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myOntology: Tapping the Wisdom of Crowds for Building Ontologies

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Abstract. A pre-requisite for the Semantic Web to become a reality is the availability of metadata. Despite its maturity in many aspects, semantic technology faces a severe lack of semantic content: only few well-maintained domain ontologies can be found on the Web and the amount of annotated data is rather limited. We believe that this situation is caused by the pre-dominant ontology building paradigm: a small team of domain experts and knowledge engineers build and maintain ontologies. The actual user community is not involved in the process. In this paper, we (1) propose a paradigm shift from the expert-centered to the community-grounded evolution of lightweight domain ontologies. Furthermore, we (2) delineate the myOntology approach to building lightweight ontologies in a community-driven fashion based on the Wiki philosophy and the idea of combining human and computational intelligence, (3) we then describe the portal and provide a short walk-through. Next, we (4) provide the evaluation results and give preliminary evidence that myOntology is a high-usability solution. Finally, we (5) outline the next steps in the development of myOntology as a solution for tapping the wisdom of crowds for building ontologies.

1. Introduction

A pre-requisite for the Semantic Web to become a reality is the availability of metadata. Even though semantic technology can already show some mature applications and tools, it is confronted with a severe lack of semantic content. There are tools for processing, composing, and finding pieces of data. However, the knowledge acquisition bottleneck is still a major problem: one can observe scarceness of well-maintained domain ontologies. Similarly, only little metadata, i.e. semantic annotations, can be found on the Web. We believe that the current poverty of ontologies can be traced back to several reasons [1]:

Current ontology engineering methodologies concentrate on formal means for specifying ontologies instead of describing the intended meaning of ontology elements by informal means, such as lexical or multimedia resources. Informal means are crucial because they capture and convey the intended meaning more efficiently to human users.

Many relevant domains of discourse, such as e-commerce, comprise a high degree of conceptual dynamics, i.e. it is hard to keep up with the pace of change in reality. An ontology being updated twice a year will be outdated most of the time, which is a huge flaw. For a small team of engineers it is not only difficult and time-consuming to capture these changes in the conceptual model but also to actually keep track of the changes.

Using an ontology and thus committing to its view of the world requires understanding the meaning of concepts and relations, which is problematic for many users, since they cannot easily figure out what they would be committing to when using a particular ontology file from the Web. This is not only because ontology serializations, e.g. OWL, are not really human readable, but also because the discourse that lead to a certain specification is not available. As we already mentioned before, lexical resources as well as multimedia elements enhance the description of conceptual elements as well as facilitate better understandability.

In this paper, we describe myOntology, an approach to collaborative ontology building that allows a community to interact and achieve consensus on the domain ontologies built. Thereby, myOntology uses mechanisms to combine human and computational intelligence efficiently and to tap the wisdom of crowds for building lightweight ontologies.

1.1. Community-grounded ontology engineering

In consideration of the bottlenecks hindering ontology building, it is straightforward that a "traditional" approach, i.e. a small team or elite constructing the representation of a domain, is not suitable for all stages of ontology development. We can see that an open and community-driven approach has many advantages:

Timeliness. For a community, i.e. several individuals working towards a common goal, it is much easier (and cheaper) to keep up with the pace reality is changing and to capture the conceptual dynamics of a domain.

Cost. As the burden of creation and maintenance is distributed among several participants, it is cheaper to have a community to collaboratively work on a specification of an ontology than for a small team of domain experts and ontology engineers.

Community Grounding. In a community-grounded approach, the ontologies are built and maintained by the actual user community, thus representing real community contracts. A community-agreed specification of a conceptualization will more likely be accepted and further developed by the user community.

Expressivity. In an open approach where the community drives the creation and maintenance, not many individuals can be expected to have the skills to produce heavyweight ontologies. However, lightweight models have the advantage of having a larger user community, as they can be understood by many.

Consistency. In community-grounded ontology engineering, inconsistency might occur due to many contributors with diverse backgrounds. However, inconsistency can be spotted more easily with a big user community.

