Integrated Ontology Matching and Evaluation*

Isabel F. Cruz
ADVIS Lab
Department of Computer Science
University of Illinois at Chicago
ifc@cs.uic.edu

Flavio Palandri Antonelli
ADVIS Lab
Department of Computer Science
University of Illinois at Chicago
flav@cs.uic.edu

Cosmin Stroe
ADVIS Lab
Department of Computer Science
University of Illinois at Chicago
cstroe1@cs.uic.edu

ABSTRACT
The AgreementMaker system for ontology matching includes an extensible architecture, which facilitates the integration and performance tuning of a variety of matching methods, an evaluation mechanism, which can make use of a reference matching or rely solely on quality measures, and a multi-purpose user interface, which drives both the matching methods and the evaluation strategies. Our demo focuses on the tight integration of matching methods and evaluation strategies, a unique feature of our system.

1. INTRODUCTION
The design of effective methods to find a complete set of correct mappings between semantically related entities of different real-world ontologies is a hard task for several reasons. First of all, an algorithm may be effective for a given scenario, but not for others. Even within the same scenario, the use of different parameters can change the outcome significantly. Therefore, state-of-the-art ontology matching systems [3] tend to adopt different strategies within the same infrastructure even though the intelligent combination of multiple matching results is still an open problem. Our collaboration with domain experts in the geospatial domain [1] has revealed that they value highly automatic matching methods especially for ontologies with thousands of concepts. However, they want to be able to follow closely the matching process, thus requiring to be directly involved in the loop.

2. AGREEMENTMAKER
We demonstrate the AgreementMaker system that tightly integrates matching methods and evaluation strategies within the same graphical user interface.[1] Using our system, users load the source and target ontologies, which are visualized side by side using the familiar outline tree paradigm (see

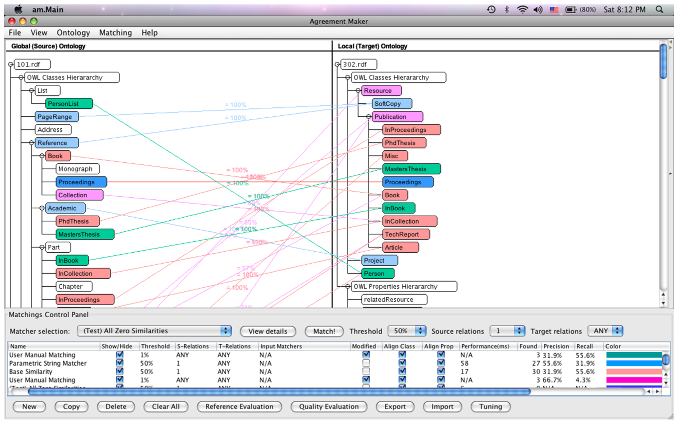

Figure 1: Graphical User Interface.

Figure 1). Different standard formats of input (i.e., XML, RDFS, OWL, and N3) and output (i.e., XML, XLS, and the INRIA-API [2] format) are supported by the system. A control panel allows users to run and manage a wide variety of matching methods and their results.

The AgreementMaker supports a wide variety of matching methods (or matchers). The matching process of a generic matcher (see Figure 2), can be divided into two main modules: (1) *similarity computation* in which each concept of the source ontology is compared with all the concepts of the target ontology, thus producing two similarity matrices (one for classes and one for properties) that contain a value for each pair of concepts; (2) *mappings selection* in which the matrix is scanned to select the best mappings according to a given threshold and cardinality of the correspondences. Our architecture allows for serial and parallel composition where, respectively, the output of one or more methods can be used as input to another one, or several methods can be used on the same input and then combined. A set of mappings may therefore be the result of a sequence of steps, called *layers*. To improve readability, the system allows users to show/hide the results of the layers, as desired. In contrast with other matching systems, users can also edit the mappings that are automatically produced by the system, by adding, deleting, and updating them. In order to do this, they can access the information associated with each concept, including descriptions, annotations, properties, and instances. In addition, users can modify at runtime the parameters associated with each method or can select as input previously calcu-

*Research supported by NSF Awards ITR IIS-0326284, IIS-0513553, and IIS-0812258.

[1] We provide an accompanying video available at www.AgreementMaker.org.

