KC-Viz: A Novel Approach to Visualizing and Navigating Ontologies

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ABSTRACT

There is empirical evidence that the user interaction metaphors used in ontology engineering toolkits are largely inadequate and that novel interactive frameworks for human-ontology interaction are needed. Here we present a novel tool for visualizing and navigating ontologies, called KC-Viz, which exploits an innovative ontology summarization method to support a 'middle-out ontology browsing' approach, where it becomes possible to navigate ontologies starting from the most information-rich nodes (i.e., *key concepts*). This approach is similar to map-based visualization and navigation in Geographical Information Systems, where, e.g., major cities are displayed more prominently than others, depending on the current level of granularity.

EKAW Topics

Human-knowledge interaction; Cognitive systems and knowledge engineering.

1. INTRODUCTION

A key component of the Semantic Web is provided by the large number of ontologies available online. In particular, hundreds of ontologies containing thousands of classes have been made available online in the last few years. Given such large scale availability of ontologies, ontology reuse is becoming commonplace and indeed tools such as the Watson plug-in for the NeOn toolkit (http://neon-toolkit.org/) are now available, which facilitate the task of locating and directly reusing ontologies or ontology fragments. In this reuse-centric context, it is highly desirable to have mechanisms that can efficiently help users in making sense of the content of an ontology. However, the empirical studies carried out in the NeOn project [1] show that the visualization and navigation facilities available in today's ontology engineering environments are not necessarily able to provide effective overviews of ontologies and often end up hindering rather than helping users. Our studies show that this is a problem especially for non-expert users.

To address this issue we have developed a novel tool for visualizing and navigating ontologies, called KC-Viz, which has been realized as a plugin for the NeOn Toolkit. KC-Viz exploits automatically created ontology summaries, based on the idea of *key concepts* [2], to facilitate the task of making sense of large ontologies. In this short paper, we give a brief description of some of the functionalities provided by KC-Viz.

2. KEY CONCEPT EXTRACTION

Informally, key concepts can be seen as the best descriptors of an ontology, i.e., information-rich concepts, which are most effective in summarizing what an ontology is about. In [2] we considered a number of criteria, and correspondingly developed a number of algorithms, to identify the key concepts in an ontology. In particular, we used the notion of **natural category** [3], to identify concepts that are information-rich in a psycho-linguistic sense. This notion is approximated by means of two operational measures: *name simplicity,* which favors concepts that are labeled with simple names, and *basic level,* which measures how 'central' a concept is in the taxonomy of an ontology. Two other criteria were drawn from the topology of an ontology: the notion of **density** highlights concepts which are information-rich in an ontological sense, i.e. they have been richly characterized with properties and taxonomic relationships*,* while the notion of **coverage** aims to ensure that no important part of the ontology is neglected. Finally, the notion of **popularity**, drawn from lexical statistics, is introduced as a criterion to identify concepts that are commonly used. The **density** and **popularity** criteria are both decomposed in two sub-criteria, *global* and *local density*, and *global* and *local popularity* respectively. While the global measures are normalized with respect to all the concepts in the ontology, the local ones consider the relative density or popularity of a concept with respect to its surrounding concepts. The aim here is to ensure that 'locally significant' concepts get a higher score, even though they may not rank too highly with respect to global measures. Each of these seven criteria produces a score for each concept in the ontology and the final score assigned to a concept is a weighted sum of the scores resulting from individual criteria. As described in [2], our algorithm has been shown to produce ontology summaries that correlate significantly with those produced by human experts.

3. OVERVIEW OF KC-VIZ

To illustrate KC-Viz, we use the Dolce ontology (http://www.loa-cnr.it/ontologies/DLP3971.zip) as an example. Dolce is an upper-level domain-independent ontology describing generic concepts which can be used to provide the foundational structure for more specific ontologies. Figure 1 shows an initial overview of the Dolce ontology, generated using the "Visualize Key Concepts" functionality in KC-Viz. The solid grey arrows in the figure indicate direct rdfs:subClassOf links, while the dotted green arrows indicate indirect rdfs:subClassOf links As shown in the figure, by hovering the mouse over an indirect rdfs:subClassOf links, we can see the chain of rdfs:subClassOf relations, summarized by the indirect link.

