Using Events from UFO-B in an Ontology Collaborative Construction Environment

Douglas Eduardo Rosa[1], **Joel Luis Carbonera**[1], **Gabriel M. Torres**[1], **Mara Abel**[1]

[1]Institute of Informatics – Universidade Federal do Rio Grande do Sul (UFRGS)
Caixa Postal 15.064 – 91.501-970 – Porto Alegre – RS – Brazil

{derosa,jlcarbonera,gmtorres,marabel}@inf.ufrgs.br

Abstract. *In previous works, it was introduced an approach to support collaborative construction and evolution of domain ontologies based on UFO-A. However, there are areas of knowledge, like in the petroleum geology, where we need to represent some natural/geological phenomena which aren't possible to be well represented by UFO-A constructs, by the fact that this concepts are treated as* events *that occur during time. Thus, this paper presents the results of the study to support events from UFO-B in an ontology collaborative construction environment, which initially was designed to maintain a collaboration record from a domain ontology based on UFO-A.*

1. Introduction

Recently, Torres' work [Torres et al. 2011, Torres 2012] has introduced an approach to building domain ontologies in a collaborative manner, in which the coherence in the negotiation of meaning during the collaboration is established with the use of a foundational ontology called UFO [Guizzardi 2005]. However, Torres' work just covers the fragment from UFO called UFO-A, which is an on ontology of *Endurants*, leaving aside the representation of events included in UFO-B (an ontology of *Perdurants*). UFO-A deals with objects that are wholly present whenever they are present, we say that the Endurants *are in time*, in the sense that, if in a circumstance c_1 an endurant e has a property P_1 and in a circumstance c_2 the property P_2 (probably incompatible with P_1), the object e is still the same endurant. On the other hand, Perdurants are individuals composed of temporal parts and, unlike Endurants, they *happen in time*, in the sense that they extend in time accumulating temporal parts [Guizzardi et al. 2008a]. For the record, examples of Endurants are a person, a car, a house, a rock; constitute example of Perdurants a conversation, a football game, a business process, a depositional process etc.

The Carbonera's work [Carbonera et al. 2011, Carbonera 2012] investigated the role played by foundational ontologies in the problem solving methods involving visual information, and proposed a cognitive model for visual interpretation of depositional processes, within the Sedimentary Stratigraphy domain. This work also developed a domain ontology in the area of Sedimentary Stratigraphy domain, in which were identified concepts that should be represented as Perdurants, i.e., it is required a representation of the temporal aspects in order to support reasoning.

So, there are knowledge domains in which their representation by a domain ontology requires the use of specific constructs that can represent temporal aspects, so this knowledge can be represented in a reliable way.

This paper presents the results of the study to support events from UFO-B in an ontology collaborative construction environment, which initially was designed to maintain a collaboration record from a domain ontology based on UFO-A. The choice of UFO-B, instead of UFO-C, comes from the fact that UFO-C represents intentional agents (that have *intentions* and *goals*), which is not our case. Our research group works with petroleum geology, so we do not want to represent intentional agents, we want to model geological and natural phenomena. This kind of phenomenon does not occur by the intention of an agent, but for natural reasons that do not have a specific goal. It is important to be clear that this work does not presents contributions in the creation of constructs for modeling events or temporal aspects in a domain ontology, but it is about the requirement that our modeling tool must have to support the collaborative construction of ontologies based on both concepts from UFO-A and UFO-B.

This paper is organized as follows: in section 2 are presented the main concepts envolving UFO. In section 3 we present the related works, which were the basis for the development of this work. In section 4 are presented the changes made in the architecture of the environment to support UFO-B events. In section 5, we conclude and anticipate some future work.

2. Foundational Ontology: UFO

The UFO (*Unified Foundational Ontology*) [Guizzardi 2005, Guizzardi et al. 2008a] is a Foundational Ontology which arose as a unification of concepts addressed by other foundational ontologies. UFO is divides into 3 parts - UFO-A, UFO-B and UFO-C - that structure notions of different scopes. The core of the UFO is the fragment called UFO-A, which is an ontology of *Endurants*, and is concerned with structural aspects, like objects, their types, their part/wholes, their intrinsic, relational properties and spaces of property values, distinction between different types and their allowable relationships etc. UFO-B is an ontology of *Perdurants* that deals with dynamic aspects, like events and their parts, relations between events, object participation in events, temporal properties of entities, time etc. UFO-C is built on top of UFO-A and UFO-B to systematize social aspects, like agents, intentional states, goals, actions, norms, social commitments among many others.

