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Ontology Maturing with Lightweight Collaborative Ontology Editing Tools

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Abstract. *Ontology building is an important prerequisite for state-of-the-art semantic technologies for knowledge worker support. But ontology engineering methods have so far neglected the early phase of ontology building where a conceptualization only exists rather informally and undergoes continuous evolution through collaboration and interaction within the community. We have to view ontology building as a maturing process that requires collaborative editing support and the integration into the daily work processes of knowledge workers. In spirit of current Web 2.0 applications, we present an AJAX-based lightweight ontology editor as a first approach to this problem.*

1. Introduction

Within state-of-the-art semantic approaches, ontologies have emerged as the key to enable more advanced technological support for knowledge workers. However, current research and development concentrates more on what we can do as soon as we have ontologies—rather than having a closer look at the processes of creating and especially maintaining such (domain-specific) ontologies. In real-world settings these issues are crucial and insufficiently dealt with. Either we assume that there is a modelling expert moderating the ontology creation processes (on whom users will depend indefinitely) or we assume that users become ontology modelling experts right away. Both depend on users acknowledging the importance of modelling and using ontologies. But actually, users are concerned with their work processes and regard ontology modelling as an overhead. Still, if we have a closer look at knowledge work processes, we discover that knowledge workers *are* concerned with ontologies—they are constructing and negotiating shared meaning in collaboration with others by augmenting and evolving a community vocabulary. The main challenge is then how to leverage this *implicit and informal* ontology building for the *explicit formal* models *needed for semantic approaches.* In this paper, we want to investigate this further both on a conceptual and technical level. On the conceptual level, we want to explore the idea of ontology maturing, on the technical level we

want to present the lightweight collaborative tool **SOBOLEO** (**So**cial **Bo**okmarking and **L**ightweight **E**ngineering of **O**ntologies) supporting such ontology maturing processes. First, we will collect requirements and introduce the notion of ontology maturing (section 2) before exploring existing work (section 3). In section 4 we present our approach and its implementation before concluding in section 5.

2. Requirements and the Issue of Ontology Maturing

2.1 General Requirements

At first, we have to acknowledge that ontology building is not the primary activity of knowledge workers but that vocabularies emerge in their daily work implicitly. Thus, we need to integrate work processes with ontology building processes. This leads to the following general requirements:

- *Task-embedded.* Building ontologies must be integrated with the users' usual tasks, i.e., when using ontologies (e.g., for annotation, or navigation); necessary changes must be possible on demand and with low effort. This especially implies that we have no separate setup phase, but rather continuous maintenance.
- *Easy to understand.* As we cannot assume that users are modelling experts, the complexity of the ontology editing tasks must be reduced to a minimum. This also means balancing the expressiveness of ontologies with the usability of the editor; e.g., by reducing constructs to taxonomic structures.
- *Collaborative.* Not only because ontologies are shared conceptualizations, but also because we must distribute the editing effort over a larger number of people.

2.2 The Issue of Ontology Maturing

In addition to these general requirements, we also need to consider that it is not always *possible* to define ontologies, especially in knowledge work settings, even if there were enough time for domain experts explicitly sitting together with knowledge engineers to model the ontologies. This can be traced back to the fact that defining ontological entities requires a specific level of formalization (and thus understanding). However, in knowledge work there are always concepts not clearly defined yet. They underlie a process of continuous evolution where a common vocabulary matures only gradually through the interaction with others. Based on the knowledge

maturing process introduced in [Sch05], we have to view ontology building as a maturing process (see fig. 1). It starts with some emerging ideas of the individual without having a clear or even shared terminology, communicated only informally. These vague concept ideas are gradually disseminated into the community where the community discusses and consolidates them. The result of this can still be textual definitions without a formal semantics. The formalization is accomplished in a third phase in which a common conceptualization and terminology matures until a formal ontology is established. These maturing phases apply to individual parts (concepts, relations etc.) of the ontology so that the ontology as a whole is under continuous transformation and always characterized by different degrees of maturity.

Therefore, we need support for (a) the transition of the individual emergent idea level to the community level and (b) the community level itself where we must not require too much formalization at the beginning and where the users can start with informal structures like tagging which they can formalize later on.

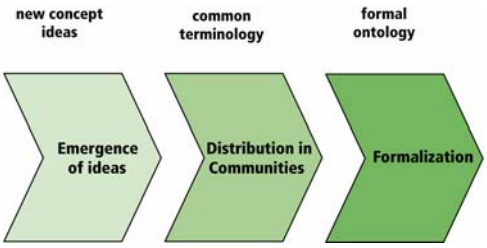

Figure 1: Ontology maturing process

3. Related Work

For ontology engineering several methodologies have been proposed. They define how to support the ontology life cycle from development, via evaluation and maintenance, to further evolution. An overview is given in [Fer02]. However, these methodologies focus on expert knowledge engineers and not on knowledge workers. A more "human-centered approach" is taken by [KVA04] with HCOME. They also view ontology development as a dynamic process and focus particularly on ontology evolution. They assume a decentralized engineering model where everyone first formalizes her own ontology and shares it in a further step within the community. There, the individual ontologies are merged or further developed. However, findings in [AMR06] (based on action theory) suggest

that collaboration plays a more important role *before* we have formalized (individual) ontologies. So we think that the HCOME methodology can benefit from incorporating the notion of different maturity levels.

