

Supporting collaborative conceptualization tasks through a semantic wiki based platform

Carlos Sá¹, Carla Pereira², Cristóvão Sousa³, António Lucas Soares⁴

1) Instituto de Engenharia de Sistemas e Computadores do Porto, Porto, Portugal

ryuxuyr@gmail.com

2) INESC, Porto, Portugal

csp@inescporto.pt

3) INESC, Porto, Portugal

csp@inescporto.pt

4) INESC, Porto, Portugal

als@fe.up.pt

Abstract

The collective development of conceptual structures has not been satisfactorily addressed in the knowledge representation research literature. Nevertheless and assuming that a shared conceptualization of a given reality is the cornerstone to build semantic artifacts such as ontologies, this paper presents ConceptME, a platform that supports the collaborative modeling of conceptual models. The platform is based on semantic web technologies and proposes a set of functionalities for importing, creating, manipulating, discussing and documenting conceptual models that can act e.g., as the specification of a formal ontology. The platform is in a prototype state and is being tested and used in a research project¹.

Keywords: Knowledge management, Semantic Web, Social construction of meaning

1. Introduction

The use of semantic artifacts, such as taxonomies or ontologies, in organizations is becoming more and more frequent and important. If we consider organizational networks, particularly the ones where relationships are materialized mainly in collaborative processes (collaborative networks), these artifacts become even more important and this is reflected, for instance, in the support provided to discussion and negotiation activities during the initial stages of common projects, or in the implementation of processes for information classification, structuring and retrieval. Focusing on ontologies (as a computational semantic artifact), it is widely accepted

¹ The work presented on this paper describes results obtained in the *cogniNet* project funded by the *Fundação para a Ciência e Tecnologia* under the contract and PTDC/EIA-EIA/103779/2008

that, since they are the "specification of a conceptualization", the construction of a shared conceptualization is a fundamental process.

According with [15], the conceptualization process has as input non structured and informal domain Knowledge and representations of conceptual structures. The main output is an enriched conceptual structure. Ontologies can be constructed by formalizing conceptual structures, however, and agreeing with [15], the conceptualization process is a socio-semantic process and requires involvement and agreement from several actors. Therefore, there is an increased difficulty in managing this process due to informal nature of Conceptual models (Cmodels) as they do not follow any specific metrics or guidelines. Nevertheless, this process has not been sufficiently studied and there are no suitable and effective tools to support it, particularly if considered within a collaborative network of organizations. Being the conceptualization support the main focus point of this research work, this paper presents a new system named ConceptME which supports the collaborative development of conceptual structures. The specification of the platform was accomplished in an iterative and incremental mode, considering the knowledge obtained mainly during two action-research based projects [1]. ConceptME prototype was developed in order to accomplish the envisioned objectives: (1) Support Cmodels collaborative development, regardless of their domain, (2) interoperability: allow reusing and sharing Cmodels, and (3) support users in the knowledge sharing and visualization. In Fig.1 is illustrated the main focus of this platform.

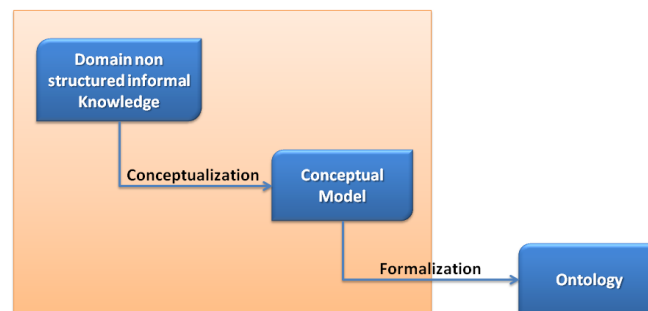


Figure 1 – Focus on building the conceptual model. (Source: [15])