1.2. Incentives for building ontologies

Building ontologies requires domain expertise and the ability to capture this knowledge in a clean conceptual model. Creating ontologies is a costly and time-consuming task, usually requiring more than one contributor as the domain expertise and the conceptual modeling skills are unlikely to be found in one individual. Additionally, the nature of ontologies is to be community contracts, i.e. not an opus produced by one person. Additionally to those described above, traditional ontology building is facing another problem right now, which might play a role in the obvious lack of domain ontologies: the effort of building the ontology is detached from the benefits: by building an ontology alone, one does not improve one's own access to existing knowledge [1]. The problem is that it is not guaranteed that those investing resources in the creation or improvement of an ontology will materialize sufficient benefits out of the usage of this ontology.

While incentive models are an established research topic in various disciplines, such as economics and psychology, incentives for ontology building have not been investigated so far. Besides economic incentives, i.e. remuneration, intrinsic motivations, which are impressively put to work in Web 2.0 applications, can be motivations for users to create and maintain ontologies. In myOntology, we implement various incentives known and successfully applied in Web 2.0 applications in order to foster the creation of semantic content.

1.3. Combining human and computational intelligence

In [2], we also provide evidence that the Wikipedia community, despite its openness and non-authoritative nature, manages to create Wikipedia articles with a stable ontological meaning. The quality of Wikipedia articles is not only high regarding the ontological meaning, but also the content: studies have shown [3] that the quality of Wikipedia articles can be compared to print encyclopedias.

This is an indicator that even a completely open, uncontrolled group can achieve great things and will not go down in chaos given the appropriate computational support from the system, like Wikipedia supports its community with its wide range of background functionality, i.e. "Special pages"[1]. In myOntology, we apply this paradigm of efficiently combining human and computational intelligence for ontology engineering in order to support users in ontology building and to ensure quality of ontologies.

1.4. Related work

We only consider approaches that focus on collaborative development of ontologies as related work. Even though there is work on semantic wikis [13-16], they aim at the implicit creation of semantic data, while myOntology is not a semantic wiki but a (mutated) wiki for semantics.

OntoSaurus [4] is a web-based tool for editing and browsing ontologies; however, it has no explicit support for collaborative work. Domingue [5] describes Tadzebao and WebOnto: Tadzebao supports asynchronous and synchronous discussions on ontologies. WebOnto complements Tadzebao by supporting collaborative browsing, creation and editing of ontologies. Vrandecic and colleagues [6] describe the DILIGENT knowledge process where ontology evolution and collaborative concept mapping are applied to deal with conceptual dynamics of domains. OntoEdit [7] is a collaborative ontology editing environment. Kotis and Vouros describe the HCOME methodology in [8], which is a "human-centered" approach: ontology development is defined as a dynamic process with a focus on ontology evolution. HCOME is a

[1] http://en.wikipedia.org/wiki/Special:SpecialPages

decentralized engineering model where everyone first formalizes her own ontology and shares it in a further step within the community. This is different to our approach as the ontology is not open to the community at all times. Braun and colleagues [9] present an ontology maturing process consisting of four steps: emergence of ideas, consolidation in communities, formalization, axiomatization. They regard the evolution of an ontology as maturing from tags to formal ontologies via the community. De Moor, De Leenheer and colleagues, describe the DOGMA ontology engineering approach [10, 11] focusing on community-grounded ontology evolution in interorganizational settings, based on lexical resources. Di Maio [12] describes the idea of an open ontology.

1.5. Contribution

In this paper we present myOntology, a novel approach to ontology creation and maintenance. myOntology is an open and community-grounded approach to ontology evolution. We first describe the (1) philosophy of the approach as well as the (2) myOntology methodology of ontology building. We also outline the underlying (3) metamodel of myOntology. We then delineate the (4) myOntology portal, a prototype implementation and provide a short (5) walk-through. Next, we (6) provide preliminary evidence that the tool provides high usability and is straightforward to use, even for non-experts. Finally, we (7) outline our plans for future work and draw our conclusions.

2. The myOntology Approach

This section is dedicated to the underlying concept and philosophy of myOntology: we present the basic ideas and design principles as well as the underlying metamodel. We then describe the LICONE methodology which is the foundation for building ontologies in myOntology. Finally, we summarize the user roles known in the system.

