04391 Abstracts Collection
Semantic Interoperability and Integration
— Dagstuhl Seminar —

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Abstract. From 19.09.04 to 24.09.04, the Dagstuhl Seminar 04391 "Semantic Interoperability and Integration" was held in the International Conference and Research Center (IBFI), Schloss Dagstuhl. During the seminar, several participants presented their current research, and ongoing work and open problems were discussed. Abstracts of the presentations given during the seminar as well as abstracts of seminar results and ideas are put together in this paper. The first section describes the seminar topics and goals in general. Links to extended abstracts or full papers are provided, if available.

Keywords. Semantic Interoperability and Integration

1 Executive Summary

Semantic Interoperability and Integration

Executive Summary of the Seminar on Semantic Interoperability and Integration held at Schloss Dagstuhl, September 19-24, 2004.

Keywords: Semantic Interoperability and Integration

Joint work of: Kalfoglou, Yannis; Schorlemmer, Marco; Uschold, Mike; Sheth, Amit; Staab, Steffen

Full Paper: http://drops.dagstuhl.de/opus/volltexte/2005/50

2 Mapping and Translation

Ontology Alignment: An annotated Bibliography

Heiner Stuckenschmidt (Vrije Universiteit Amsterdam)

Ontology mapping, alignment, and translation has been an active research component of the general research on semantic integration and interoperability. In our talk, we gave our own classification of different topics in this research. We talked about types of heterogeneity between ontologies, various mapping representations, classified methods for discovering methods both between ontology concepts and data, and talked about various tasks where mappings are used. In this extended abstract of our talk, we provide an annotated bibliography for this area of research, giving readers brief pointers on representative papers in each of the topics mentioned above. We did not attempt to compile a comprehensive bibliography and hence the list in this abstract is necessarily incomplete. Rather, we tried to sketch a map of the field, with some specific reference to help interested readers in their exploration of the work to-date.

Keywords: Ontologies, mapping, integration

Joint work of: Noy, Natasha; Stuckenschmidt, Heiner

Full Paper: http://drops.dagstuhl.de/opus/volltexte/2005/48

The CIDOC CRM, an Ontological Approach to Schema Heterogeneity

Martin Doerr (ICS-FORTH - Heraklion)

The CIDOC Conceptual Reference Model (CRM), now ISO/CD21127, is a core ontology that aims at enabling information exchange and integration between heterogeneous sources of cultural heritage information, archives and libraries. It provides semantic definitions and clarifications needed to transform disparate, heterogeneous information sources into a coherent global resource, be it within a larger institution, in intranets or on the Internet. It is argued that such an ontology is property-centric, compact and highly generic, in contrast to terminological systems. The presentation will demonstrate how such a well-crafted core ontology can help to achieve a very high precision of schema integration at reasonable cost in a huge, diverse domain. It is further argued that such ontologies are widely reusable and adaptable to other domains which makes their development cost effective.

Keywords: Formal ontologies, knowledge engineering, semantic interoperability, core ontology, information integration, heterogeneous information, museums, archives, libraries, cultural heritage, ISO/CD 21127, CIDOC CRM

Extended Abstract: http://drops.dagstuhl.de/opus/volltexte/2005/35

S-Match: an algorithm and an implementation of semantic matching

Fausto Giunchiglia (Università di Trento)

We think of Match as an operator which takes two graph-like structures and produces a mapping between those nodes of the two graphs that correspond semantically to each other. Semantic matching is a novel approach where semantic correspondences are discovered by computing and returning as a result, the semantic information implicitly or explicitly codified in the labels of nodes and arcs. In this paper we present an algorithm implementing semantic matching, and we discuss its implementation within the S-Match system. We also test S-Match against three state of the art matching systems. The results, though preliminary, look promising, in particular for what concerns precision and recall.