A complete and detailed description about UFO's fragments is outside the scope of this paper. For a more detailed description of UFO-A and UFO-B, including their logical meaning, refer to [Guizzardi 2005, Guizzardi et al. 2008a, Guizzardi et al. 2008b], in which the theoretical foundation of this work was based.

3. Collaborative Construction of Domain Ontologies

The work in [Torres et al. 2011] and [Torres 2012] presents an approach to build visual domain ontologies in a collaborative way using meta-data based on foundational ontologies. It makes use of the concepts from the foundational ontology UFO, seeking a well-structured construction of domain ontologies that could serve as a future reusable artifact. Furthermore, a goal of using foundational ontologies is to establish a theoretical basis to achieve consistency in the negotiations of meaning during the collaboration process. The collaborative aspect is motivated by the fact that knowledge domains are not static, they evolve as new elements become part of the domain or when elements become obsolete. These changes must be adapted to the domain model, updating the ontology by adding

or removing elements. As knowledge about a certain domain can belong to several geographically dispersed collaborators, a collaborative process to create and maintain an ontology helps to make explicit the changes that occur in this ontology, and also makes explicit the concepts involving the vocabulary used by different collaborators.

In order to support the creation of domain ontologies in a collaborative way, two meta-data ontologies are used: the $R.O.$ (Representation Ontology) and $C.O.$ (Collaboration Ontology). The $R.O.$ defines primitives to represent the domain ontology, while the $C.O.$ defines primitives to represent the collaboration events. The domain ontology components are defined as instances of the concepts of the $R.O.$, and the changes made in the domain ontology are defined as instances of the concepts of $C.O.$. The meta-ontology $R.O.$ extends some of the major components of ontologies (concept, property, relation, axiom) specializing them in the constructs proposed by foundational ontology UFO-A [Guizzardi 2005], providing thus an ontological foundation for the model. The meta-ontology $C.O.$ defines which events of collaboration can be performed in the domain ontology. The instances of $C.O.$ are the changes related to what is represented by the $R.O.$, which is the domain ontology. Figure 1 shows an example of the interaction in the ontology of meta-data and collaboration history generated due to changes in the domain ontology.

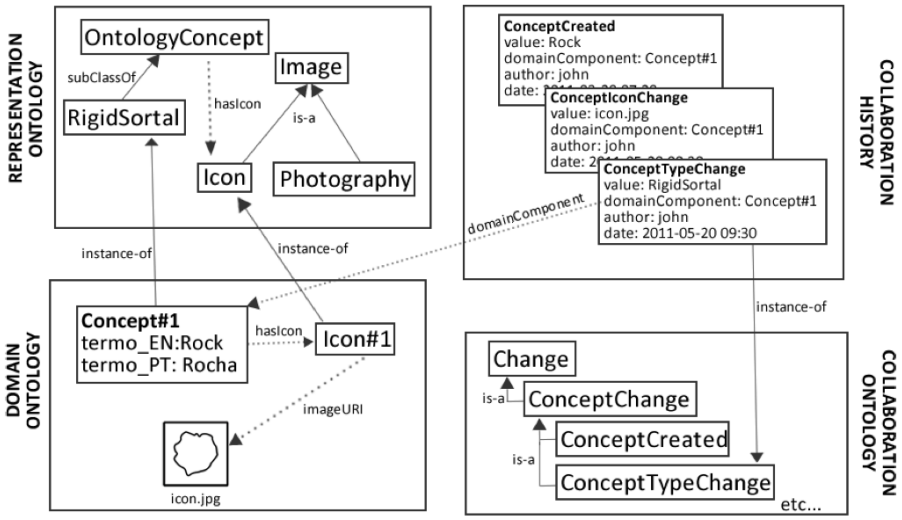

Figure 1. The collaboration structure

Currently, this approach covers *Endurants* objects in building models. But it is important, for Geology interpretation or natural phenomena, to represent the transformation of objects (*Endurants*) through the events.

4. Supporting Events from UFO-B

This work is an extension of the work presented in [Torres et al. 2011, Torres 2012], in which it was developed an environment to support collaborative construction and evolution of domain ontologies based on UFO-A. Now, we are concerned with the temporal aspects, i.e., with the representation of UFO-B events in that same environment. This section presents the modifications realized in the original meta-data ontologies ($R.O.$ and $C.O.$) used to specify the structure of the domain ontology components and collaboration

episodes. These modifications were realized in order to represent the temporal aspects in the domain ontologies created for this system. The first change made was to organize the meta-data ontologies to reflect the taxonomic structure of the foundational ontology UFO. Figure 2 depicts the main differences between the original and the new taxonomy in the $R.O.$.