2. Related Work

Tools and methodologies for the collaborative development of ontologies have been emerging in the last years, but only a few focuses in the first stages of the ontologies development process, more specifically in the conceptualization process. The OntoShare platform, described in [9], is closely related to the On-To-Knowledge methodology. This tool is a Java based client where users can collaborate in a virtual community, contributing for the growth of a shared ontology. According to [9], OntoShare has the capability to summarize and extract keywords from the Web, allowing users to automatically share information and create RDF²-annotated information resources. Others methodologies like Two-layered approach to knowledge representation [10], opt to use graphical representations to allow users to share their ideas in the collaborative conceptualization process. According to [11], concept maps are an effective way of representing a person understanding of a domain of knowledge. ConceptME also uses concept maps for the visualization of Cmodels. HCOME [12] also supports ontology development and evaluation by communities. Users have access to different spaces where ontologies can be stored before being shared. When ontologies are accepted they are moved to an Agreed space. In the context of this methodology a prototype was developed, HCONE [13], also developed in java, and provides features for ontology management, user communication, reasoning services for consistency, but unfortunately it has not been updated and currently is not

² Resource Description Framework

supported. One interesting aspect in HCONE is the strong participation by the users in the conceptualization process, heavily focused in the participation, discussions and knowledge sharing.

The NeOn Toolkit is a free, open source ontology editor, developed under the NeOn Project. It provides an extensive set of plug-ins covering a variety of ontology engineering activities, including annotation, documentation, and interaction among other ontology editing features. According to [6] Semantic wikis are a solution for both creating and managing pages but also allows knowledge representation. Its main objectives are facilitating the authoring of formal or informal ontologies, provide collaborative design mechanisms, discussion environment and Integration with the Semantic Web Technologies. OntoWiki [7] is semantic wiki more oriented for ontology management and creation of semantic knowledge bases. Due to its technical side it is not very easy to use by regular users who may not have training in formal notations. MokiWiki [8] is another Semantic Wiki empowered platform that focuses on Enterprise modeling. It is based on Semantic Media Wiki, like ConceptME, and supports the collaboration in the development of enterprise models from an informal to a formal state. Unlike MokiWiki which focus mainly on Enterprise modeling, ConceptME can be used to model a wide range of scenarios and domains, i.e. Health, Insurance, Education, Finance, etc.

Although these approaches are quite interesting and each one has important features and characteristics, currently there is no platform that brings together all necessary functionalities to meet the requirements of a platform that supports the collaborative development of Cmodels, within a semantic enabled platform.

3. ConceptME Framework

The main aspects considered in the design of ConceptME were collaboration, user interaction and interoperability. In this section is presented in detail the main considerations taken in the systematization of our vision.

Collaboration

Collaborating in the development of shared Cmodels is a process strongly dependent to the participation of several partners with the same purpose, which is the specification of a given domain. Therefore, supporting the collaboration between partners, regarding the exchange of ideas, debate and negotiation is of great importance for the outcome quality. In our approach, network partners form work groups cooperating towards the conceptualization of a given reality. They can develop their proposals asynchronously, while creating discussions and brainstorming sessions. This is particularly important due to the possible physical distance between actors or time difference. Being ConceptME a collaborative platform used by users with different skills, backgrounds and with different point of views, it is also interesting to take advantage of the synergies generated by supporting a decentralized development environment. This environment is inspired on a method to support the collaborative conceptualization process [14] and is formed by aligning each partner's proposal in order to reach a single proposal, resulting in richer and more comprehensive models. We chose to make the platform as generic as possible, regarding methodologies to support the conceptualization processes. This makes the platform easier to use and moreover, makes it extensible and configurable for a wide range of scenarios where specific conceptualization methodologies may be used. So, if users do not want to follow any specific methodology, they are free to collaboratively construct their models using a large part of the platform functionalities, without being restricted by conceptualization processes rules and constraints. In Fig. 2 is possible to observe the basic structure that supports the cooperative modeling activity.

