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The LNCS Journal on Data Semantics

Computerized information handling has changed its focus from centralized data management systems to decentralized data exchange facilities. Modern distribution channels such as high-speed Internet networks and wireless communication infrastructure, provide reliable technical support for data distribution and data access, materializing the new, popular idea that data may be available to anybody, anywhere, anytime. However, providing huge amounts of data on request often turns into a counterproductive service, making the data useless because of poor relevance or inappropriate level of detail. Semantic knowledge is the essential missing piece that allows the delivery of information that matches user requirements. Semantic agreement, in particular, is essential to meaningful data exchange.

Semantic issues have long been open issues in data and knowledge management. However, the boom in semantically poor technologies, such as the Web and XML, has boosted renewed interest in semantics. Conferences on the Semantic Web, for instance, attract crowds of participants, while ontologies on their own have become a hot and popular topic in the database and artificial intelligence communities.

Springer's *LNCS Journal on Data Semantics* aims at providing a highly visible dissemination channel for most remarkable work that in one way or another addresses research and development on issues related to the semantics of data. The target domain ranges from theories supporting the formal definition of semantic content to innovative domain-specific application of semantic knowledge. This publication channel should be of highest interest to researchers and advanced practitioners working on the Semantic Web, interoperability, mobile information services, data warehousing, knowledge representation and reasoning, conceptual database modeling, ontologies, and artificial intelligence.

Topics of relevance to this journal include:

- Semantic interoperability, semantic mediators
- Ontologies
- Ontology, schema and data integration, reconciliation and alignment
- Multiple representations, alternative representations
- Knowledge representation and reasoning
- Conceptualization and representation
- Multi-model and multi-paradigm approaches
- Mappings, transformations, reverse engineering
- Metadata
- Conceptual data modeling
- Integrity description and handling
- Evolution and change
- Web semantics and semi-structured data
- Semantic caching

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- Data warehousing and semantic data mining
- Spatial, temporal, multimedia and multimodal semantics
- Semantics in data visualization
- Semantic services for mobile users
- Supporting tools
- Applications of semantic-driven approaches

These topics are to be understood as specifically related to semantic issues. Contributions submitted to the journal and dealing with semantics of data will be considered even if they are not within the topics in the list.

While the physical appearance of the journal issues looks like the books from the well-known Springer LNCS series, the mode of operation is that of a journal. Contributions can be freely submitted by authors and are reviewed by the Editorial Board. Contributions may also be invited, and nevertheless carefully reviewed, as in the case for issues that contain extended versions of best papers from major conferences addressing data semantics issues. Special issues, focusing on a specific topic, are coordinated by guest editors once the proposal for a special issue is accepted by the Editorial Board. Finally, it is also possible that a journal issue be devoted to a single text.

The journal published its first volume in 2003 (LNCS 2800), its second volume at the beginning of 2005 (LNCS 3360), and its third volume in summer 2005 (LNCS 3534). Volumes I and II, as this volume V, are special issues composed of selected extended versions of best conference papers. Volume III is a special issue on Semantic-based Geographical Information Systems, coordinated by guest editor Esteban Zimányi. The fourth volume is the first "normal" volume, comprising spontaneous submissions on any of the topics of interest to the journal. Currently planned volumes include a special issue on Emergent Semantics.

The Editorial Board comprises one Editor-in-Chief (with overall responsibility) and several members. The Editor-in-Chief has a 4-year mandate to run the journal. Members of the board have a 3-year mandate. Mandates are renewable. More members may be added to the board as appropriate.

We are happy to welcome you to our readership and authorship, and hope we will share this privileged contact for a long time.

Stefano Spaccapietra
Editor-in-Chief
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JoDS Volume V – Guest Editorial

To foster the dissemination of the best ideas and results, the *Journal on Data Semantics* (JoDS) pursues a policy that includes annually publishing extended versions of the best papers from selected conferences whose scope encompasses or intersects the scope of the journal.

This initiative is motivated by the difference in goals we have between conferences and journals. Conferences usually have a faster turnaround and focused audience, but they have to enforce space limitation and a fixed time frame, with no chances for improving a paper by producing multiple versions. In contrast, journals offer more space, room for debate and refinement, and are usually considered the real archival venue.

Therefore, the publication of an extended version of a conference paper is a much appreciated opportunity for researchers to widely disseminate a significantly improved presentation of their work, where they can develop the appropriate motivations, reasoning, results and comparative analysis.

This issue includes selections from three international conferences: ER 2004, the 23rd International Conference on Conceptual Modeling, which took place in November 2004 in Shanghai, China, ODBASE 2004, the Third International Conference on Ontologies, Databases, and Applications of Semantics, which took place in October 2004 in Ayia Napa, Cyprus, and ICSNW 2004, the First International Conference on Semantics of a Networked World, organized by IFIP WG 2.6 in Paris, France, June 2004.