In the example shown in Figure 1, we have elected to display a small quick overview of the ontology by setting the size of the

summary to 16[1], however this parameter is under user control, to allow him/her to decide the size of the initial summary. Another option available to the user is whether to display only classes local to a particular ontology, or to also include inherited ones. In particular, the Dolce ontology actually consists of a set of eleven different ontologies. Given the relative small size of the overall set of ontologies, we have produced a snapshot of the entire network of ontologies, rather than that of an individual ontology in the overall network.
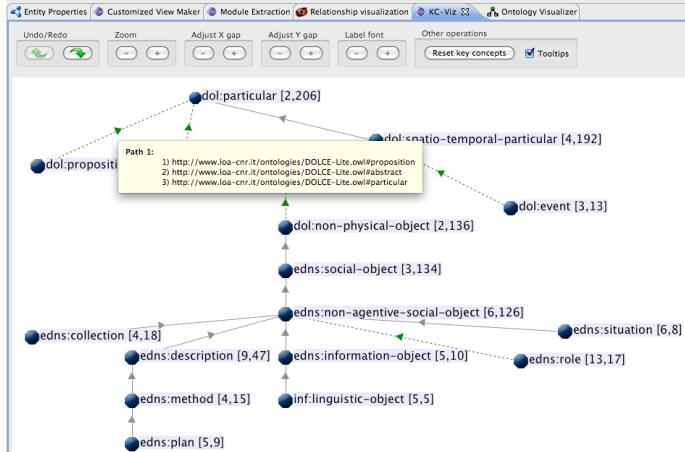

Figure 1. Visualizing ontologies in KC-Viz

As shown in Figure 1, the visualization allows us to easily get an initial overview of the entire ontology. In particular we can see that the Dolce ontology has at its root the class particular, which has two direct subclasses and 206 subclasses in total. We can also see that most of the modeling in the ontology has focused on spatio-temporal-particular, which is at the top of a subtree comprising 192 classes. Going down the tree, we can see that important classes include social-object and non-agentive-social-object, the latter covering 126 of the 134 types of social objects. In sum, the claim here is that this style of summary-based visualization provides the abstraction facilities missing in other ontology engineering editors and facilitates the process of making sense of an ontology, especially in the context of reuse. In particular, by focusing on displaying the most information-rich concepts in an ontology, KC-Viz avoids the typical problems encountered when exploring ontologies using the classic top-down browsing approach supported by both file-system-like navigational windows and by visualization interfaces, which fail to provide effective abstraction/summarization functionalities. For instance, key concepts for the Dolce ontology include endurant, description, social-object, event, description, and role, and all of these are displayed when generating the initial ontology summary. To uncover these concepts using a standard top-down navigational approach would require a minimum of ten mouse-clicks. If we were to consider larger ontologies, it would of course require even more effort to uncover the most information-rich concepts.

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[1] KC-Viz may add a few extra concepts to a summary, beyond the size specified by the user, in order to maximize the coherence of the presented tree, specifically by maximizing coverage with respect to rdfs:subClassOf relations and by avoiding 'islands' – i.e., groups of nodes disconnected from other displayed nodes.

Our approach is consistent with the *middle-out* approach to ontology engineering [4], which suggests that ontologies should be developed identifying *basic concepts* first, e.g., Event, then specializing them, e.g., GivingATalk, and then grouping them into more abstract categories, e.g., IntangibleThing.

Another important aspect of KC-Viz is that this abstraction mechanism can be used recursively to explore specific parts of an ontology. For example Figure 2 shows the menu that is opened up by i) right clicking on node edns:description and ii) selecting the option Expand. As shown in the figure a rich set of options is presented to the user, which make it possible to explore the subtree under edns:description using (or not using) key concepts, expanding up to a certain level, and possibly including also superclasses, domain, and range relations to other concepts in the resulting visualization. Analogously, in a situation in which the user does not need to investigate further the subtree under a class and wishes to remove it from the visualization, a Hide menu item is available, which opens up the window shown on the right hand side of Figure 2.
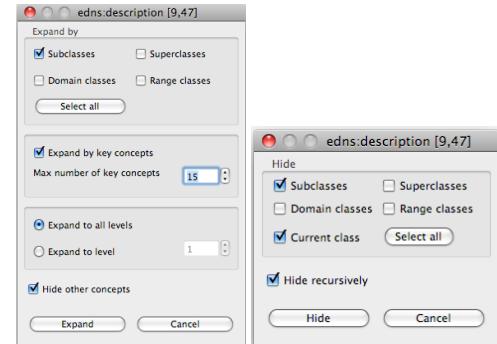

Figure 2. Options for expanding and hiding nodes

KC-Viz is available as a plugin for the NeOn Toolkit. Currently a new version of KC-Viz is being developed and in the future we plan to conduct a task-centric evaluation of the tool to verify empirically our hypothesis that KC-Viz provides more effective ontology visualization and navigational support than other tools currently available.

ACKNOWLEDGMENTS

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