2.1. Philosophy

The myOntology philosophy is composed of the following six design principles:

Tapping the Wisdom of Crowds. Following the “wisdom of crowds” [17] paradigm, we believe that a diverse community consisting of domain experts as well as knowledge engineers is smarter and more agile than only a small ontology development team. Instead of forcing one view of the world onto the user communities, we envision co-existence and interoperability of conflicting views and to support the community in achieving consensus. We are aware, that groups are only smart under certain conditions [17] and we aim at creating those conditions for myOntology.

Openness and multimedia richness. Traditional ontology building environments usually impose quite high entrance barriers on a user while wikis allow many users to contribute easily with only basic Web-editing skills. The culture of Wikis is the underlying paradigm of this work. Additionally, we propose the use of multimedia elements to better convey the informal part of the intended meaning of a concept.

Lightweight ontologies. *"We expect the majority of the ontologies on the Semantic Web to be light-weight. […] Our experiences to date in a variety of Semantic Web applications […] all point to light-weight ontologies as the most commonly occurring type."* [18] In 2008, lightweight ontologies are an important topic in many approaches. The advantages are clear: inconsistencies are less likely and the user community as well as domain experts can understand those models more easily. Still, lightweight models provide meaningful models that can used for several reasoning tasks.

Integration of linked data. With the Web growing daily, there is a wealth of data available that can be re-used for enriching ontologies. Here we list some examples. The goal of the W3C Linking Open Data (LOD) [19] community project[2] is to bootstrap the Semantic Web (the "Web of Data") by publishing datasets using RDF and to publish and interlink open data on the Semantic Web by identifying and using already existing sets of open data available on the web, and by creating new linked datasets. Further examples are the multimedia sharing platforms YouTube[3] and Flickr[4]. Additionally, we are re-using information from sources such as Wikipedia[5], Google[6], Watson[7], or the data from OntoGame[8] [20].

Combination of human and computational intelligence. Building ontologies is a task that depends on human intelligence, both as a source of domain expertise and for producing a consensual conceptualization as well as aligning ontologies and resolving inconsistencies. We aim at developing functionality that combines human and computational power and thus supports users in achieving several ontology building tasks.

Incentives. The online encyclopedia Wikipedia provides a setting that successfully facilitates collaboration of a large and diverse group. At the same time, it also implements incentive models that keep motivating many people to contribute a large amount of human labor, intelligence, and knowledge. In [2], we have shown that there are about 230 000 change operations per day in the English version of Wikipedia alone – almost 7 Million per month. The intrinsic motivations for contributors to Wikipedia has been discussed by Kuznetsov [21]:

- Reciprocity: Altruistic contributors receive a benefit in return.
- Community: "Wikipedians […] feel needed", there is "a sense of common purpose and belonging ".
- Reputation: Contributors "develop identities in order to be respected, trusted, and appreciated by peers".
- Autonomy: Contributors enjoy "the freedom of independent decision"

In myOntology, we acknowledge the importance of incentives and adapt several incentives known in Web 2.0 applications to ontology building (**Table 1**).

Table 1. Incentives

[2] http://esw.w3.org/topic/SweoIG/TaskForces/CommunityProjects/LinkingOpenData
[3] http://www.youtube.com
[4] http://www.flickr.com
[5] http://wikipdia.org
[6] http://google.com
[7] http://watson.kmi.open.ac.uk
[8] http://ontogame.org

Traditional OE	**Collaborative Tagging (Folksonomies)**	**Possible Incentives for Community-driven OE**
Money in business environments. Research projects or theses in academia.	*Future retrieval* *Contribution and sharing* *Attract attention* *Play and competition* *Self presentation* *Opinion expression* [22]	*Reciprocity:* all ontologies in the portal can be used by all the users at any time. *Community:* myOntology is a collective project with users working towards a common goal. The feeling of belonging is a strong motivation. *Autonomy:* Users enjoy freedom of decision making without hierarchical limitations. *Reputation:* Registered users are awarded points for community-accepted actions. Thus, this creates a reputation.