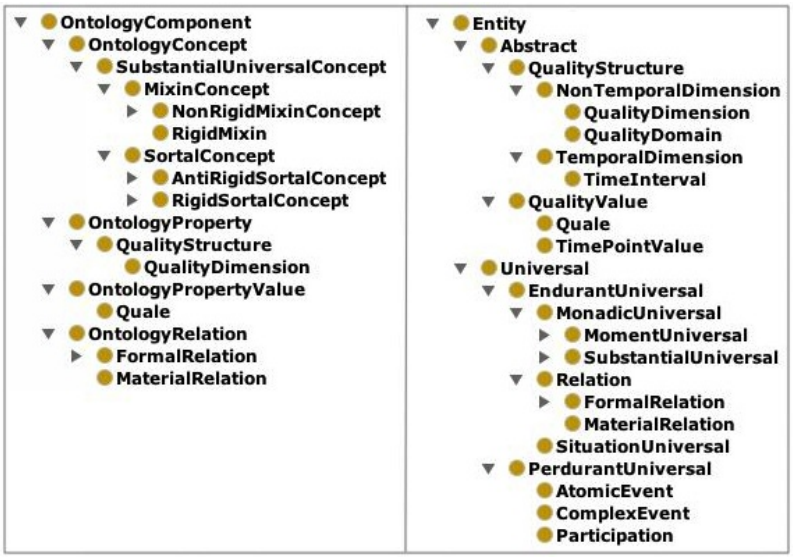

Figure 2. On the left, a fragment of the former $R.O.$. On the right, the updates performed

We renamed some terms of this meta-data ontology to conform to terminology used in UFO, and thus avoid possible confusion between the terms used in this work and in the UFO. For example, the term *OntologyComponent* was the concept from which all other concepts were specialized. In UFO, the concept that is the *top concept*, i.e., the concept from which all other concepts were specialized is the concept named *Entity*, so we renamed the term *OntologyComponent* to *Entity*. We have also made changes in the taxonomy of this meta-data ontology. For example, the *Relations* were structured as expected in the UFO, i.e., as an *EndurantUniversal*. There were many changes in nomenclature and taxonomy to match the terms used with those predicted in the UFO.

In order to organize the changes made, we will first present the theoretical concepts of UFO-B, and then show the changes made to represent the concepts in the approach proposed by Torres. Below, we explain some theoretical concepts from UFO-B along with the modifications made in the meta-data ontology to support the representation of them.

Mereological Structure: Events are examples of entities that obey the so-called Extensional Mereology, we have that: i) No event is part of itself; ii) If event X is part of event Y then event Y is not part of event X; iii) If event X is part of event Y and event Y is part of event Z then event X is part of event Z; iv) If event Y is part of event X then there is an event Z disjoint from Y which is also part of X; v) Two events are the same if and only if they are composed of exactly the same parts. Figure 3.A depicts the mereology structure in the $R.O.$.

Ontological Dependence: The Events from UFO-B are ontologically dependent on a relationship of participation with any object from UFO, i.e., an event exists only

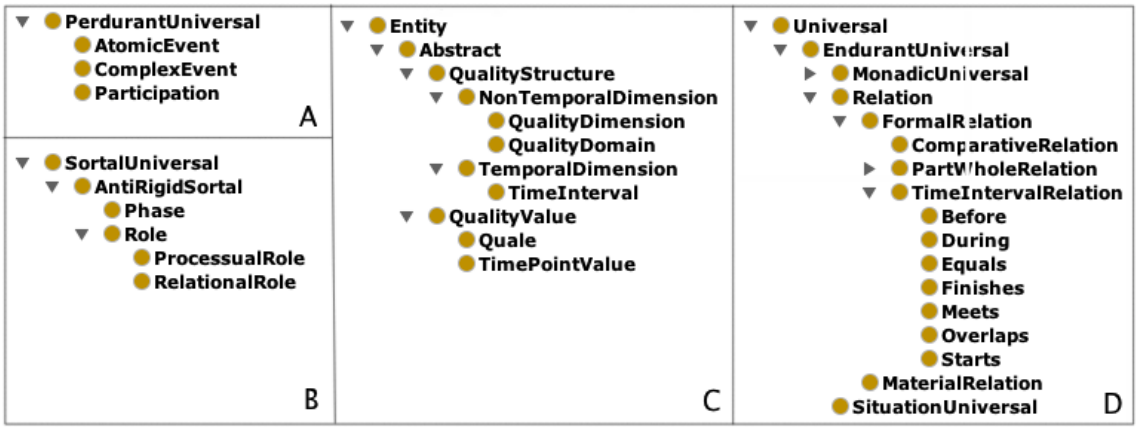

Figure 3. A) the mereologic structure of events and the Participation concept; B) the role differentiation in the UFO-B; C) the temporal qualities; D) the time interval relations

if at least one object is participating on it. The UFO-B provides the use of a special construct to establish a participation relation with one *object*, the construct is called *Participation* and it is depicted in Figure 3.A.