Keywords: Context, mappings between ontologies, automatic discovery of mappings

Joint work of: Giunchiglia, Fausto; Shvaiko, Pavel; Yatskevich, Mikalai

Full Paper: http://drops.dagstuhl.de/opus/volltexte/2005/37

Ontology Merging with Formal Concept Analysis

Gerd Stumme (Universität Kassel)

In this short paper, we summarize two methods for merging ontologies: FCA-Merge and OntEx. Both methods are based on Formal Concept Analysis.

Keywords: Ontology Engineering, Ontology Merging, Formal Concept Analysis

Full Paper: http://drops.dagstuhl.de/opus/volltexte/2005/49

Ontology mapping: the state of the art

Yannis Kalfoglou (Univ. of Southampton)

Ontology mapping is seen as a solution provider in today's landscape of ontology research. As the number of ontologies that are made publicly available and accessible on the Web increases steadily, so does the need for applications to use them. A single ontology is no longer enough to support the tasks envisaged by a distributed environment like the Semantic Web. Multiple ontologies need to be accessed from several applications. Mapping could provide a common layer from which several ontologies could be accessed and hence could exchange information in semantically sound manners. Developing such mapping has beeb the focus of a variety of works originating from diverse communities over a number of years. In this article we comprehensively review and present these works. We also provide insights on the pragmatics of ontology mapping and elaborate on a theoretical approach for defining ontology mapping.

Keywords: Ontology mapping

Joint work of: Kalfoglou, Yannis; Schorlemmer, Marco

Full Paper: http://drops.dagstuhl.de/opus/volltexte/2005/40

3 Industrial Experiences

Semantic-Web Technology: Applications at NASA

Naveen Ashish (NASA (RIACS) - Moffett Field)

Abstract. We provide a description of work at the National Aeronautics and Space Administration (NASA) on building systems based on Semantic-Web concepts and technologies. NASA has been one of the early adopters of Semantic-Web technologies for practical applications. Indeed there are several ongoing (IT) endeavors on building semantics based systems for use in diverse NASA domains ranging from collaborative scientific activity to accident and mishap investigation to enterprise search to scientific information gathering and integration to aviation safety decision support. We provide a brief overview of many applications and ongoing work with the goal of informing the external community of these NASA endeavors.

Keywords: Semantic Web, Applications, Real World, NASA

Full Paper: http://drops.dagstuhl.de/opus/volltexte/2005/32

From Semantic Search & Integration to Analytics

Amit P. Sheth (University of Georgia)

Semantics is seen as the key ingredient in the next phase of the Web infrastructure as well as the next generation of enterprise content management. Ontology is the centerpiece of the most prevalent semantic technologies and provides the basis of representing, acquiring, and utilizing knowledge. With the availability of several commercial products and many research tools, specifications and increasing adoption of Semantic Web standards such as RDF for metadata and OWL for ontology representation, ontology-driven techniques and systems have already enabled a new generation of industry strength semantic applications. In particular, Semagix's Freedom has powered applications in leading verticals such as, financial services, government & intelligence, pharmaceuticals, and media & entertainment. In this paper, we portray some of the requirements of high-end enterprise applications requiring search to integration, and more advanced analytical capabilities, discuss the enterprise scale capabilities expected of a semantic technology, and how Semagix has put an ontology-driven approach to use.

Keywords: Ontology, Semantic Search, Semantic Integration, Semantic Analytics

Full Paper: http://drops.dagstuhl.de/opus/volltexte/2005/46

Integrating XML Data Sources using RDF/S Schemas: The ICS-FORTH Semantic Web Integration Middleware (SWIM)

Vassilis Christophides (ICS-FORTH - Heraklion)

Semantic Web (SW) technology aims to facilitate the integration of legacy data sources spread worldwide. Despite the plethora of SW languages e.g., RDF/S, OWL recently proposed for supporting large scale information interoperation, the vast majority of legacy sources still rely on relational databases RDB published on the Web or corporate intranets as virtual XML. In this paper, we advocate a Datalog framework for mediating high level queries to relational and or XML sources using community ontologies expressed in a SW language such as RDF/S. We describe the architecture and the reasoning services of our SW integration middleware, called SWIM, and we present the main design choices and techniques for supporting powerful mappings between different data models, as well as reformulation and optimization of queries expressed against mediation schemas and views.

