Schema-less Data-gathering, Integration, and Processing: Towards Support for Knowledge Discovery Process in Heterogeneous Environments

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Research question
Sara, a compliance officer in a bank, is analyzing a case flagged as suspicious to inform the authorities of a crime (if necessary) and use the gathered data to refine the fraud-detection system. To that end she needs to access a variety of different data sources such as the transaction-chains connected to the case from the transaction processing systems, information from other intuitions about in-/outgoing transactions, case notes from the police, marketing databases, etc., in order to understand the case’s nature and refine the knowledge discovery process used by the automated fraud-detection system.

Peter would like to predict if a new protein might be able to curb the growth of cancer cells. To that end he needs to determine the structure of the protein using NMR spectrometer, process the specimens’ gene sequences, combine them with data from a number of protein, cross-reference these with references from Medline, and use the gathered data to build a predictor for the likelihood that the protein will curb cancer-cell growth.

Sara’s and Peter’s problem is complex and ubiquitous to knowledge-intensive industries. To achieve their goal they need to:

1. Access a number of data-sources, each having its own scheme in different formalisms and gather them for processing
2. Integrate these different data, and generate an interoperable “data-could”.
3. Devise a suitable inference experiment to induce/test an inference model.

Indeed, these hurdles reflect the overall knowledge discovery process as outlined Fayad et al (1996, see also Figure 1). Unfortunately, however, whilst much work has gone into each of the steps in this process support for the overall process has been largely neglected: enormous advances have been made in the areas such as feature selection, development of advanced induction algorithms, visualizations, data integration techniques, etc. – an integrated environment, that guides real-world users in the overall process from the heterogeneous data sources to the results is still missing.

Figure 1: The Knowledge Discovery Process as presented by Fayyad et al (1996)

The goal of this study is to present and evaluate the suitability of three technologies to overcome the abovementioned hurdles and serve as the major building blocks for such an integrated environment. Specifically, we propose (i) the use of schema-less, typed graph knowledge bases (Weiss et al, 2008; Stocker et al, 2008) as an efficient means to store gathered heterogeneous information, (ii) the use of approximate/probabilistic
reasoning techniques on top of these kinds of knowledge bases (Ziegler et al., 2006; Kiefer et al., 2007) as an appropriate means to address the integration issue, and (iii) the development of advanced Intelligent Discovery Assistants (Bernstein et al., 2005; Kalousis et al., 2008) to support the design, execution, and exploration of KD processes.

**Approach**
This study explores the suitability of the three techniques as major building blocks for an integrated knowledge discovery environment. As such it will aim to (i) identify the requirements for each of the building blocks, (ii) assess the suitability of the proposed technologies to fulfill the requirements qualitatively, and (iii) evaluate the technologies quantitatively using benchmarks. As such it represents a typical technical/design science approach.

**Main findings/expected contributions**
We expect three levels of contributions of this study.

First, the proposition and evaluation of the three major building blocks is a major contribution in itself. Each of them has been the subject of very active research over the last decades and is still very much under investigation. As such, any insight into how the development of each of them can be improved is a contribution in itself.

Second, the investigation of how to combine the components into an integrated system is still in its beginnings. Indeed both the NSF and the EU are funding projects to start exploring such approaches. Furthermore, workshops on the subject are currently being held at major conferences. As such, any insight in how such systems can be developed/deployed would be a substantial contribution.

Lastly, we hope that this study would serve as a call to arms and contribution from the IS research community.

**Current status of the manuscript**
Whilst some of the studies on the building blocks are very mature (some even published) others are new and evaluated to different degrees. Any statement on the integrated system is very new and not yet evaluated. Input from the community is highly valued at this point in the investigation.

**References**

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