2.2. Metamodel

Following myOntology's design principles, the underlying model of the myOntology system is a lightweight ontology that maps to OWL Lite[9], more precisely it is a subset of OWL Lite[10]. The myOntology metamodel supports the creation of the *ontologies, concepts, datatype and object properties,* as well as *ontologically significant individuals*. Even though creation and maintenance of individuals is supported, myOntology's objective is not to create a huge knowledge base. Instead the system aims at ontologically significant instances, i.e. individuals that are necessary for specifying an ontology. An example would be creating a concept "New Yorker" where "New York" instance of the concept "City" is required in order to complete the specification. Furthermore, a hierarchy can be created by establishing *subClassOf*-relations among concepts. Each element has a set of properties to add a rich description including lexical resources and multimedia elements. In order to create mappings between ontologies we do not only use mapping relations specified in OWL (*sameAs*, *equivalent*) but also make use of relations from SKOS [23, 24] as they are lightweight and straightforward to understand.

2.3. The LICONE methodology

MyOntology relies on the LICONE (**Li**ghtweight and **C**ommunity-Grounded **On**tology **E**volution) methodology, which adapts the methodology proposed by Uschold and King [25] to the requirements of community-driven ontology building. In a first step, the scope of the ontology is specified informally. This means that the target domain of the ontology should be described by informal means, i.e. a label, description, lexical and multimedia resources. In all steps, the availability of existing elements that can be re-used is checked. In a subsequent step, relevant named entities are collected. Every step is accompanied by enrichment of the specification by lexical and multimedia resources as a community agreement.

[9] http://www.w3.org/TR/2004/REC-owl-features-20040210/#s2.1
[10] http://www.w3.org/TR/owl-features/

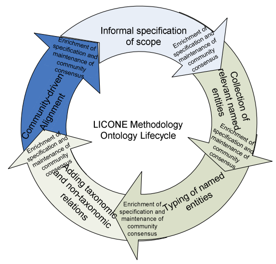

Fig. 1. LICONE Methodology

In the following step, the collected relevant terms are typed according to the myOntology metamodel. This means specifying whether a term is a concept or a property. Once a set of relevant elements has been identified and typed, the subsumption hierarchy is built, i.e. subClassOf relations are added. Finally, if required, alignments are established.

The current prototype implements the LICONE methodology to a large extent. However, we are planning to realize a wizard that guides users through the process in a step-by-step fashion.

2.4. User roles

In [26], we describe two approaches to user role models: a restrictive one that distinguishes between nine different user roles and a lightweight one that distinguishes between three different roles. We plan to start out with a rather lightweight approach. After all, the underlying Wiki philosophy [27] is openness and does not impose too many entrance / participation barriers on their users. In the following we outline the lightweight user role approach for myOntology.

- *Anonymous users* are unregistered users that have no rights except viewing and using content.
- *Domain experts* and *modeling experts* need to be registered; an anonymous user can achieve this status by taking a test and according to its result, becomes a domain expert or a modeling expert depending on the test results.
- *Technical administrators* are not involved in content provision and modeling aspects. They are responsible administrative tasks, like user administrations. TAs can also block other users or lock certain concepts if edit wars [28] occur.

The role model is not yet implemented in the current prototype; however, we expect this feature in early fall 2008.

3. Building Ontologies in myOntology

In the following, we will outline the functionality of the portal, sketch its architecture and describe ontology building in myOntology with a short walk-through.