Partly embedded into methodologies, *editing tools* like Protégé[1] or KAON OIModeler [MMS03] are commonly used for ontology building. ([PAL02], [Den04]) discuss them in detail. Most existing ontology editors are standalone desktop applications lacking a collaborative environment or providing only little support (except of KAON). Like the methodologies, these tools are not geared towards knowledge workers and their work processes and thus not task-embedded. Further, they consider ontology construction as an isolated and detached task. The evolutionary process, where the concepts are informal at first and yet not established, is not supported.

Other approaches considering more the aspects of collaboration and early stage in ontology construction are based on *wiki systems* where in particular the semantic wiki systems try to extend the traditional wikis with semantic web technologies (e.g. Semantic MediaWiki [VKV06], OntoWiki [HBS05] or IkeWiki [Sch06]). These systems help the users to create definitions (e.g. beginning with informal texts) and are suitable for complex coordination and consolidation processes, but they are usually more time-consuming. For more complex use cases a combination with our approach is conceivable.

A third application group is formed by the *collaborative tagging systems* that are getting more and more popular on the web. Their lightweight approach allows the user to assign easily keywords to various contents. The social bookmarking systems BibSonomy (cf. [HJS06]) and Del.icio.us[2] further allow to group tags underneath a super-tag. However, they do not define a clear concept structure and this functionality is very restricted. For instance, all super-tags are listed alphabetically with their sub-tags. Structures like super-tags of super-tags are not further regarded.

4. Approach & Implementation

4.1 Task-Embedded Ontology Building

If we regard embedding into working processes as a primary requirement, we have to analyze how users could move from work processes to ontology building. For this purpose, we assume to have ontology-based tools like

[1] cf. http://protege.stanford.edu
[2] cf. http://www.del.icio.us

task-embedded annotation tools (e.g., ontology-enabled social bookmarking or in-place annotation of documents) and retrieval tools supporting both exploratory and query-based search. The following list presents opportunities or triggers for moving from working to ontology building:

- *Tagging resources.* In the first phase of the maturing process ("emergence of ideas"), we can only expect an informal tagging of resources as an annotation. These are just added informally.
- *Discovering tags of others (or previously used tasks).* When comparing currently envisioned tags with previously used ones or tags from other people for the same resource, similarities and differences can be discovered that allow for creating concepts from tags.
- *Navigating imperfect structures.* Especially when retrieving resources in a (semi-)navigational style, users often discover semantic inconsistencies in the taxonomy and from there change the structure.
- *Refining existing concepts.* Both during searching and annotation, users also discover missing lexical entries or missing taxononomic relationships (e.g., in the case of multiple broader terms).

From this, we can also conclude that we need special ontology transparency mechanisms in the tools that use the ontology, e.g. annotation tools must list previously used tags or tags for the same resource of other users, search tools must provide navigation possibilities etc.

4.2 Lightweight tool functionality

We propose a lightweight ontology editor and web annotation tool integrated into the browser. With our approach adding an informal idea to the ontology is as simple as searching Google, the editor is never more than one click away. The core design principles were:

- Our approach supports *tagging* to allow users to define concepts in a free and informal manner without the usual modelling overhead. Later, tags can be abstracted into concepts and placed into the taxonomy.
- Users are always working on a *shared ontology* where everyone has the right for editing and modifications following the wiki paradigm of self-regulation.
- For structuring the concepts we concentrate solely on *taxonomic relations*. As our requirements analysis and [HJS06] revealed, the taxonomic relationship is the dominating one. Going beyond the common tagging systems, where the users can only bundle concepts underneath another, the users can organize their concepts within our approach in a shared structure of one or more trees where the concepts

are connected by “broader”, “narrower” and “related” links according to the SKOS Core Vocabulary [MB05] and where each tree represents a part (or facet) ontology .

- Another important feature is the *separation of the conceptual and lexical layer* to overcome the problem of multilingualism and synonymy. Thus, the emerging ontology has the structure of a structured controlled vocabulary where concepts have one preferred label and a number of alternative labels or synonyms. Further, the users can add to each concept a textual description.

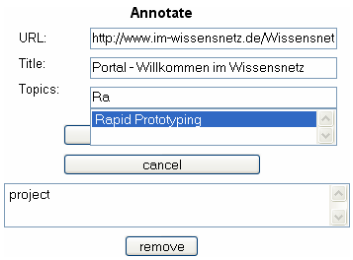

Figure 2: Tagging an online resource with concepts.