Papers from these conferences were selected based on their quality, relevance and significance, and the viability of extending their results. All extended papers were subject to a scholarly review process, and the authors were required to respond to all concerns expressed by the reviewers before papers were accepted.

Four papers, showing consistently high reviews from the Program Committee, were selected among those presented at ER 2004.

When reusing ontologies, many superfluous concepts are often included in the final conceptual schema. The first paper, entitled "A Method for Pruning Ontologies in the Development of Conceptual Schemas of Information Systems" by Jordi Conesa and Antoni Olivé presents a formal method of pruning ontologies to remove these superfluous concepts automatically.

The second paper, "XSLTGen: A System for Automatically Generating XML Transformation Via Semantic Mappings" by Stella Waworuntu and James Bailey, presents a method to automatically generate XSLT transformations based on the semantic mappings between input and output documents. Their experimental results show that the XSLTGEN works well with varieties of XML and HTML documents.

Based on the premise that semantically related data are highly likely to be changed as a result of the effort by the same or even different information sources for maintaining freshness and consistency, the third paper, "An Ontology-Guided Approach to Change Detection of the Semantic Web Data" by Li Qin and

Vijayalakshmi Atluri presents an approach that explores the relationship among concepts in guiding the change detection to their data instances for the Semantic Web.

The fourth paper, "Conceptual Modelling Patterns for Roles" by Jordi Cabot, and Ruth Raventós, studies role semantics in conceptual modeling and proposes a pattern based approach.

The selection from the ODBASE conference resulted in two extended papers being accepted for JoDS.

Relationships among concepts, namely inclusion dependencies, are also analyzed in the paper by Andreas Koeller and Elke A. Rundensteiner. The authors present heuristics to scale hypergraph-based inclusion dependencies discovery algorithms. Heuristics are based on the notion of inclusion dependencies between different relations of a database (or different databases) that are discovered by hypergraph-based algorithms, but that do not correspond to a real semantic relationship between such relations.

The paper by de Souza et al. describes a complete solution for the alignment of subdomain ontologies using an upper domain ontology that is built based on a thesaurus of terms. Mappings from the concepts of the individual ontologies to sets of thesaurus terms are established. A novel measure of similarity among concepts is also introduced together with suitable visualization techniques.

Finally, two of the selected papers from the ICSNW conference were accepted after rigorous review. The first one, by Bagüés et al., addresses "Semantic Interoperation Among Data Systems at a Communication Level." The authors propose to achieve semantic interoperability in a framework of agent-based data systems that exchange messages at a semantic level without requiring pre-established communication patterns. An ontology of communication acts is a key resource for this kind of interoperability. Semantic description of Web services and two case studies are also discussed.

The second paper, "Matching Ontologies in Open Networked Systems: Techniques and Applications," by S. Castano, A. Ferrara, S. Montanelli, and G. Racca, describes an algorithm and related techniques for performing matching of independent ontologies in open networked systems. A key feature is the capability of dynamically configuring the algorithm taking into account the complexity of the ontologies at hand. Implementation and experimental results are also presented.

The Guest Editors

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Katia P. Sycara, Carnegie Mellon University, USA

ICSNW 2004
Stefano Spaccapietra, EPFL, Switzerland

Paolo Atzeni and Wesley Chu would like to dedicate this issue to the memory of Hongjun Lu, ER04 Program Co-chair, who passed away a few months after the conference, to which he had dedicated a lot of effort, especially in coordinating the overall program and the relationships between the Chinese and the international research community.

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We are please to mention the reviewers who contributed their voluntary effort to the timely completion of this volume:

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Semantic Interoperation Among Data Systems at a Communication Level

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Abstract. The traditional perception of isolated data systems is changing to a new one where the interest of a real and efficient interoperation among those data systems is recognized. However, many problems must be solved yet before a real interoperation becomes true. In order to overcome the existing problems, there is a considerable number of proposals that can be found in the specialized literature that promote the idea of semantic interoperability.

A new framework to achieve semantic interoperability among agent based data systems at a communication level is proposed in this paper. This framework permits agents belonging to different data systems 1) to send each other suitable messages without requiring the establishment of a common communication pattern in advance; 2) to understand, completely or partially, those messages that are interchanged among themselves; and 3) to invoke web services offered by the data systems at a high level without needing to go into technical details. An ontology that captures the semantics of different communication acts is the key element for supporting the functionalities provided by the framework. Furthermore, the framework has been extended to support semantic descriptions of web services, which favor their automatic discovery. The usefulness of the presented framework is evaluated using two case study of interoperation among heterogeneous data systems; on one side through the agents of those systems, and on the other side, through the combination of an agent and a web service.

1 Introduction

The traditional perception of isolated data systems is changing to a new one where the interest of a real and efficient interoperation among those data systems is recognized. New advances in the areas of Internet and network communications are favoring somehow this change. However, many problems must be solved before a real interoperation becomes true. To that end, many proposals appear

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in the specialized literature aiming at overcoming those existing problems. A great number of those proposals promote the idea of semantic interoperability.