3.1. Functionality summary

- myOntology covers processes in ontology building, as previously described by Uschold and King and adapted in the LICONE methodology. Additionally, it addresses lexical and multimedia enrichment in order to enhance understanding of ontology specifications.
- The metamodel behind myOntology is a sub-set of OWL DL as a trade-off between expressiveness and suitability for lay people. The ontology built in myOntology are intended to be lightweight.
- The editor makes use of the Wiki philosophy and exploits Web 2.0 technology for the easy-to-use user interface. Furthermore, it provides several visualization techniques in order to convey the intended meaning of ontologies. The user interface has been designed according to usability guidelines.
- myOntology will implement user roles in a rather lightweight manner, comparable to Wikipedia user roles.
- In order to keep the system clean, myOntology runs several algorithms in the background that track inconsistencies. In many cases, these findings need to be confirmed by the human user, which is done in the *special page* functionality.
- myOntology is currently being integrated with OntoGame [20], a series of games for generating semantic content. This allows an efficient combination of human and computational intelligence. The games paradigm will also be exploited to complement the background intelligence functionality by human intelligence.
- myOntology adopts existing methods for alignment. Currently, the prototype supports the manual alignment of ontologies which will be extended by re-using (semi-) automatic methods as described in [29].
- myOntology tracks changes with a simple history and an undo mechanism.
- myOntology implements several incentive structures that are also found in various Web 2.0 applications, especially Wikipedia, in order to motivate users to further contribute.
- myOntology exploits existing knowledge that is freely available on the Web in order to enrich ontology specifications.
- myOntology allows import and export in common ontology representation formalisms.
- myOntology supports the creation of freeze points in order to ensure stability of certain versions.

3.2. Architecture

The architecture of myOntology is visualized in Fig. 2. The current prototype implementation of myOntology can be found at http://myontology.deri.at/prototype, which runs on a Tomcat 5.5 Web server. Storage of all data (both, administrative and ontological data) is done in a Sesame triple store (Sesame 2.0). The application itself is implemented in Java and AJAX. Finally, the user interface is a HTML interface.

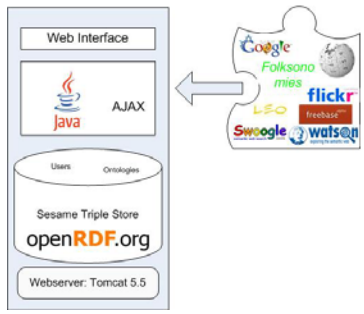

Fig. 2. myOntology architecture

3.3. Walk-through

The target audience of myOntology is domain experts that are not willing to look deep into ontology editors in order to capture their domain knowledge. We expect that a large share of users will not have a computer science or Semantic Web background. Therefore, we sometimes use different labels for elements than scientific literature does, such as domain vocabularies for ontologies as well as attributes and relationships for data type and object properties. In the following, we provide a brief walk-through of myOntology.

0. <u>Registration and login</u>

myOntology allows users to browse the system and download ontologies anonymously. Editing requires users to register to the system. Once a profile has been created, the user can immediately log-in to the system using his/her credentials.

1. <u>Overview and start page</u>

Users can navigate the system from the start page (Fig. 4), which contains several elements. At the very center are three tag clouds for navigating (1) ontologies, (2) concepts, and (3) relationships and attributes. This "sediment metaphor" [30] makes it easier to find important elements but also brings back elements randomly. The font size reflects the importance of the element for the community. A sidebar displaying the subsumption hierarchy of all concepts can be enlarged by hovering over it. The sidebar also allows changing the subsumption hierarchy by drag&drop. The top menu contains the tools bar, which allows uploading ontologies and access to the special page functionality which will be addressed later.

The search box is the main navigation, creation, and editing tool: regardless the intention of the user (creation, editing, search): once she is starting to type, existing elements that might be relevant (Fig. 3) – if no relevant element is found, the user can go ahead and create a new one. This functionality tries to avoid duplicates and forces users to see what is there in the first place.

Fig. 3. Find while you type

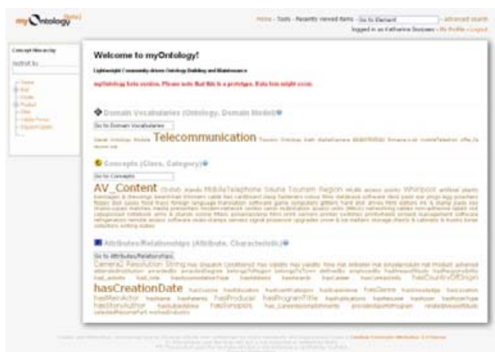

Fig. 4. myOntology start page

Users can also edit their profile in the top menu or log out. Besides the "find while you type" functionality, myOntology also offers an advanced search. The advanced search allows for searching (1) any element, (2) domain vocabularies, (3) concepts, and (4) attributes/relationships. Furthermore, users can perform a more structured search by querying the elements of the myOntology metamodel.