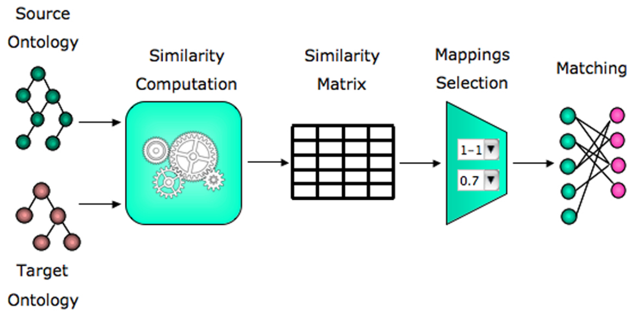

Figure 2: Structure of a generic matcher.

	similarity level	selection level
local	Quality of each row (or column) of the similarity table	Quality of a mapping
global	Quality of the entire similarity table	Quality of the whole set of mappings

Table 1: Categorization of measures of quality of a matching method.

lated matchings. Multiple matchings can also be combined manually or with an automatic combination matcher. The control panel contains a table where each row is associated with a method and displays its performance values, thus allowing for a quick comparison among different methods.

Finally, our system also provides a powerful framework for developers. Each matching method is implemented as a standard component following the object-oriented template pattern, which allows reuse and composition. A standard extensible API is defined to let developers plug and test new matching methods thus minimizing effort and maximizing reuse.

3. EVALUATION METHODS

The most effective evaluation technique compares the mappings found by the system between the two ontologies with a reference matching or "gold standard," which is a complete set of correct mappings as built by domain experts, in order to measure precision, recall, and F-measure. The AgreementMaker system supports such evaluation technique. However, a gold standard is usually not available. Therefore, "inherent" quality measures need to be considered. These measures can be defined at two levels as associated with the two main modules of a matcher: *similarity* or *selection* level. We can consider *local* quality as associated with a single row (or a single column) of the similarity matrix at the *similarity* level (or mapping at the *selection* level) or *global* quality as associated with all the correspondences in the similarity matrix at the *similarity* level (or with all the mappings in a matching at the *selection* level). This categorization of quality measures is summarized in Table 1.

We have adapted in our system two *global-selection* quality measures proposed by others [4], and one *local-similarity* quality measure that we have devised. The intuition behind the two *global-selection* quality measures, namely (1) *order* and (2) *distance preservation*, is that given a set of mappings we can measure the structural properties of the produced matching to help determine its quality. In particular, according to (1), a matching should not change the order of concepts as defined by the *is-a* or *part-of* relations, and, according to (2), it should preserve the distance between concepts as much as possible.

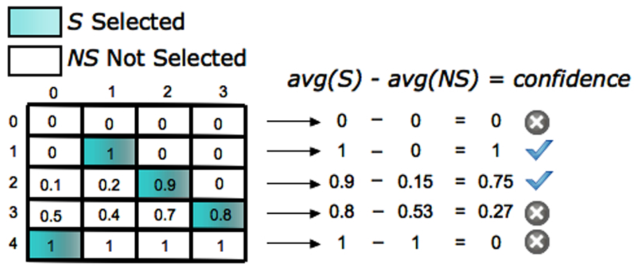

Figure 3: Local confidence quality measure example.

In addition to these measures, we incorporate our own quality measure, called *local confidence*, which is independent of the properties of the ontologies. Indeed, it measures the reliability of the similarity measures assigned by a matching method. In particular, for each concept we want to measure the confidence of the method as related to the selected mappings for that concept. Similarity-based matching techniques are based on the idea that if two concepts are very similar, they probably deserve to be matched. Therefore, our measure is directly proportional to the similarity values of selected mappings. At the same time, it detects and penalizes those methods that tend to assign high similarity values too generously. For instance, if the correct solution is a 1-1 matching we expect each concept to be very similar (i.e., high similarity value) to one concept at most, and very different (i.e., low similarity value) to all others. In addition, it favors those similarity assignments that are stable in respect to the threshold value, so that changing the threshold slightly should not affect the final alignment considerably. A simple application of this quality measure is shown in Figure 3. Using our system, users can adopt any of these quality measures to define the weighting scheme of a fully automatic method that combines multiple matchings. Experiments have shown that the *local confidence* quality measure can be quite effective in such a task.

4. REFERENCES

[1] I. F. Cruz, A. Rajendran, W. Sunna, and N. Wiegand. Handling Semantic Heterogeneities using Declarative Agreements. In *International ACM GIS Symposium*, pages 168–174, 2002.

[2] J. Euzenat. An API for ontology alignment (version 2.1). http://gforge.inria.fr/docman/view.php/117/251/align.pdf, February 2006.

[3] J. Euzenat and P. Shvaiko. *Ontology matching*. Springer-Verlag, Heidelberg (DE), 2007.

[4] C. Joslyn, A. Donaldson, and P. Paulson. Evaluating the Structural Quality of Semantic Hierarchy Alignments. In *International Semantic Web Conference (Posters & Demos)*, 2008.