BioMixer: Visualizing Mappings of Biomedical Ontologies

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ABSTRACT

The majority of current ontology mapping visualization tools are limited to showing mappings between a pair of ontologies at a time. However, it is often the case that concepts from one ontology are mapped to concepts in several other ontologies. Understanding how multiple ontologies relate to one other, as well as understanding the quality of mappings created across ontologies, can be supported through visualizations that show mappings across more than two ontologies. In this paper, we present how BioMixer, a tool for visualizing biomedical ontologies, provides a number of customizable views to support the understanding, analysis and navigation of mappings across multiple ontologies.

1 INTRODUCTION

With a rapid growth of the semantic web, there is an increasing need to visualize ontologies as well as to visualize how ontologies that are somehow related may have concepts mapped to each other (Falconer & Storey, 2007). For example, in the NCBO[1] BioPortal repository, there are many mappings stored between terms in the Protein Modification ontology and the PRotein Ontology (PRO), but there are also 423 terms in the Protein Modification ontology that are mapped to the Chemical entities of biological interest ontology. A potential user of any one of these ontologies, may wish to gain an understanding of how all three ontologies are related by mappings, or an ontology curator may wish to explore how the three ontologies are mapped and whether such mappings make sense or are incomplete.

Although visualizing mappings among multiple ontologies can provide valuable information, most existing visualization tools that show ontology mappings, confine the user to view exclusively two ontologies at a time from a single perspective. Some of the most common approaches for mapping visualization include (1) visualizing two ontologies side by side and showing similarities visually in terms of matching position, colour, shape, or pattern to show the alignment, as in AlVIz (Lanzenberger & Sampson, 2006) and Optima (Kolli & Doshi, 2008), and (2) showing indented trees for two ontologies where mappings are represented by links connecting matching terms between the two ontologies, as in CogZ (Falconer & Storey, 2007) and COMA++ (Aumueller et al., 2005).

What is lacking, however, is a visualization tool that can show mappings or clusters of mappings across terms in more than two ontologies, or a way to visualize which ontologies have mapping in a large set of ontologies. In this paper, we present how the BioMixer tool (Fu et al., 2012), a tool for visualizing ontologies, has various techniques for visualizing mappings at both the term and at the ontology level across multiple ontologies.

2 BIOMIXER MAPPING VISUALIZATIONS

Through discussions with ontology users and ontology curators, we became aware that visualization of mappings at the term level, as well as aggregated mappings at the term and ontology level, would be desirable. Thus, BioMixer contains three visualizations that show mappings between multiple ontologies. These three views differ in their level of detail and in their scalability. The **mapping overview** aggregates mappings between a large amount of terms at the ontology level, the **mapping matrix** shows mappings between many terms at the term level ordered by ontology or term label, and the **detailed mapping graph** shows the mappings between a few terms within the context of other term relationships.

The **mapping overview visualization** (Fig. 1) provides a summary of mappings across multiple ontologies. When there are a large number of ontology term mappings, it is difficult to show that much information in detail. The user can use this overview visualization to decide which ontologies and terms are relevant for viewing their mappings. For example, the content of the mapping overview can be based on a keyword search for terms across multiple ontologies. With this view, the user can quickly see which ontologies have many or lack any mappings. The next two views allow the user to drill in to explore mappings in detail.

The **mapping matrix visualization** (Fig. 2) facilitates the understanding of mapping patterns at the term level. Terms can be ordered by either term label or by ontology name. Users can easily see clusters of mappings for similarly-named terms or for ontology, and thus identify potentially missing mappings. The matrix visualization also supports understanding how a subset of concepts from one ontology is mapped into a set of other ontologies.

The **detailed mapping graph** (Fig. 3) supports users in analyzing and understanding mappings in the context of other term relationships. The user can search for a term of interest using the BioMixer search feature. The results can be showed in the detailed graph view, with mappings and

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[1] http://www.bioontology.org/

other relationships expanded. For example, the user can view the parent-child hierarchies and mappings for terms from multiple ontologies. Such a view should help a user in identifying missing mappings along the hierarchies, as well as gaining a broader idea about the meaning of similar or unrelated but superficially similar terms.