2. <u>Creating /editing a domain vocabulary</u>

Before creating a new domain vocabulary, users are forced to check whether the ontology they are about to create already exists: they have to start typing and eventually – in case there is no such ontology yet – click "create new domain vocabulary". The domain vocabulary editing and creation forms (Fig. 5) are the same in order to enhance clarity and familiarity: users can add a description, synonyms, images and videos, translations, tags, a seeAlso link, and concepts. Most of these attributes gather data from the Web, such as Wikipedia, Flickr, YouTube, Wordnet, etc.

Fig. 5. Creating a new domain vocabulary

3. Adding concepts

Concepts (Fig. 6) can be added either from domain vocabularies or from the start page. Similarly to domain vocabularies, concepts can be richly described using various lexical and multimedia resources.

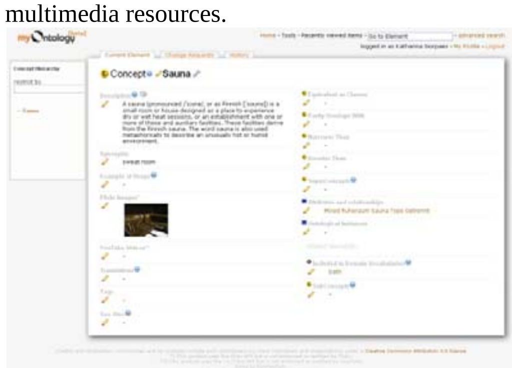

Fig. 6. A concept in myOntology

Additionally, users can manually create mappings between existing concepts. Attributes and relationships can also be added, as explained in the following section. Users can also create ontological instances, i.e. instances that are required for specifying abstract models. Finally, sub- and super-concepts can be created or chosen. Attributes or relationships of concepts can be specified in a manner very similar to conepts.

4. Import, export, freeze points

myOntology is an open environment with evolving ontologies. In order to enable reliable references, the system allows the creation of freeze points of domain vocabularies, i.e. stable snapshots of the current version of an ontology plus a URI. Additionally, the system allows to export the ontologies in OWL. Additionally, users can upload OWL ontologies to the system in order to further edit them using myOntology via a simple upload mask, available from the top menu “Tools”. In case uploaded ontologies contain elements that are not supported by myOntology, those elements are stored as an annotation property (“hasUnsupportedFeature”).

5. History

myOntology logs all changes to all ontological elements in a history (Fig. 7). This allows users to undo certain changes and go back to a previous version. This very lightweight mechanism is similar to Wikipedia's with the difference that myOntology does not only log changes for the ontology element but the precise attribute that was edited, i.e. the description or synonyms.

Fig. 7. History

6. Special pages and dynamic special pages

As already explained in the previous section, myOntology cleans the system in the background via algorithms that track inconsistencies or missing / obsolete information (Fig. 8). This process is a combination of human and computational intelligence as the findings of those algorithms have to be confirmed by the human user. Finally, the system also allows the specification of new queries in the "dynamic special pages" functionality.

Fig. 8. Special pages

4. Evaluation

myOntology was released only recently (June 2008). In early experiments, we have evaluated the usability of the tool in form of a usability study. In this section, we present the results of this usability analysis. We will further evaluate myOntology based on the usage of the tool of an open Web community and in controlled experiments where a dedicated group develops a domain ontology[11].

