accordance with the vision of the founders of the Web, most certainly utopian, which postulated the "notion of open community of specialists" – whose aims are to bring knowledge on the Web- as opposed to the experience of a just one expert. Within such a context, expression and representation of multiple points of view, sometimes contradictory, appear to be strongly significant. It's also necessary for concepts and associations which compose the semantic representation to be frequently questioned and upgraded.

Table 1: Comparison between the two approaches : a Web we call "cognitively semantic" and another approach we call "computationally semantic"

Criteria	Documents		Domains and concepts		Experts' identification		Needs	
	Benchmark data or DataBase's information	Contingent and evolutionary documents	« Closed » and consensual	« Open », multi point of view, evolutionary	Experts authority	Community	Strongly specific	«open »
Computationally-Semantic Web	✓		✓		✓		✓	
Cognitively-Semantic Web		✓		✓		✓		✓

In the opposite approach –the computational one- attention will be first focused on the identification of experts and then, achievement of a consensual definition for each concept and each association in order to elaborate a logically valid and unambiguous model.

3.3 A model of semantic representation based on Topic Maps

Topic Maps [14] seemed to us perfectly adapted to the specifications described above. This is the reason why we chose this formalism as a semantic representation in accordance with our view of the Semantic Web. Topic Maps define a meta-model : these generic models of topics and associations can be instanciated to create particular types of Topic associations. We exploited this property to adapt the standard and propose pre-defined types of associations, e.g. to differentiate instances ("Topic-instances") and generic subjects ("Topics"), and make ontological commitments [9] more explicit.

Another extension deals with the representation of Topics trough multiple hierarchies which model different points of view. This choice is part of solution related to our aim of cooperative knowledge acquisition. For example, during the classification of an object, the ability to classify the same Topic-instance into two Topics (belonging or not to different hierarchies) should allow an agreement to be obtained without adding the heavy methodology of search for consensus. For the same reason, it is also useful to be able to give multiple names to the same Topic or identical names to different Topics. Such logical inconsistencies can correspond to a cognitive reality (individual or collective) which deserves to be represented too.

4. Conclusion

An important line of research around in the Semantic-Web concerns the development or the adaptation of ontologies in order to give computer agents the ability to make inferences from the semantic contents of Web resources, and not only from keywords. One can easily imagine how text-mining technologies could be used for automatic annotation of the Web textual documents. We think a complementary approach can exist which could aid human activities in information retrieval by regarding users not only as users but also as actors of the ontologies development and ontologies updating which is recurrent for Web resources. This approach is based on semantically-weakened representations with regard to formal ontologies, but more cognitive than computational, and consequently allowing updates by users themselves. To reach this level of autonomy it is necessary to support and to favour cognitive interactions which appear in the cooperative elaboration of a semantic representation.

We tried to identify the nature of these interactions and to show how they can constrain the design of semantic representation. Such analysis and our own experience of Topic Maps lead us to the formalism presented above in accordance with the specific path that we chose in the Semantic Web : a semantically-cognitive Web.

Future research promises hold in improvements on cognitive conditions of navigation in semantic representation and also in the means to support cooperative development of Topic Maps. This kind of help addresses the use of predetermined relations according to the nature of Topic that links them.

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