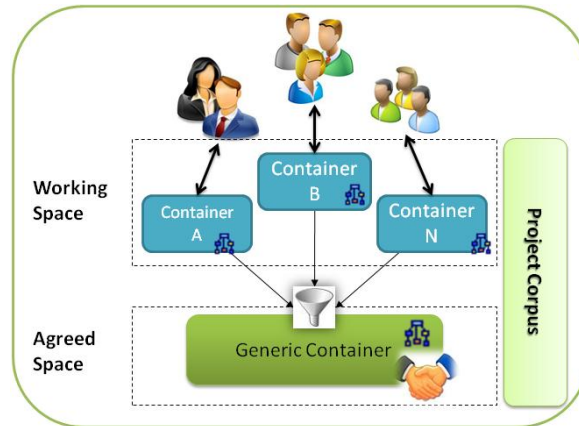


Figure 2 – Conceptualization project structure in ConceptME.

User interaction

Usability is a major concern in any system designed to be used by large communities. The need to provide tools that can be used effectively and with minimum effort became a very important aspect for the cooperative modeling activity. Semantic Wikis are a good example of collaborative and usable systems which allows users to create and manage meaningful content in a web based environment. Other approaches do not give much importance to usability matters, making it difficult for domain experts to contribute with their knowledge. The vast majority of ConceptME users are domain experts. Such users have a high level of knowledge in specific areas, however, they may not be familiar with complex ontology management systems. Therefore, we intend to support these users in the conceptualization tasks, providing them tools that support the selection of relevant resources, decision support and guidance through the evolution of their proposals. Another fundamental aspect for the easy understanding and visualization of Cmodels are their graphical representations. These representations allow a quick understanding of the relationships between concepts and their surroundings, and moreover, facilitate the identification of possible errors and ambiguities.

Interoperability

Cmodels as the main result of the conceptualization process are an abstraction or a simplified view of a given reality. The main objective of using Cmodels is to express the meaning of terms of a given domain, and to specify the correct relationships between different concepts. Cmodels contributes to the clarification of the meaning of various, usually ambiguous terms, and ensure that different interpretations of a given reality cannot occur. However, in order to take advantage and be able to share these models with other entities, it is required to formalize them. In other words it is necessary to map these models in accordance with schemas or knowledge representation standards, e.g. RDF(s). We call these formalized versions as informal ontologies. According to [2], informal ontologies may be specified by a catalog of types that are either undefined or defined only by statements in a natural language. Then, informal ontologies may be axiomatized and its formalization improved by other applications such as Protégé [3]. Cmodels in ConceptME are stored in a Triple store, allowing to share semantic information and content with third-party applications.

4. Collaborative modeling with ConceptME

ConceptME is a wiki-based platform that joins semantic technologies with content and *Meta data* management. The main objective is to support the collaborative development of Cmodels in an easy and intuitive way, giving focus to graphical knowledge representations. The platform enhances negotiation and discussion capabilities by means of specialized extensions. Cmodels manipulation, management and consistency analysis are also supported within the platform. Cmodels development is supported by allowing users to associate relevant resources to their projects which can be used to extract candidate terms that can be used in their conceptualization process. Cmodels elements are mapped into wiki pages, creating a semantic repository of wiki articles. This allows users to perform semantic operations over the content, persist Cmodels meta data in a Triple Store and export data to standard formats (e.g. RDF, OWL³ or XTM⁴). This enhances ConceptME search capabilities and information retrieval. The intended platform can be used without high IT expertise, in order to form discussion and work groups, joining together their efforts in the conceptualization of a given domain.