[11] This will be done in the ebSemantics workshops. More information is available from http://www.ebsemantics.net

4.1. Methodology

The evaluation described in the following, can be found in more detail in [31]. In order to evaluate the usability of the myOntology portal, we make use of the ISO 9241-110 [32] standard[12]. The standard defines usability as *"the extent to which a product can be used by specified users to achieve specified goals with effectiveness, effciency and satisfaction in a specified context of use."* Nielsen [33] and Mayhew [34] describe methods for evaluating usability and distinguish between two types of questionnaires: summative and formative. Summative questionnaires are usually applied to a completed product in order to check whether it fulfills the requirements and use numeric values. Formative questionnaires aim at detecting weaknesses at design time. In this evaluation, we make use of the Isometrics questionnaire [35] evaluating whether a software system fulfills the ISO-U, which contains seven dialog principles:

1. Suitability for the task: The dialog should be suitable for the user´s task and skill level.
2. Self-descriptiveness: The dialog should make it clear what the user should do next.
3. Controllability: The user should be able to pace and sequence of the interaction.
4. Conformity with user expectations: The dialog should be consistent.
5. Error tolerance: The dialog should be forgiving.
6. Suitability for individualization: The dialog should be able to be customized to suit the user.
7. Suitability for learning: The dialog should support learning.

Isometrics distinguishes between two kinds of questionnaires: one for summative (IsoMetrics-short) and one for formative (IsoMetrics-long) evaluation. For this evaluation, we used the formative version that contains the same questions as the short version, but a participant additionally has the possibility to rank how important each single question is for the whole system. In the formative questionnaire the participant also has the possibility to give qualitative feedback to improve the prototype. Each question consists of three sub-questions: in the first one, a numeric value hast to be chosen ranging from 1 (predominantly disagree) to 5 (predominantly agree); in the second one, participants have to rate the importance of the question; in the third part participants are asked to give feedback.

As Isometrics is not tailored to the needs of ontology engineering, we added questions from a questionnaire carried out in the NeOn project [36] in order to evaluate ontology engineering environments. From the Neon questionnaire we selected questions that correspond to functionality intersecting with the functionality of myOntology.

We carried out the experiment in the following fashion: the participants were split into two teams that each were assigned a task. Each team had to build a domain ontologies in two different domains, one hotel ontology and one about academic resumes. We provided a generic competency question for each of the ontologies. Participants did not communicate besides the communication channels provided by the myOntology system. The participants were give a time slot of 80 minutes for

[12] We will abbreviate this standard with ISO-U in the remainder of this paper.

designing their ontologies. After completing the work on the ontologies, they were asked to fill in an online questionnaire[13]. Four people participated in the experiment: 3 of them were male and one was female. Two of them indicated they were beginners in ontology engineering, two had moderate experience.

4.2. Results and Discussion

In this section, we present a summary of the usability evaluation. The detailed numbers are available in [31].

Isometrics

We summarize our findings in Figure 1 from the Isometrics questionnaire: participants had to give ratings from 1 (predominantly disagree) to 5 (predominantly agree). In the figure, we indicate the mean of user replies as well as the mean of the ratings on the importance of the questions.

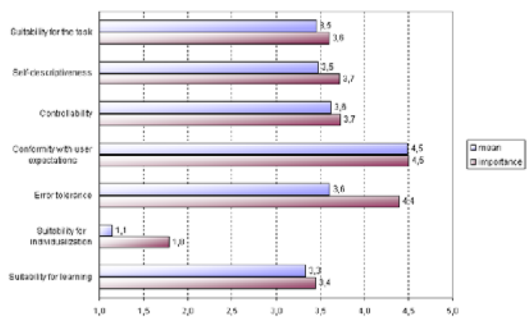

Figure 1. Isometrics questionnaire results [31]

Given that the evaluation was performed with an early version, the results are quite promising. The participants found that the suitability of the tool for learning was satisfying. This is especially good considering that the help and documentation functionality has not been implemented yet. We expect a significant improvement of this issue once help and documentation is in place. The next issue addressed by the Isometrics questionnaire is suitability for individualization, which means that "*the system is constructed to allow for adaptation to the user's individual needs and skills for a given task*" [35]. This issue has not been addressed in the myOntology development. However, we plan to implement a lightweight approach to different roles (described in [26]) in the near future, which distinguish between *anonymous users, domain experts, modeling experts,* and *technical administrators*. Roles will be assigned dynamically depending on the capabilities and skills of the users.

