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Evolva: a comprehensive approach to ontology evolution

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Evolva: A Comprehensive Approach to Ontology Evolution

Fouad Zablith[⋆]

Knowledge Media Institute (KMi), The Open University
Walton Hall, Milton Keynes, MK7 6AA, United Kingdom
f.zablith@open.ac.uk

Abstract. Ontology evolution is increasingly gaining momentum in the area of Semantic Web research. Current approaches target the evolution in terms of either content, or change management, without covering both aspects in the same framework. Moreover, they are slowed down as they heavily rely on user input. We tackle the aforementioned issues by proposing Evolva, a comprehensive ontology evolution framework, which handles a complete ontology evolution cycle, and makes use of background knowledge for decreasing user input.

1 Problem and Methodology

Ontologies form the basis of Semantic Web systems. As such, they need to be kept up-to-date for the dependent systems to remain usable. With the increase of complexity and changes occurring in the represented domains, ontology evolution becomes a painstaking and time-consuming process. Thus research has witnessed an increased interest in ontology evolution. We regard ontology evolution as the "timely adaptation of an ontology to the arisen changes and the consistent management of these changes" [10]. "Timely adaptation" suggests a quick adaptation, that can only be achieved by decreasing user involvement in the evolution process. However, most of current approaches heavily rely on user input. Moreover, the definition suggests that a successful evolution can only be achieved by having both "adaptation" and "change management". Yet, as we discuss in Section 4, no existing approach handles the two tasks in one framework. One set of approaches considers evolution as the management of changes performed by users for preserving consistency [11,13,16,17], while another set targets techniques for integrating new knowledge into the ontology [2,5,12,14], without an extensive handling of change and evolution management. Our research tackles the following two main questions:

Question 1: How to cover a complete ontology evolution cycle? The focus here is on providing both ontology adaptation and change management.

Question 2: How to decrease user involvement in ontology evolution? In order to be as agile as possible, especially in dynamic domains where information is

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abundantly generated, ontology evolution should be performed with the mini-
mum user involvement.

Our methodology for resolving the above questions has three main phases: in
the first phase we analyzed a concrete case within our KMi Semantic Web portal[1]
that helped us determine the main required tasks for evolution. Then we propose
an ontology evolution framework covering all previously identified tasks. In the
second phase, we are conducting an experiment on using background knowledge,
in addition to a pilot system implementation. The third phase will include the
evaluation of our approach.

2   Proposed Approach

We propose a comprehensive ontology evolution framework, Evolva[2], covering
a complete ontology evolution cycle including a) performing changes based on
external data sources, and b) the management of these changes as shown in
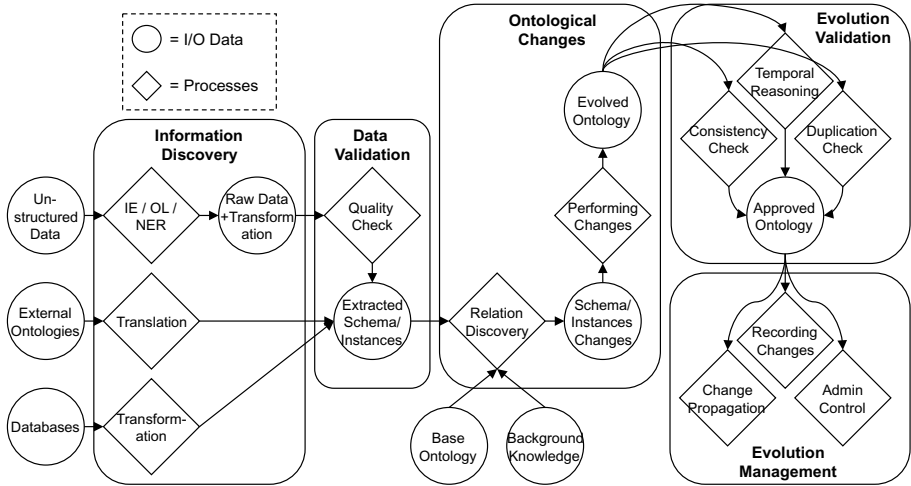Figure 1. Such framework is designed to meet the requirements of our research
Question 1.

