

A Semiotic Framework for Ontology Development

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Abstract: We address the issue of ontology construction and reuse, and regard such processes as collaborative negotiations among stakeholders. A semiotic framework is proposed to model the communication environment. Accordingly, content and expression of an ontology have been clearly distinguished, and formalized independently. A twofold model is proposed: at an operational level, two stakeholders – such as designer and user – negotiate by proposing and modifying ontology fragments. At a reflexive level, the negotiation involves interpretations, until a set of shared meanings is reached; the process can be described adopting a narrative approach.

Key Words: Semiotics, Semantic Web, Pragmatic Web, Ontologies, Engineering

Category: M.4, M.8, I.2.4

1 Introduction

Ontologies are artifacts, i.e., artificial systems that are intentionally designed for specified purposes [Gruber 2004], and several development methodologies have been proposed [Fernandez Lopez 1999]. In the field of ontology engineering, another issue is the reuse of existing artifacts. Development and reuse are still open problems. The latter, for example, cannot be regarded as a matter of importing a structure valid in any case, and so immediately applicable. The current techniques [Paslaru-Bontas 2007] do not go beyond empirical mechanisms of adaptation of imported pieces of knowledge. As matter of fact, contexts are likely to be different: basic assumptions, perspectives, goals, intentions, and by no means semantic consistency is ensured to the fragments once they have been assembled.

In a previous paper [Toppano et al. 2008] we stressed that the development of an ontology is a collaborative work within a community of stakeholders. This lead us to regard it as a semantically-effective communication problem, in the realm of the Pragmatic web [Verschueren 2003].

In this paper we argue that design and reuse of an ontology obey essentially to the same process. A semiotic approach offers an adequate framework, involving the stakeholders and their operational contexts. The ontology is a semiotic object (text). The dialogue is a negotiation leading to a contract, and binding the stakeholders to a shared semantics. We propose a twofold model of the development process, which involves the use and the negotiation of meanings.

The next section of the paper contains the main ideas borrowed from Semiotics; Section 3 presents our model; Section 4 contains our conclusions.

2 A semiotic framework

2.1 The ontology as a text

As a semiotic object, according to the model by [Hjemslev 1961], the ontology has a content and an expression. The former is the underlying conceptualization; the latter, a formal description. Other groups have applied such a distinction. [Hartmann et al. 2005] individuate the ontology base and the document — its specific realization. However, only the formal expression is reified by symbolic artifacts. We argue that the content is to be represented too, which allows to make semantics clear and simplify the reuse. On the contrary, when the conceptualization is left implicit it should be anyhow extracted for the sake of sharability.

2.2 A communication framework

The scheme in Figure 1 generalizes the model by [Jakobson 2002]. The ontology (text) includes an addresser and an addressee, i.e., the imprints of the actual sender — e.g., the designer — and the receiver (the user), respectively. They are connected by means of an instrumental medium — e.g., a PC connected to a network — enabling the circulation of the text within a socio-cultural context. They establish a direct relationship with a possible world, i.e. an implicit conceptualization of the ontology.

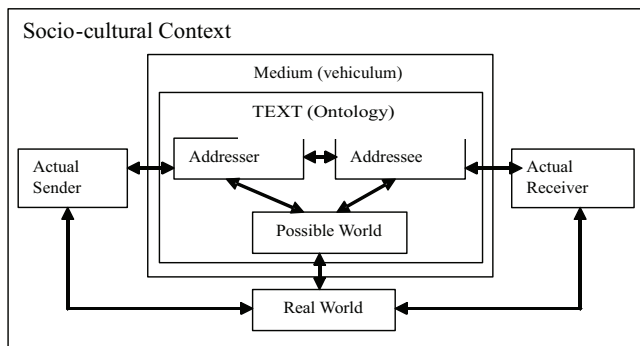


Figure 1: The communication framework.

The ontology is not only a text about the domain, but also an example of how a domain can be represented according to the assumptions. An agreement is required: an addressee who agrees on a conceptualization can get concrete results: achieve goals; share meanings ultimately, become a member of a community! Therefore, the agreement is to be made explicit, namely: the conceptualization; its purposes; the preconditions; the expected effects; the point of view; the

assumptions and abstraction levels. All of this may be expressed by another artifact describing the context [Benerecetti et al. 2000],[Gangemi et al. 2006], which is, in turn, a text. The framework in Figure 1 can be applied again. Information like metadata — mainly static and oversimplified — do not tell anything about the way consensus has been reached.

3 Ontology development: a twofold model

We propose a model that makes explicit the negotiation, and is grounded on the triadic model by Peirce [Peirce 1931]. A generic sign (a text) is decomposed into three elements: *representamen*, *interpretant* and *object*. The first one is the form taken by the sign; the second is the sense made of it; the object is what the sign stands for (the *referent*).

Building a conceptualization is a situated, collaborative synthesis of knowledge. 'Situated' means that the decisions taken by the stakeholders depend on their status at a given time, which includes, as in [Gero and Kannengiesser 2002], the ideas and expectations of the designer, as well as the external status of the ontology. The scenario is sketched in Figure 2.