Error tolerance is mainly related to being able to undo things that have unwanted consequences. This is already addressed to a large part in the myOntology system. The mean of 3.6 leaves room for improvement but shows that the direction taken is

[13] The questionnaire was created using phpESP62.

promising. The issue of conformity to user expectations scored high with a mean of 4.5, which means that the behavior of the system is consistent. Controllability of the system was also rated quite high (3. 6), which shows that users were able to control the pace and sequence of interaction largely. Results for self-descriptiveness as well as suitability for the task were similar (3.5 and 3.5). Obviously, it was pretty clear for the users what to do next after accomplishing a task. Furthermore, users found the overall suitability for the task of collaborative ontology building of the system more than good.

NeON Questionnaire

The NeOn questionnaire aims at evaluating ontology engineering environments. However, we selected questions that corresponded to the functionality covered by the myOntology portal. In Table 2, we outline the selected questions and the respective results. Participants had to answer questions using a scale including -1 (inadequate or no), 0, and 1 (excellent or yes). 1 means that there is no need for improvement. Additionally, we asked participants to give free text feedback, which is available in [31].

Table 2. Results of NeOn questionnaire

Question	-1	0	1	Total	Mean
C-1a Please indicate how useful you found the documentation in the tools and editors used.	1	1		2	-0.5
C-1b Did you find the tool-tips provided by the editor were sufficient?		1	2	3	0.7
C-2a Please indicate how well designed you felt the system interface was.		3	1	4	0.3
C-2b Did you find the graphic elements, e.g. icons, of your editor clear and legible?			4	4	1.0
C-2c Do you find it necessary to add greater customization regarding fonts or colors in your editor?	4			4	-1.0
C-2f. Are you satisfied with the interface design of the editor?	1	2	1	4	0.0
D-1c Did you find the editor used allows to set a clear and simple sequence of steps to accomplish each necessary action, e.g. create a new instance of a concept?		3	1	4	0.3
D-1e How was the overall behavior of the ontology editor and tools?		3	1	4	0.3

Question C-1a scored low: this is because there is a clear need for improvement regarding documentation of myOntology. As mentioned above, the current prototype hardly contains any help functionality. C-1b clarified that the tool tips of myOntology are useful and were found very good by the participants. The graphical elements of myOntology got very positive feedback with all participants finding no need for improvement. Similarly clear was the answer to the next question whether greater customization should be added (which is not enabled currently): all participants required this. The majority of users liked the interface design of the editor. Users also found that the sequence of steps for accomplishing a task could be improved. Finally, they rated the overall behavior OK but with room for improvement.

5. Outlook and Conclusion

We are planning to improve the system in the following directions:

Support for instances. Currently, we support the creation of ontologically significant instances. We plan to extend this in two directions: (1) find a way to communicate the meaning of ontologically significant instances to a broad audience and (2) improve the functionality of the prototype.
Automatic matching algorithms. Currently, myOntology supports the manual matching of ontologies. Following the paradigm of efficiently combining human and computational intelligence, we aim at implementing existing matching algorithms [29] in order to find possible similarities or relations automatically. The final decision however, is then taken by a human user (possibly via "special pages").
Usability. The usability study shows promising results but also that there is a lot to improve: we will carry out improvements based on the results of this study and perform further usability studies.
Background intelligence. The special pages in myOntology are a first attempt of supporting the user community with some computational power. We plan to extend this functionality and add more sophisticated queries.
Re-use of widely used ontologies. Even though myOntology allows importing ontologies, each ontology is then assigned a URI in the myOntology namespace. This might not be desired in cases, where one wants to re-use parts of common ontologies, such as Dublin Core[14] or FOAF[15]. Therefore, we plan to allow uploading with a "read-only" flag that allows those ontologies keeping their original namespace and their re-use.
Help. Help features and documentation need to be extended. Furthermore, we are considering to implement a sandbox feature, where users can try out with toy ontologies without making changes to the "real" portal.

In this paper, we have described myOntology, its philosophy, methodology, metamodel and the prototypical implementation. We provide preliminary evidence from a small usability study that the tool is easy to use and intuitive. Community-driven ontology building involves many challenges but also opportunities. myOntology takes a step in this direction and taps the wisdom of crowds for building ontologies collaboratively.

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