Providing three mapping visualizations with different levels of detail allows BioMixer to address a variety of use cases, which is hard to achieve with a single visualization. The three visualizations can be linked together to implement the visual information seeking mantra ("Overview first, zoom and filter, then details-on-demand" (Shneiderman, 1996)) in the domain of ontology mapping visualization.

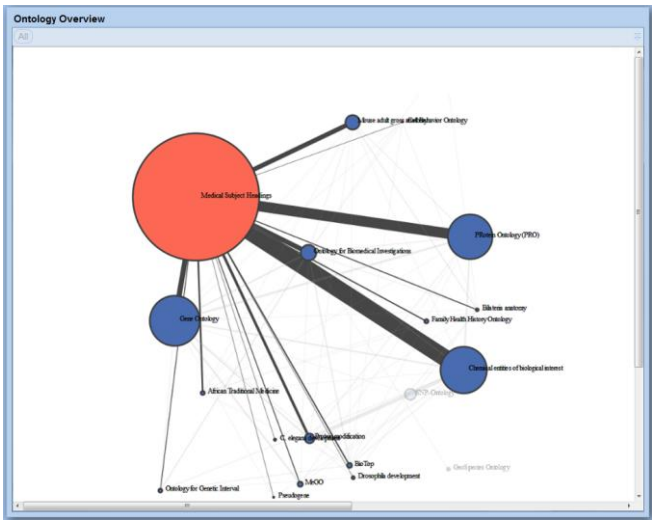

Fig. 1. Mapping Overview Visualization. The ontologies are shown as circles. The radius represents the number of concepts in the ontology. The number of mappings between two ontologies corresponds to the width of the edge between them.

Fig. 2. Mapping Matrix Visualization. Concepts from multiple ontologies are shown as rows and columns. Mappings are shown as colored cells. The user can hover over mappings to highlight row and column. The concepts can be sorted by name or by ontology.

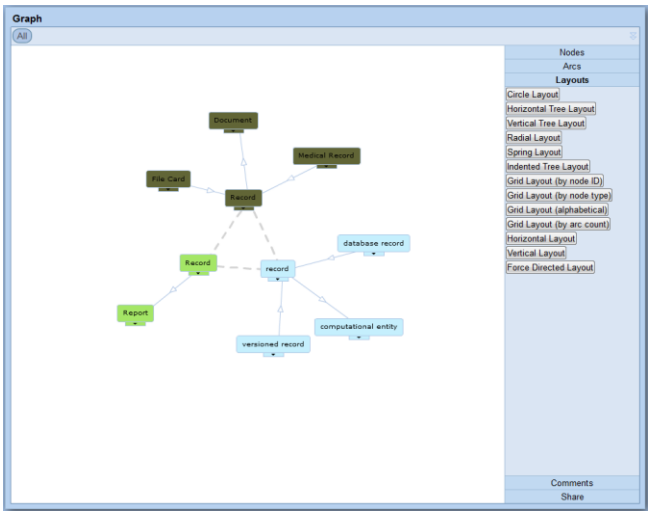

Fig. 3. Detailed Mapping Graph. Concepts are shown as nodes, which are colored by ontology. Both mappings between ontologies (dashed gray edges) and relationships within one ontology (solid blue edges) are displayed. Users can expand mappings and other relationships on each node. Different layouts (e.g. force-directed, circle, tree) can be applied.

3 CONCLUSION

The BioMixer tool was designed to support the visualization of mappings across multiple ontologies. It uniquely visualizes mappings in a variety of ways that has not been previously supported by other ontology mapping visualization tools. Early feedback indicates these views will be useful for exploring, analyzing and editing mappings across multiple ontologies. Future work involves evaluating these views within the NCBO BioPortal website, and developing future views based on user feedback.

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