Fig. 1. Evolva Framework Architecture

We focus on identifying the need for evolution by contrasting the content of
the ontology to external data sources. Such sources could be text documents,
folksonomies, databases, or other ontologies. Each source requires a different
method of content extraction handled by the *information discovery* component.
The *data validation* component identifies new terms that are relevant for the

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ontology. It also checks the quality of content and filters out noise generated from the information discovery component. The validated information is passed to the *ontology changes* component in which background knowledge plays a core role in automating the integration of new information to the ontology. The evolution could generate conflicts and problems that are handled at the level of the *evolution validation* component. We plan to have in this component temporal reasoning for time related problems, coupled with duplication and consistency checks. Finally the validated ontology is passed to the *evolution management* component (bottom right part of Figure 1) where the user has control over the evolution, and changes are recorded and propagated to dependent ontologies.

With response to Question 2, Evolva uses background knowledge for decreasing, or even eliminating user input throughout the evolution. Background knowledge exists through various formats including lexical databases e.g. WordNet [7], online ontologies, and unstructured web documents. Our relation discovery step uses background knowledge to determine the relationship path of new knowledge to existing knowledge in the ontology.

3   Initial Results and Conclusions

By the end of the first year of the PhD, we have implemented part of Evolva within the NeOn ontology editor[3]. Our second major result is an experiment on the potential use of background knowledge as a replacement of user input.

The Evolva plugin allows users to run the evolution process step-by-step and to control the relevant parameters for each step. Figure 2 highlights the main features of the Evolva plugin. The left panel shows the evolved ontologies, and the right panel shows the various steps of Evolva. Using those, the user can specify the external data sources from which the new content is extracted. Then the content is validated, and the user has the option to modify the automatic validation settings, as well as to manually exclude unwanted terms. In the relation discovery part, the validated terms are linked to existing terms in the base ontology through background knowledge. For example, WordNet linked *Applicant* as *subClassOf Person*, and online ontologies linked the new concept *Website* with a *hasWebsite* relation to *Organization*. Finally, the user can choose to apply the changes to the base ontology itself, or create a new, updated ontology.

Our background knowledge experiment, described in [19], focused on using WordNet and online ontologies for relation discovery in the context of the KMi portal ontology. Online ontologies are accessed using Scarlet [15], a Semantic Web based relation discovery engine, that matches [6] terms to online ontological entities for resolving relations. The overall precision of around 77% shows that background knowledge can largely contribute to automating the integration of new knowledge into the ontology. This is where user input is traditionally most needed. We also found that precision can be further increased through introducing validation techniques like using the ontology itself as a relation validator, and by using filter mechanisms for excluding irrelevant terms.
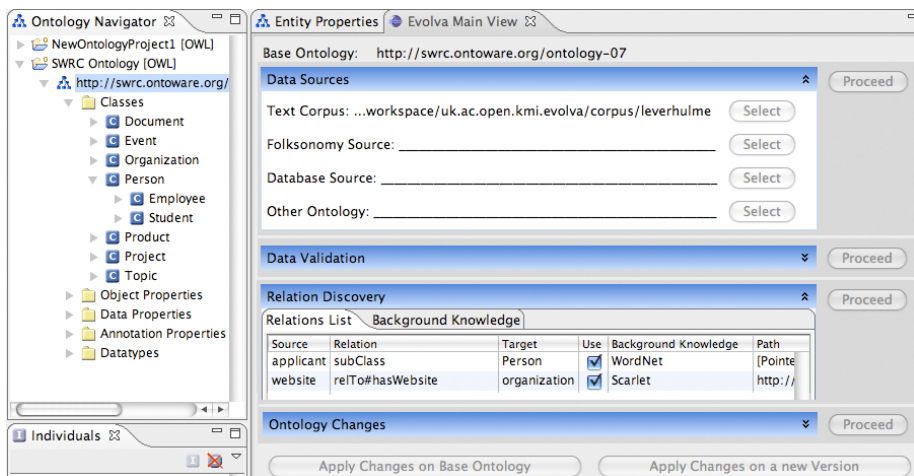
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[3] http://www.neon-toolkit.org

Fig. 2. Evolva Pilot System Screenshot

4   State of the Art

Research on ontology evolution is roughly divided in two groups: The first group considers ontology evolution as the process of managing changes performed by users [11,13,16,17]. In brief, the idea is to evolve an ontology as a closed entity by analyzing its content by e.g. identifying changes based on data mining techniques [16]. A key achievement, common in [11] and [16], is the representation of changes in an ontology of changes. However, the user here is the only source of new knowledge added to the ontology. The second group focuses on identifying new information to be added to the ontology [2,5,12,14]. This is done either through analyzing trends in user behavior [2,5], or by exploiting changes in external data sources such as databases or text documents [12,14]. However, the user still plays a major role throughout their process, and in this case, little attention is given to the management of evolution. The intention of Evolva is to cover both approaches.