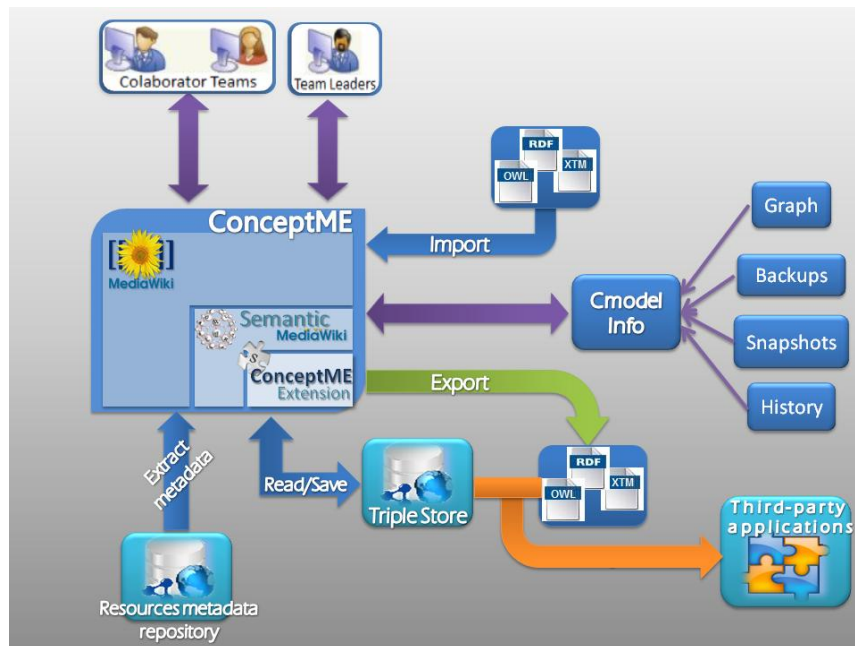


Figure 3 – ConceptME high level view and context.

As can be observed in Fig.3, conceptME is based on Semantic Media Wiki (SMW) [5], extending it with advanced features to support the collaborative modeling of conceptual models. It was also developed an extension to support interoperability and Cmodel management. ConceptME associates wiki pages to each Cmodel element, representing an informal but structured view of the model, allowing taking advantage of SMW semantic features, visualizing and browsing its contents, discussing, negotiating and using manipulation functionalities. SMW allows users to annotate wiki pages with properties giving meaning to relations between pages, e.g. the page Berlin has the following annotation [[Is capital of::Germany]]. Accordingly to RDF specification this can be seen as a Triple where the Subject is “Berlin” the Predicate is “Is capital of” and the Object is “Germany”.

In ConceptME, each Cmodel proposition is considered as a Triple. These Triple components are mapped as wiki pages within a specific namespace. From its beginning

³ Web Ontology Language

⁴ XML Topic Maps

ConceptME was envisioned as a platform where different conceptualization projects could take place, allowing the existence of identical terms in different projects. For instance, it is possible to have several subjects and objects with different meanings depending on its context. For example, the concept “Berlin” which is connected with “Germany” by a relation “Is capital of” may exist in different Cmodels. To overcome this limitation emerged the need to associate namespaces to wiki pages, allowing the mapping of Cmodels elements labels to unique wiki pages URLs. However, the semantic layer is implemented to consider only the labels of the concepts instead of the URL, as can be observed in Fig. 4.

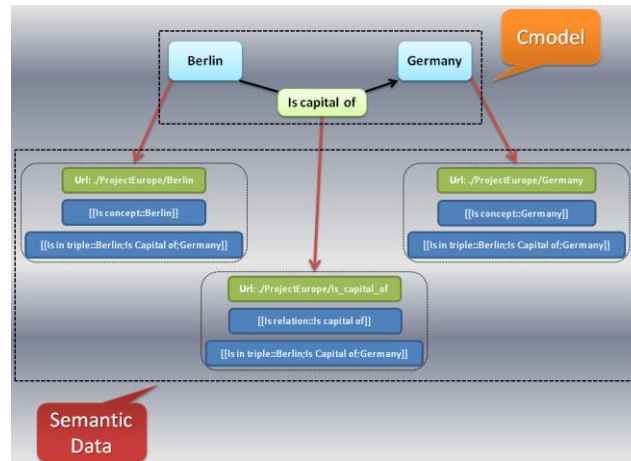


Figure 4 – Cmodels meta-model at ConceptME.