Establishing semantic interoperability among heterogeneous and distributed data systems has been, and still is, a critical issue attracting significant attention from research and practical reality. That issue can be tackled from two main perspectives. From one side, the focus is on the data sources and how to provide a unified view of their underlying representational and reasoning formalisms for a semantic mediation process (sometimes the notion of *data integration* is used to refer to this perspective). Several proposals consider this perspective and can be distinguished according to: first, the type of mappings among the unified views and the schemas of the sources (Global as View *versus* Local as View); and second, the languages used for modelling the views and the sources. Among those proposals, we can mention [1, 2, 3, 4, 5, 6, 7]. From the other side, the focus is on the communication aspects and how to achieve communication at a semantic level in presence of different execution platforms when the data systems agree on the semantics of the interchanged data. So far, this second perspective has yielded less proposals (e.g. [8]). However, the relevance of the semantic communication problem is also widely accepted and this matter goes far beyond the use of XML for the interchange of data. The framework presented in this paper considers the latter perspective.

Moreover, nowadays there is a tendency to use agents in data systems because agent technology is broadly recognized as an appropriate technology for approaching problems which show a highly distributed nature and need flexible and adaptable solutions [9]. In this paper we focus on these kinds of agent based data systems.

There are two ways in which agent based data systems can interoperate among themselves. One, through messages that are interchanged among the agents of both systems, and two, using the web services that are provided by each data system. In this paper we present a proposal that considers both cases.

Currently the communication among agents is, in general, based on the interchange of messages. Agents must be aware in advance of the structure, language and the meaning of the messages in order to deal with them. Although this kind of communication is useful, it is also true that it is somehow limited because it forces agents to share the same communication pattern. Therefore, the interoperation of agents from different systems, independently developed, is extremely unlikely in this scenario. Moreover, nowadays interoperation is unconsidered when the agents follow different standards of communication languages. The framework proposed in this paper is used as a basis for automating the detection and resolution of conflicts that arise when dealing with messages interchanged by agents of different systems.

Furthermore, concerning the use of web services, the most used approach is to invoke them. In this case it is necessary to know in advance the number and type of the parameters of the invocation and the service capabilities. In addition, the Semantic Web Services framework is trying to soften those requirements. Semantic Web Services [10], as a new paradigm, is generally defined as the

augmentation of Web Service descriptions through Semantic Web annotations in order to facilitate the higher automation of service discovery, composition, invocation, and monitoring in an open and unregulated environment that is the Web. Several research activities in Semantic Web Services are emerging [11, 12, 13]. Our contribution in this paper with regard to web services concerns the framework we propose for a semantic communication among agents, in the sense that it can be easily adapted to support Semantic Web Services descriptions. This issue can help in the process of discovering dynamically and on the fly web services, and therefore facilitating the data systems interoperation using web services.

Taking into account the aforementioned difficulties when communicating different data systems through agents or web services, and being aware of the interest of the web services discovering process, we present in this paper a new framework that promotes communications among different data systems at a semantic level (the basics of this framework can be found in [14]) with the goal of overcoming those difficulties. The proposed framework is mainly based on the use of ontologies: a communication acts ontology, domain specific ontologies and an actions/operations ontology.

We have dedicated a considerable effort to develop the communication acts ontology (called COMMONT), so we present it more in detail. The desideratum for the other ontologies is to use the ones developed by specialists in the corresponding areas. We distinguish three categories in the COMMONT ontology: the *Actors* category that represents those entities that send or receive messages; the *Communication Acts* category that represents the messages which have different purposes and deal with different kinds of contents; and the *Contents* category that represents the kind of sentences included in the message. In the ontology there are axioms which describe the interrelationships among these categories. Moreover, for the sake of presentation we explain the *Communication Acts* category divided into three layers. The *upper layer* of the ontology, which include classes that describe general communication acts with the aim of being shared by any communication framework. The *standards layer* of the ontology which is devoted to general purpose communication languages, is specified as subclasses of the upper layer classes. Furthermore in the communication acts category appear classes of messages that different standards such as, FIPA-ACL [15] and KQML [16], have defined to use as communication acts (e.g. `FIPA-Inform` term for FIPA-ACL and `KQML-Tell` term for KQML). Finally in the *applications layer* all the classes described are directly related to a concrete data system that it is considered. Therefore, the first two layers may be shared by all data systems. Only the applications layer must be defined for each data system. Thus, for each data system, the classes of messages that it is capable of dealing with must be specified. If a data system can deal with a particular class `M` of messages then it can also deal with any message of a subclass of `M` in the COMMONT ontology. We claim that the whole communication acts ontology provides interoperability support due to the recognition of communication acts from one language as instances of communication acts in another language. Sometimes the "translation"

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