This approach of ontology building is easy to integrate into the users’ usual work processes; e.g. social bookmarking systems are used to search, collect and share weblinks and publications (cf. fig. 2). If a needed concept does not exist in the shared ontology or is not suitable, the users can create a new concept or modify an existing one in a natural and seamless way. Thus, the ontology evolves gradually without explicit and laborious modelling.

Another use case can be found in the semantic annotation of documents. There are semantic annotation tools (for an overview see [Cor06]), which also allow for editing the underlying ontology. However, so far they integrate the usual ontology editors that do not support *collaborative* ontology editing. We plan to integrate an “in-place” annotation tool which enables “semantic note-taking” during reading an article or presentation. If modifications seem to be appropriate, our web-based ontology editor will be invoked.

4.3 Implementation

For the demonstration of our approach to ontology building, we have built SOBOLEO—a lightweight ontology editor based on AJAX technology (using the Google Web Toolkit[3]) that does not require any local installation and can be easily invoked from other applications; e.g. here in combination with social bookmarking (cf. fig. 2).

Our editor (cf. fig. 3) displays a tree view of all concepts and their relations on the left hand side of the screen. When a concept is selected in the tree

[3] cf. http://code.google.com/webtoolkit/

view its properties are displayed and can be changed in the middle part of the screen. The editor further supports the creation of narrower, broader and related links through auto completion. It also has a chat panel on the right hand side that allows having a conversation with other people editing the same ontology at the same time. Informal tags are added into a special branch with “prototypical concepts” and can be consolidated later on by merging and placing them into the taxonomy following the wiki paradigm of self-regulation.

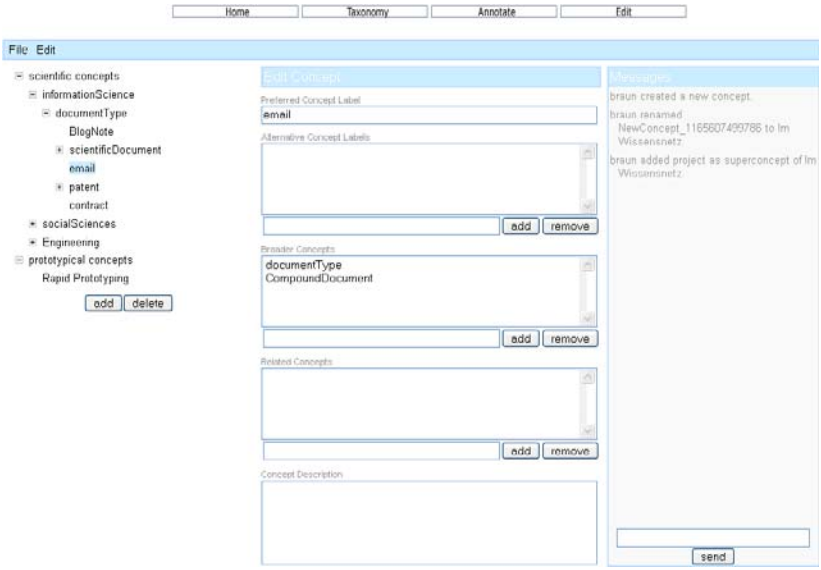

Figure 3: Ontology editor user interface.

Changes done to the ontology by one user are visible almost instantaneously on all machines without requiring any intervention by the users. Changes are propagated as unobtrusively as possible in order not to interrupt the current user in her work. In particular, the tree display of the resources can update to reflect the changes done by other users without any visible update sequence or changing the expansion state of the nodes. For each change the system also automatically generates a chat message that details who did which change (cf. right screen part). Updates of other users are also immediately reflected in middle screen part showing the details of the currently selected resource—in case two users are editing one concept at the same time.

5. Conclusions and Outlook

We will only ever achieve sustainable ontology-based systems by embedding the task of building and maintaining ontologies into everyday work processes, enabling domain experts to do it without the help of knowledge engineers and by making it truly collaborative. We also have to acknowledge that ontologies cannot be formalized from scratch, but rather continuously evolve in a maturing process from informal tags to formal taxonomy hierarchies. We have presented an approach and a web-based tool for very lightweight ontology editing. It substantially lowers the barriers to ontology editing for non-experts in the field of ontology building.

This lightweight approach covers "the simple 80%"; as we know from previous research, consensus building in ontology building is not always that easy. In order to support complex negotiation processes, we see a combination with a (semantic) wiki system as useful in the future. It should be noted, however, that such negotiation activities have to be carried out separately from work processes. Likewise, for the sake of simplicity, we also did not consider aspects of ontology versioning because we assume that changes in this stage of ontology building do not have such a deep impact on the usage of the ontologies. Here, we refer to the works of [Sto04]. Currently, within the project *Im Wissensnetz* ("*In the Knowledge Web"*), end users in the domain of chemical engineering are evaluating SOBOLEO within their work processes.

Acknowledgement

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