5. ConceptME functionalities

Visualization functionalities

As previously said, ConceptME is based on SMW, then web-based. Users can modify conceptual models, view and navigate between its elements in an understandable graphical representation. On the other hand users can easily exploit the semantic features of SMW using its semantic extensions. Conceptual models graphical representations are easily understandable and allow users to rapidly find information about specific Cmodel elements. They are interactive and allow navigation between its elements. Its representation follows a concept map structure and is updated with every change detected, triggering the re-generation of the diagram.

Interoperability functionalities

Cmodels in ConceptME can be formalized and exported to standard formats, like RDF(s), OWL and XTM. Importing from standard formats is also allowed. In a more technical point of view, when importing a formalized model, its structure is mapped in wiki pages in accordance with ConceptME Meta model. In an initial phase imported models are persisted in the Cmodel Repository. The export process consists in formalizing or converting the structure of a Cmodel to a standard format.

Cmodel Management functionalities

ConceptME as a collaborative modeling platform provides functionalities for the manipulation and edition of conceptual models. These operations consist in adding, renaming and removing concepts or relations. It also allows users to attach or remove resources to concepts and

descriptions. ConceptME also manages Cmodels changes history and has a versioning management system which allows reverting or committing previous states. It also allows backup and creating snapshots. When a network is formed, projects are created and containers are allocated to each group, the collaborative conceptualization process can begin. Therefore each group can work on their private proposal in their respective container. Whenever each proposal is ready to be shared with the entire network, they are moved to a Generic Container (or public container) to be discussed and improved by all network actors. This transition is carried out by automated operations that search for similar terms and propositions in all proposals and consequently merge the initial proposals in single model which is stored in the Generic Container, as can be observed in Fig. 2.

Negotiation functionalities

Communication in the cooperative modeling activity is a fundamental aspect, as well as achieving consensus when conflicts arise. Therefore, ConceptME provides discussion environment via forum, negotiation via commenting, rating and voting on each Cmodel element. Users can take advantage of these features while modeling their proposals and can be notified whenever changes are made in pages of their interest.

Modeling support functionalities

One of the main problems when modeling a domain conceptual model lies on the lack of support regarding the on-going modeling activity. In the collaborative development of conceptual models the documentation support is a very important aspect. In ConceptME users can select a collection of pre-classified resources for a project and retrieve relevant data from them. For instance, it may be interesting to extract relevant candidate terms from unstructured textual documents. The resource selection can be carried out by accessing a resource repository where resources are categorized, classified and rated. Therefore, in a conceptualization project, users can create a resource corpus based on selected resources, which can be used as reference for the entire process. When resources are attached to a project, ConceptME allows to extract relevant terms (candidate terms), based on specified metrics and the project domain. These candidate terms can be accessed by users and used in their proposals. To align the direction of each partner proposal, ConceptME provides decision support functionalities to help users in the modeling activity. These functionalities are presented to users in form of suggestions messages, term clouds, auto complete fields, pop ups and statistic data, e.g. “The term ‘France’ was used in 75% of the network” or “Did you mean City instead of Cities?”. Along with decision support, consistency analysis is also a matter of importance. According with [16], in concept maps construction there are a set of rules and guidelines that helps users to build better concept maps. In ConceptME users are encouraged to follow pre-defined guidelines to achieve better results in their task. These guidelines consist in pre-defined best practices for Cmodel construction.

6. Conclusions and future work

In this paper was presented the vision and a platform to support the development of shared conceptualizations. This was achieved by extending Semantic Media Wiki and developing a set of extensions to support the required functionalities. Visual knowledge representation, consensus building, on-going development support and interoperability are the main areas of the collaborative conceptualization process supported by ConceptME. The main characteristics that distinguish ConceptME from other approaches mentioned in section are: the use of integrated graphical representations for visualization of conceptual models, the paradigm of continued

support and collaborative development of shared conceptual models, conception and association of semantic information and the automated support for the formalization, integration and interoperability of conceptual models. Another important differentiating factor lies in the generic nature of the platform, in which conceptual models can be modeled independently of its domain and on the other hand, the possibility to customize the platform for specific conceptualization processes.