Keywords: Integration, xml, rdf schema

Joint work of: Christophides, Vassilis; Koffina, Ioanna; Serfiotis, Giorgos; Tannen, Val; Deutsch, Alin

Extended Abstract: http://drops.dagstuhl.de/opus/volltexte/2005/34

4 Theoretical Foundations

Model-theoretic Approaches to Semantic Integration

Michael Grüninger (NIST - Gaithersburg)

Extended Abstract: http://drops.dagstuhl.de/opus/volltexte/2005/39

Basic Semantic Integration

Chris Menzel (Texas A&M University)

The use of highly abstract mathematical frameworks is essential for building the sort of theoretical foundation for semantic integration needed to bring it to the level of a genuine engineering discipline. At the same time, much of the work that has been done by means of these frameworks assumes a certain amount of background knowledge in mathematics that a lot of people working in ontology, even at a fairly high theoretical level, lack. The major purpose of this short paper is provide a (comparatively) simple model of semantic integration that remains within the friendlier confines of first-order languages and their usual classical semantics and logic.

Keywords: Ontology, semantic integration, first-order logic, model theory, SCL

Full Paper: http://drops.dagstuhl.de/opus/volltexte/2005/42

Semantic Integration in the Information Flow Framework

Robert E. Kent (TOC - Pullman)

The Information Flow Framework (IFF) is a descriptive category metatheory currently under development, which is being offered as the structural aspect of the Standard Upper Ontology (SUO). The architecture of the IFF is composed of metalevels, namespaces and meta-ontologies, whose core forms a metastack representing the set-theoretic notions of the "small", the "large", the "very large" and the "generic". The main application of the IFF is institutional: the notion of institutions and their morphisms are being axiomatized in the upper metalevels of the IFF, and the lower metalevel of the IFF has axiomatized various institutions (information flow, equational logic, many sorted first order logic, the common logic standard) in which semantic integration has a natural expression.

Keywords: Descriptive category metatheory, institutions, semantic integration

Joint work of: Kent, Robert E.

Full Paper: http://drops.dagstuhl.de/opus/volltexte/2005/41

Heterogeneous Theories and the Heterogeneous Tool Set

Till Mossakowski (Universität Bremen)

Heterogeneous multi-logic theories arise in different contexts: they are needed for the specification of large software systems, as well as for mediating between different ontologies. This is because large theories typically involve different aspects that are best specified in different logics (like equational logics, description logics, first-order logics, higher-order logics, modal logics), but also because different formalisms are in practical use (like RDF, OWL, EML). Using heterogeneous theories, different formalims being developed at different sites can be related, i.e. there is a formal interoperability among languages and tools. In many cases, specialized languages and tools have their strengths in particular aspects. Using heterogeneous theories, these strengths can be combined with comparably small effort. By contrast, a true combination of all the involved logics into a single logic would be too complex (or even inconsistent) in many cases.

We propose to use *institutions* as a formalization of the notion of logical system. Institutions can be related by so-called institution morphsims and comorphisms. Any graph of institutions and (co)morphisms can be flattened to a so-called *Grothendieck institution*, which is kind of disjoint union of all the logics, enriched with connections via the (co)morphisms.

This semantic basis for heterogeneous theories is complemented by the heterogeneous tool set, which provides tool support. Based on an object-oriented

interface for institutions (using type classes in Haskell), it implements the Grothendieck institution and provides a heterogeneous parser, static analysis and proof support for heterogeneous theories. This is based on parsers, static analysers and proof support for the individual institutions, and on a heterogeneous proof calculus for theories in the Grothendieck institution.

