Position Statement

The Authors

Marco Schorlemmer. Dr. Marco Schorlemmer is a *Ramón y Cajal* Research Fellow at the International University of Catalonia. Until recently he was a Research Fellow at The University of Edinburgh's School of Informatics, where he was involved in the Advanced Knowledge Technologies project, a multi-million pound, six-year collaboration between internationally recognised research groups at five UK universities. He obtained his PhD in Artificial Intelligence in 1999 from the Technical University of Catalonia, carrying out his research at the Artificial Intelligence Research Institute in Spain, and at SRI International and Indiana University in the USA. Dr. Schorlemmer is mainly interested in applying mathematical techniques from theoretical computer science to challenging engineering problems faced by software and knowledge engineers today. In particular, he has been using techniques from category theory and information-flow theory to automate the semantic mapping of ontologies. He has also published over 20 papers in journals and international workshop and conference proceedings in the fields of Formal Specification & Automated Theorem Proving, Diagrammatic Representation & Reasoning, Life Cycles of Knowledge Engineering & Management, and Semantic Interoperability & Integration.

Yannis Kalfoglou. Dr. Yannis Kalfoglou is a Senior Research Fellow at the University of Southampton working on the Advanced Knowledge Technologies (AKT) project; a large scale Interdisciplinary Research Collaboration (IRC) between five UK universities funded by the British government. He received a First Class Honours B.Sc. degree in Computer Studies from Portsmouth University, England, in 1995 and a Ph.D. degree in Artificial Intelligence from Edinburgh University, Scotland, in 2000. His research interest is focusing on ontologies, in particular ontology-based services in a variety of application areas. He has researched extensively the intersection of software and knowledge engineering with emphasis on intelligent support for the early stages of software design when working with knowledge models. He has published over 30 papers on this and similar subjects and recently his focus is on ontology mapping and merging technologies. He is an active member of the EU funded OntoWeb & KnowledgeWeb thematic networks of excellence where he is working on industry-strength ontology tools and environments.

Our Research on Semantic Integration

Our approach draws heavily on proven theoretical work but our work goes further in providing a systematic approach for ontology mapping with precise methodological steps. In particular, our method, Information-Flow based Ontology Mapping (IF-Map) [2], draws on the proven theoretical ground of Information Flow and channel theory [1], and provides a systematic and mechanised way for deploying the approach in a distributed environment to perform ontology mapping among a variety of different ontologies.

The IF-Map system formalises mappings of ontology constructs in terms of logic infomorphisms, the fundamental ingredient of Information Flow. These are well suited for representing the bi-directional relation of types and tokens, which corresponds to concepts and instances in the ontology realm. IF-Map is focusing on instances and how these are classified against ontology concepts. This reveals the operational semantics that the ontology's community has chosen by virtue of how it uses its instances. The IF-Map algorithm makes use of this information in order to map onto related concepts from another ontology with which its concepts classify the same instances.

We have used IF-Map with success in a variety of ontology mapping scenarios within and outside AKT such as mapping of computer science departments' ontologies from AKT participating universities [3]; mapping of e-government ontologies from a case study using UK and US governments ministries [6]. We have also conducted a large-scale survey of the state-of-the-art of ontology mapping [4] and we are currently exploring the role of Information Flow and the IF-Map approach in the wider context of semantic interoperability and integration [5].

Challenging Issues on Semantic Integration

One of the core aspects on semantic integration and interoperability research nowadays is to find ways to share knowledge across diverse systems and domains and make them semantically interoperable. A key challenge and starting point for achieving this, is to have their ontologies shared. One aspect of ontology sharing is to perform some sort of mapping between ontology constructs. That is, given two ontologies, one should be able to map concepts in one ontology onto those in the other. Further, research suggests that we should also be able to combine ontologies where the product of this combination will be, at the very least, the intersection of the two given ontologies. These are the dominant approaches that have been studied and applied in a variety of systems [4].

There are, however, some drawbacks that prevent engineers from benefitting from such systems. Firstly, the assumptions made in devising ontology mappings and in combining ontologies are not always exposed to the community and no technical details are disclosed. This is an important hindrance for progress within this newly founded and diverse community as the less information is exposed about an allegedly problem-solving technique the more difficult becomes to replicate and experiment with it.

Secondly, the systems that perform ontology mapping are often either embedded in an integrated environment for ontology editing or are attached to a specific formalism. This makes it difficult to assess their performance outside these nicely designed "sandy-boxes" which act as a controlled environment and cannot accommodate the dynamism of ontologies available in the real world and being attached to a specific formalism precludes familiarity with it and availability of translators for making it possible to work in a large scale.

Thirdly, in most cases mapping and merging are based on heuristics that mostly use syntactic clues to determine correspondence or equivalence between ontology concepts, but rarely use the meaning of those concepts, i.e., their semantics. This is a big assumption as in most of the cases syntax alone can say little or nothing about the actual meaning of a concept. The intended semantics of concepts are not revealed and the proposed outcome has to be manually verified by a human expert.

Fourthly, most, if not all approaches do not exploit ontological axioms or rules often found in formal ontologies. This will allow for mathematical proofs to performed on the mapping outcome which will, at least, increase the assurance that the proposed mapping conforms with the underpinning ontological knowledge.

Finally, ontology mapping as a term has a different meaning in different contexts due to the lack of a formal account of what ontology mapping is. There is an observed lack of theory behind most of the works in this area [4].

References

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