The experiments carried out through an action-research approach in two multi-national projects revealed a high receptiveness regarding the use of the approach. In conclusion, the development of ConceptME prototype proved to be possible to implement a web semantic enabled Cmodel modeling system and fill a gap in collaborative knowledge building. This approach is a good way to overcome the limitations of untrained users, that cannot be expected to conform with the constraints of formal semantics. Nevertheless, a more rigorous approach to the evaluation of the tool is needed. As intended future work, we plan to further develop consensus building features, polish visualization techniques, resources integration and decision support to improve the usability of the platform.

7. References

- [1] Pereira, C.; Sousa, C.; Soares, A. "Building an informal ontology to support collaborative network operation: a case study". Accepted in the *11th IFIP Working Conference on Virtual Enterprises*, Saint-Etienne, France, 2010.
- [2] Sowa, J.F. (2006). "Concept Mapping." <http://www.jfsowa.com/talks/cmapping.pdf>
- [3] Protégé: The protégé project (2000) <http://protege.stanford.edu>
- [4] Alberto J. Cañas, Greg Hill, Adrián Granados, Carlos Pérez, Juan David Pérez. "The Network Architecture of CmapTools.", *Institute for Human and Machine Cognition*, 2003
- [5] Krotzsch, M., Vrandečić, D., Volkel, M. "Wikipedia and the semantic web - the missing links". In: *Proc. of the 1st Int. Wikimedia Conference*, 2005.
- [6] Tolksdorf, R., and Simperl, "Towards Wikis as Semantic Hypermedia". Institute of Computer Science, *Networked Information Systems*. Berlin, Germany, 2006.
- [7] Sören Auer, Sebastian Dietzold and Thomas Riechert, "OntoWiki – A Tool for Social, Semantic Collaboration", *The Semantic Web-ISWC 2006*, 2006.
- [8] Chiara Ghidini et al., "MoKi: The Enterprise Modelling Wiki", *The Semantic Web: Research and Applications Lecture Notes in Computer Science*, 2009.
- [9] Davies, J., Duke, A., Sure Y. "Ontoshare: a knowledge management environment for virtual communities of practice". In *K-CAP '03: Proceedings of the international conference on Knowledge capture*, New York, NY, USA, 2003.
- [10] Gómez-Gauchía, H., Díaz-Agudo, B., González-Calero, P. "Two-layered approach to knowledge representation using conceptual maps and description logics." *Proc. of the First Int. Conference on Concept Mapping*, A. J. Cañas, J. D. Novak, F. M. González, Eds. 2004.
- [11] Alberto J Cañas et al., "CMAPTOOLS: A KNOWLEDGE MODELING AND SHARING ENVIRONMENT - Concept Maps: Theory, Methodology, Technology", 2004.
- [12] K. Kotis, GA. Vouro. "Human-centered ontology engineering: The HCOME methodology", *Knowledge and Information Systems*, Springer, 2006.
- [13] K. Kotis, GA. Vouro. "The HCONE approach to ontology merging", *The Semantic Web: Research and Applications*, Springer, 2004.

- [14] Pereira, C., Soares, A., “Ontology development in collaborative networks as a process of social construction of meaning.” On the Move to Meaningful Internet Systems: *OTM 2008 Workshops*, Lecture Notes in Computer Science, Springer Berlin / Heidelberg, November, 2008.
- [15] Pereira, C., “A organização da informação e conhecimento em redes colaborativas como um processo de construção social do significado: uma teoria e um método prático”. PhD Thesis. Faculdade de Engenharia da Universidade do Porto, 2010.
- [16] Joseph D. Novak & Alberto J. Cañas. “The Theory Underlying Concept Maps and How to Construct and Use Them”, Institute for Human and Machine Cognition, 2008.