Keywords: Heterogeneity, logic, theory mediation, tool integration

Full Paper: http://drops.dagstuhl.de/opus/volltexte/2005/43

See also: http://www.tzi.de/cofi/hets

Three Perspectives on Information Integration

Joseph Goguen (Univ. California - San Diego)

Three Perspectives on Information Integration

Keywords: Information integration

Full Paper: http://drops.dagstuhl.de/opus/volltexte/2005/38

5 Standards and Benchmarks

Evaluating ontology alignment methods

Jerome Euzenat (INRIA Rhône-Alpes)

Many different methods have been designed for aligning ontologies. These methods use such different techniques that they can hardly be compared theoretically. Hence, it is necessary to compare them on common tests. We present two initiatives that led to the definition and the performance of the evaluation of ontology alignments during 2004. We draw lessons from these two experiments and discuss future improvements.

Keywords: Evaluation, ontology alignment

Extended Abstract: http://drops.dagstuhl.de/opus/volltexte/2005/36

Querying Semantic Web Resources Using TRIPLE Views

Michael Sintek (DFKI Kaiserslautern)

Resources on the Semantic Web are described by metadata based on some formal or informal ontology. It is a common situation that casual users are not familiar with a domain ontology in detail. This makes it difficult for such users (or their user tools) to formulate queries to find the relevant resources. Users consider the resources in their specific context, so the most straightforward solution is to formulate queries in an ontology that corresponds to a user-specific view. We present an approach based on multiple views expressed in ontologies simpler than the domain ontology. This allows users to query heterogeneous data repositories in terms of multiple, relatively simple, view ontologies. Ontology developers can define such view ontologies and the corresponding mapping rules. These ontologies are represented in Semantic Web ontology languages such as RDFS, DAML+OIL, or OWL. We present our approach with examples from the e-learning domain using the Semantic Web query and transformation language TRIPLE.

Keywords: Querying, TRIPLE, views

Joint work of: Miklos, Zoltan; Neumann, Gustaf; Zdun, Uwe; Sintek, Michael

Full Paper: http://drops.dagstuhl.de/opus/volltexte/2005/47

6 Breakout Sessions

Summary of the Results of the Break-out Session "Social Issues around the Semantic Web"

Klemens Böhm (Universität Magdeburg)

As part of the Dagstuhl Workshop on the Semantic Web, a break-out session focused on discussing social issues around the Semantic Web. This article is a concise summary of the main issues discussed, the controversies that have arisen, and of the open research questions that need to be addressed.

Keywords: Semantic web, social issues

Joint work of: Aberer, Karl; Böhm, Klemens; Fonseca, Fred

Extended Abstract: http://drops.dagstuhl.de/opus/volltexte/2005/33

Interesting Problems in Semantic Integration and Interoperability

Vasilis Vassalos (Athens University of Economics and Business)

We report on the issues discussed at the breakout session held at the Dagstuhl Seminar on Semantic Interoperability and Integration on September 23, 2004.

Keywords: Logic, semantic integration, semantic interoperability, natural language

Extended Abstract: http://drops.dagstuhl.de/opus/volltexte/2005/54

Architectures for Semantic Integration

Joint work of: Uschold, Michael and Gruninger, Michael

Extended Abstract: http://drops.dagstuhl.de/opus/volltexte/2005/51

Representation of Semantic Mappings

The aim of this breakout session was to chart the landscape of existing approaches for representing mappings between heterogeneous models, identify common ideas and formulate research questions to be addressed in the future. In the session, the discussion mainly concerned three aspects: The nature of mappings, existing proposals for mappings and open research questions.

Keywords: Mapping Languages, Integration

Joint work of: Stuckenschmidt, Heiner Uschold, Mike

Extended Abstract: http://drops.dagstuhl.de/opus/volltexte/2005/53

On the Mathematical Foundations of Semantic Interoperability and Integration

Marco Schorlemmer (Universitat Internacional de Catalunya - Barcelona)

We report on the issues discussed at the breakout session held at the Dagstuhl Seminar on Semantic Interoperability and Integration on September 23, 2004.

Keywords: sematic interoperability and integration, theory of institutions

Extended Abstract: http://drops.dagstuhl.de/opus/volltexte/2005/44

Infrastructure for Semantic Interoperability and Integration

Joint work of: Burstein, Mark and Uschold, Michael

Extended Abstract: http://drops.dagstuhl.de/opus/volltexte/2005/52