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ABSTRACT

Conceptual modeling is a complex task that requires domain specific knowledge as well as a good command of modeling techniques. In this paper we propose an approach that aims to capture relevant knowledge from an online pool of conceptual models. This knowledge is brought to the user in order to assist the construction of new conceptual models. With our method, relevant feedback is generated based on knowledge extracted from the pool of models. Such feedback, tailored to the current modeling process of the user, allows the model to be improved based on shared knowledge.

Categories and Subject Descriptors

H.3.3 [**Information Storage and Retrieval**]: Information Search and Retrieval—*information filtering, retrieval models, relevance feedback*

Keywords

Conceptual modeling, semantic feedback, knowledge reuse

1. INTRODUCTION

Conceptual models aim to express the meaning of terms and concepts used by domain experts to represent a certain problem, and to find the correct relationships between different concepts [4]. The construction of these models is complex and requires knowledge about both the particular modeling technique and the specific domain to be modeled [3]. Typically, conceptual models are constructed by users in an isolated fashion, thus not taking advantage of the existing knowledge contained in other models made by other expert users. We advocate reusing that already existent knowledge in order to provide feedback to enhance the modeling process.

We have chosen the domain of Qualitative Reasoning (QR) to put our ideas in practice. More in particular, we have focused on a learning scenario, in which QR models can be used for learners to formally express and test their conceptual knowledge about systems in an educational context [1]. Our approach addresses several important issues in the process. Firstly, heterogeneity in the models by aligning the diverse vocabulary used in the conceptual models. Secondly, it automatically selects the relevant models from the pool of models. Thirdly, it generates relevant feedback that is applicable to the current state of the learner's modeling activity.

2. SYSTEM OVERVIEW

The approach presented in this paper uses semantic techniques [5] to analyze user and reference models and to obtain differences between them. These differences are communicated to the user as feedback aimed to correct or extend his model.

A modeling tool is used for the creation of models. These models are stored in a semantic repository where they remain accessible online for later reuse. Besides this semantic repository (see Figure 1), our semantic techniques consist of different components.

First, the semantic grounder discovers links between the unrestricted terminology in QR models to well defined external vocabularies (http://www.DBpedia.org). In case that the term to be grounded is not well covered by the proposed groundings (the user is not satisfied, or no sense was found), the user can insert the "ungroundable" term anyway, hence generating a new ontology term that is added into an ontology of *anchor terms*. This way, the information is not lost and can be proposed for future groundings jointly with the other background ontology terms. The anchor terms may be related afterwards to terms in other ontologies (by other domain experts).

At a certain point, the learner asks for feedback from the modeling tool. Then, the automatic selector of models recommends the most relevant model from the repository to be used as reference model. Within the existing types of recommenders, we address the approach of hybrid recommendation based on feature combination [2].

Finally, the semantic feedback generator analyzes the differences between the learner model and the reference models for the generation of feedback.

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3. SEMANTIC FEEDBACK

Once we have obtained the reference model from the repository, we compare it with the user model to extract the differences between them. We can do this comparison using an ontological perspective and based on the particular structure of the models.

- **Ontology-based feedback.** Our hypothesis is that conceptual models can be treated as ontologies under certain conditions. In our particular case, it has been shown that QR models can be managed as ontologies [7]. Following that, we use ontology matching techniques to align pairs of QR models in order to obtain the equivalences and, by extension, the differences between them.

  – **Grounding-based alignment.** The reference and learner models are first analyzed to identify the common groundings between the models. If two concepts from both models are grounded to a common resource, we can use these relations to infer a preliminary set of mappings.

  – **Ontology matching.** The mentioned set of preliminary mappings is enhanced by applying ontology matching techniques [6] between the reference and the learner models. This generates the final list of equivalent terms or mappings. We process these mappings to find differences between each pair of equivalent terms. We compare the label and grounding of each pair of equivalent terms to find differences in the terminology. Also, those terms from the reference model with no equivalence in the learner model are shown as missing elements and suggested to be included in the learner model, including the missing hierarchical relationships. In the same way, those terms from the learner model with no equivalence in the reference model could be seen as extra elements to be removed.

  – **Semantic reasoning.** We apply semantic reasoning techniques to discover inconsistencies between the hierarchies of both models. Two equivalent entities should share the same terminology but also have the same equivalent position in their respective hierarchies. For instance, the entity *Whale* cannot be subtype of *Fish* in the learner model and subtype of *Mammal* in the reference model given that *Fish* and *Mammal* are disjoint classes.

- **Structure-based feedback.** We exploit the particular semantics of the QR vocabulary to perform more QR-specific comparisons between the structures of the models. Using the pairs of equivalent terms we can analyze the differences of usage according to the pool of models. We also suggest related processes from the pool of models aimed to extend the learner model.

As a result, we obtain a list of differences which we communicate back to the learner formulated as suggestions. The learner can accept or decline such suggestions, thus changing or not the model accordingly.

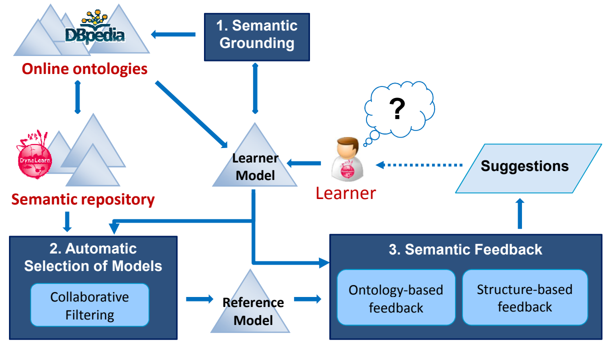

Figure 1: Components and communication.

4. CONCLUSIONS AND FUTURE WORK

In this paper we present a novel approach to generate semantic feedback to assist in conceptual modeling, based on models created by other users that are available in an online repository.

As future work, we will run more experiments to evaluate not just the correctness of the feedback but also its effect on the learning process. The validity of our model selection technique has to be also evaluated with additional tests.

5. ACKNOWLEDGMENTS

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