Role Diferentiation: When an object is participating in an event, he is playing a role in this event, which is not the same role that this object could play out of this event. Then we specialize the UFO-A *Role* concept in two types of *roles*: Those who are existentially dependent on some *Endurant* and those who are existentially dependent on some *Perdurant*. We call, respectively: *Relational Role* and *Processual Role*. Figure 3.B depicts this distinction in the $R.O.$.

Temporal Qualities: Events can be bearer of qualities, for example, a football game can be disputed, a conversation can be boring, and depositional process can be slow. Every event has a common property: its duration. Every event is framed by a time interval. And a time interval is associated with a temporal structure, which is analogous with a quality structure. An event is framed by a time interval T if we have TP_b and TP_e, that are quality values in a given temporal structure and, TP_b is the begin time point, and TP_e is the end time point. Figure 3.C depicts the changes realizes in the $R.O.$ in order to represent the time structures.

Time Interval Relations: Events may have relationship between then. We have a special kind of relationship between events which can be used to establish relationships of a partial or total ordering in their occurrences, for this we use de called Allen's Relations. These relations are added in the $R.O.$ and it is depicted in the Figure 3.D.

Change in the *State of Affairs*: Events can change the world by changing the *State of Affairs*. A *Situation* is defined in the UFO-A and it represents a particular *state of affairs*, i.e., a situation can be seen as a portion of reality that can be understood as a whole. An event takes one situation to another: from a pre-situation to a post-situation, i.e., an event has a pre-situation relationship with a particular situation, and a post-situation relationship with another particular situation different from first. We can define a Situation as a set consisting of several objects (including another situations). The inclusion of the Situation construct in the $R.O.$ are depicted in Figure 3.D.

The modifications in the $C.O.$ are still not completed in the date that this paper was written. Then, this discussion will be taken at a future opportunity.

5. Conclusions and Future Work

This work presented some modifications performed in the Torres' work to support the representation of UFO-B events in an ontology collaborative construction system. The objective of this project, in the long run, is to support the reasoning of geological interpretation of depositional process based on described characteristics of sedimentary rocks. We expect that a well founded domain ontology, built with the support of a collaborative tool, would express the geological concepts in a more precise way, therefore supporting useful interpretations.

The meta-ontologies introduced in the Torres' work were developed to provide a basis for the collaborative construction of language-independent domain ontologies, and were based on the constructs from UFO-A. Now, this work is expanding this basis, improving the meta-ontologies and supporting the representation of events and temporal aspects inherited from UFO-B. Currently this work is in constant development.

6. Acknowledgements

The scholarships in this project are funding by the program PETROBRAS PFRH 17 and CNPq. Material funding was supported by ENDEEPER Knowledge Systems.

References

Carbonera, J. L. (2012). Raciocínio sobre conhecimento visual: Um estudo em estratigrafia sedimentar. Master's thesis, Universidade Federal do Rio Grande do Sul.

Carbonera, J. L., Abel, M., Scherer, C. M. S., and Bernardes, A. K. (2011). Reasoning over visual knowledge. In *Proceedings of Joint IV Seminar on Ontology Research in Brazil and VI International Workshop on Metamodels, Ontologies and Semantic Technologies*. Ontobras/Most.

Guizzardi, G. (2005). *Ontological foundations for structural conceptual models*. PhD thesis, CTIT, Centre for Telematics and Information Technology, Enschede.

Guizzardi, G., de Almeida Falbo, R., and Guizzardi, R. S. S. (2008a). Grounding software domain ontologies in the unified foundational ontology (ufo): The case of the ode software process ontology. In *CIbSE*, pages 127–140.

Guizzardi, G., Falbo, R., and Guizzardi, R. S. S. (2008b). A importância de ontologias de fundamentação para a engenharia de ontologias de domínio: o caso do domínio de processos de software. *Revista IEEE América Latina*, v. 6(n.3):p. 244–251.

Torres, G. M. (2012). Construção colaborativa de ontologias para domínios visuais utilizando fundamentação ontológica. Master's thesis, Universidade Federal do Rio Grande do Sul. No Prelo.

Torres, G. M., Lorenzatti, A., Rey, V., da Rocha, R. P., and Abel, M. (2011). Collaborative construction of visual domain ontologies using metadata based on foundational ontologies. In *Proceedings of Joint IV Seminar on Ontology Research in Brazil and VI International Workshop on Metamodels, Ontologies and Semantic Technologies*. Ontobras/Most.