Background knowledge has been successfully used in various tasks. For example, WordNet helps in solving word sense disambiguation issues [9] and ontology matching tasks [8]. Medical domain ontologies [3] and online ontologies [15] are employed in ontology matching. Folksonomy tagspaces [4] and ontology learning [1] are also using online ontologies as a background knowledge source. In our research, we make use of background knowledge in the field of ontology evolution.

5   Future Plans

Our plan for the second year of the PhD is to study automated techniques for relation validation, crucial to increase Evolva's precision. We also plan to fine-tune and extend our prototype to cover the remaining components. Evaluating the end research product forms an important part of our planned tasks and will be conducted during the third year. We plan to run tests in real domains such

as the UN's Food and Agriculture Organization (FAO)[4] fisheries or agriculture. Such tests should give us firstly qualitative measures, which reflect the correctness of the content added to the ontology; and secondly, quantitative measures to analyze the performance of Evolva in terms of time, number of ontological entities added, and number of sources analyzed. Comparisons will be performed against other ontology building tools and against ontology designers.

References

1. Alani, H.: Position Paper: Ontology Construction from Online Ontologies. In: Proceedings of WWW (2006)
2. Alani, H., Harris, S., O'Neil, B.: Winnowing ontologies based on application use. In: Sure, Y., Domingue, J. (eds.) ESWC 2006. LNCS, vol. 4011, pp. 185–199. Springer, Heidelberg (2006)
3. Aleksovski, Z., Klein, M., Kate, W., Van Harmelen, F.: Matching Unstructured Vocabularies using a Background Ontology. In: Staab, S., Svátek, V. (eds.) EKAW 2006. LNCS(LNAI), vol. 4248, pp. 182–197. Springer, Heidelberg (2006)
4. Angeletou, S., Sabou, M., Motta, E.: Semantically enriching folksonomies with FLOR. CISWeb (2008)
5. Bloehdorn, S., Haase, P., Sure, Y., Voelker, J.: Ontology Evolution, pp. 51–70. John Wiley & Sons, Chichester (2006)
6. Euzenat, J., Shvaiko, P.: Ontology Matching. Springer, Heidelberg (2007)
7. Fellbaum, C.: Wordnet: An Electronic Lexical Database. MIT Press, Cambridge (1998)
8. Giunchiglia, F., Shvaiko, P., Yatskevich, M.: Discovering Missing Background Knowledge in Ontology Matching. In: Proc. of ECAI (2006)
9. Gracia, J., Lopez, V., d'Aquin, M., Sabou, M., Motta, E., Mena, E.: Solving semantic ambiguity to improve semantic web based ontology matching. In: Workshop on Ontology Matching at ISWC and ASWC (2007)
10. Haase, P., Stojanovic, L.: Consistent evolution of OWL ontologies. In: Gómez-Pérez, A., Euzenat, J. (eds.) ESWC 2005. LNCS, vol. 3532, pp. 182–197. Springer, Heidelberg (2005)
11. Klein, M.: Change Management for Distributed Ontologies. PhD thesis, Vrije Universiteit in Amsterdam (2004)
12. Novacek, V., Laera, L., Handschuh, S.: Semi-automatic integration of learned ontologies into a collaborative framework. In: IWOD (2007)
13. Noy, N.F., Chugh, A., Liu, W., Musen, M.A.: A framework for ontology evolution in collaborative environments. In: Cruz, I., Decker, S., Allemang, D., Preist, C., Schwabe, D., Mika, P., Uschold, M., Aroyo, L.M. (eds.) ISWC 2006. LNCS, vol. 4273, pp. 544–558. Springer, Heidelberg (2006)
14. Ottens, K., Glize, P.: A multi-agent system for building dynamic ontologies. In: Proceedings of AAMAS (2007)
15. Sabou, M., d'Aquin, M., Motta, E.: Exploring the Semantic Web as Background Knowledge for Ontology Matching. Journal on Data Semantics XI (2008)
16. Stojanovic, L.: Methods and Tools for Ontology Evolution. PhD thesis, FZI (2004)
17. Vrandecic, D., Pinto, H.S., Sure, Y., Tempich, C.: The DILIGENT knowledge processes. Journal of Knowledge Management 9, 85–96 (2005)
18. Zablith, F.: Dynamic ontology evolution. In: ISWC Doctoral Consortium (2008)
19. Zablith, F., Sabou, M., d'Aquin, M., Motta, E.: Using background knowledge for ontology evolution. In: IWOD (2008)

[4] http://www.fao.org