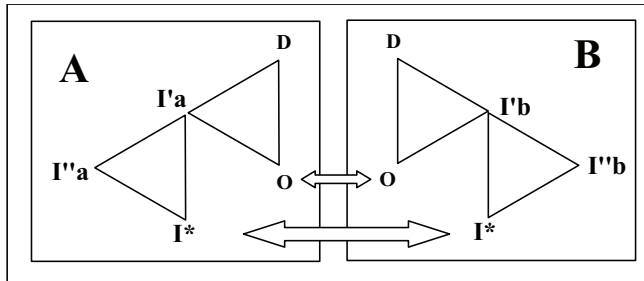


Figure 2: The triadic model of Peirce applied to domain and interpretation.

Two agents *A, B* model the domain of discourse *D*, – object, in the triadic model – and produce two symbolic models: the conceptualization *O*, – representamen – and the interpretation *I**, – representamen, also – i.e., concepts and relations in the underlying conceptualization *I'*. The triangles *D – O – I'* and *I' – I* – I''* are instantiations of the triadic model. Both the individual and common contexts of *A* and *B* are sketched as rectangular boxes. Giving the interpretation an explicit form is a precondition for the negotiation to take place. The development occurs at two distinct levels. The operational one concerns the conceptualization *O*. a process that generates, combines and transforms ontology fragments. The reflexive level concerns the shared interpretation *I**. This

level addresses the dynamics of comprehension of the ontology: for example, addressing questions like: "...What do you mean with ...?"; "...I think that by X you mean Y. Is it true?" "...What question can you answer with ...?."

3.1 The operational level

The activities can be sketched as in Figure 3 Each actor interprets the state of

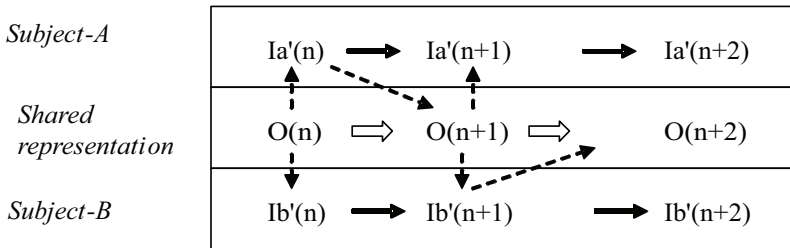


Figure 3: Activities at the operational level.

the conceptualization and eventually proposes to modify it. Three processes are at work: the conceptualization $O(n)$; the interpretation by A and B , namely $Ia'(n)$ and $Ib'(n)$. The actors can use different perspectives which may not be aligned. Being such perspectives left implicit, there is no way to discuss and eventually align them.

3.2 The reflexive level

As in Figure 4, the agents collaborate to construct a shared interpretation I of the domain. Since the meanings associated to the ontology depend on the current context, misunderstandings can occur. For this reason, reflections are necessary, being the only way to detect inconsistencies. The interpretation is expected to converge to a shared meaning. At the operational level, such a meaning may be adopted even without sharing it.

3.3 The rôle of negotiation

Both the operational and reflexive levels require negotiation. The former seeks for solutions proposed by the participants: for example, adding or deleting concept

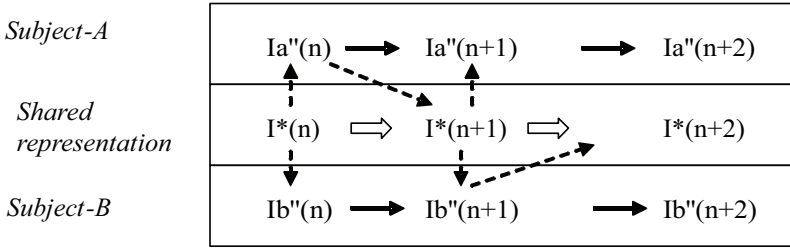


Figure 4: Activities at the reflexive level.

fragments; a distributed mechanism may be adopted, for example based on voting. At the reflexive level, an integrative approach is appropriate [Kersten 2001]. As a matter of fact, negotiating meanings is a matter of constructing an interpretation not necessarily available beforehand [Stahl and Herrmann 1999].

Semiotics suggests solutions. A narrative model [Floch 1985] can support the discussion effectively, since it captures the variability of the process. Narratives convey information about what happens – who, what, when, where and how – but also basic values and judgments.

4 Conclusions

We have addressed the issue of ontology development, assuming that consists of a collaborative negotiation among stakeholders. Our viewpoint allows for a unified approach to building an ontology from scratch and reusing an existing one. Novel contribution is the application of a semiotic framework to model the communication processes. The ontology is regarded as a semiotic object made of content and expression: both are considered as texts to be explicitly represented. The communication framework inscribes stakeholders and context within the texts, which become the mediators (media) of the negotiation. The triadic model by Peirce details a mechanism of interpretation and reification.

We propose the negotiation to occur at two distinct levels: operational and reflexive. The former concerns the ontology as a document, that is incrementally put forward and detailed; the underlying interpretation remains implicit. The context may be explicated by metadata, for the sake of an effective use of the ontology itself. However, if the conceptualization is to be truly shared, an upper, reflexive level of negotiation is to be activated. The main concern is

semantics, the interpretation of the concepts adopted at the operational level. We have proposed to represent the communication by narrative techniques, that would better account for the time evolution of the negotiation and enrich the articulation of contexts.

The importance of communication processes within the development of ontologies cannot be overlooked; a semiotic framework offers solutions that appear profound and effective, and deserve systematic experiments. Design choices are also communicative choices — which is a pragmatic perspective — and Semiotics is helpful to the study of mechanisms underlying the choices of a community of developers. We are currently working along this direction.

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