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# Knowledge Transformation for the Semantic Web

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## Schema Conversion Methods between XML and Relational Models

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*Dongwon Lee, Murali Mani, Wesley W. Chu*

In this chapter, three semantics-based schema conversion methods are presented: 1) CPI converts an XML schema to a relational schema while preserving semantic constraints of the original XML schema, 2) NeT derives a nested structured XML schema from a flat relational schema by repeatedly applying the *nest* operator so that the resulting XML schema becomes hierarchical, and 3) CoT takes a relational schema as input, where multiple tables are interconnected through inclusion dependencies and generates an equivalent XML schema as output.

## Transforming Data Models with UML

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*Martin Gogolla, Arne Lindow*

This chapter studies an approach to establish a formal connection between data models, in particular between conceptual data models and implementation data models. We use metamodeling techniques based on the Meta Object Facility MOF. MOF may be regarded as a subset of the Unified Modeling Language UML. As prominent example data models, we formally describe and thereby analyze the Entity-Relationship and the Relational data model. In addition, we represent the transformation between these data models by MOF language features. Thus we describe the data models and their transformation within a single framework. All results are formally represented and validated by a MOF compliant tool. The approach presented is general enough so that it can be used for other data models being important for the Semantic Web, e.g., the object-oriented data model or semi-structured data models like XML-based models.

## On Modeling Conformance for Flexible Transformation over Data Models

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*Shawn Bowers, Lois Delcambre*

Data models use a limited number of *basic structures* to represent data such as collections, attribute-value pairs, and scalars. They differ, however, in how structures are composed and whether they *permit* the specification of schema, *permit more than one schema*, or *require* schema. Support for transforming between heterogeneous representation schemes remains a significant challenge. To this aim, we extend our work on generic representation and transformation of model-based information by introducing a richer metamodel and abstract framework for representation. We also introduce several steps toward our vision of high-level transformations through mapping patterns and by exploiting inherent constraints.

## The 'Family of Languages' Approach to Semantic Interoperability

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*Jérôme Euzenat, Heiner Stuckenschmidt*

Different Semantic Web applications can use different knowledge representation languages. Exchanging knowledge thus requires techniques for ensuring semantic interoperability across languages. We present the 'family of languages' approach based on a set of knowledge representation languages whose partial ordering depends on the transformability from one language to another by preserving a particular formal property such as logical consequence. For the same set of languages, there can be several such structures based on the property selected for structuring the family. Properties of different strength allow performing practicable but well founded transformations. The approach offers the choice of the language in which a representation will be imported and the composition of available transformations between the members of the family.

## Tracing Data Lineage Using Schema Transformation Pathways

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*Hao Fan, Alexandra Poulovassilis*

With the increasing amount and diversity of information available on the Internet, there has been a huge growth in information systems that need to integrate data from distributed, heterogeneous data sources. Tracing the lineage of the integrated data is one of the current problems being addressed in data warehouse research. In this chapter, we propose a new approach for tracing data lineage which is based on schema transformation pathways. We show how the individual transformation steps in a transformation pathway can be used to trace the derivation of the integrated data in a step-wise fashion. Although developed for a graph-based common data model and a functional query language, our approach is not limited to these and would be useful in any data transformation/integration framework based on sequences of primitive schema transformations.

## Ontology Extraction for Distributed Environments 80

*Derek Sleeman, Stephen Potter, Dave Robertson, Marco Schorlemmer*

Existing knowledge base resources have the potential to be valuable components of the Semantic Web and similar knowledge-based environments. However, from the perspective of these environments, these resources are often under-characterised, lacking the ontological characterisation that would enable them to be exploited fully. In this chapter we discuss a technique which can be applied to identify ontological knowledge implicit in a knowledge base. Based on this technique, a tool has been implemented which allows this knowledge to be extracted, thereby promoting the re-use of the resource. A discussion of some complementary research into brokering services within distributed knowledge architectures serves to illustrate the sort of environment in which such re-use might be enacted.

## UML for the Semantic Web: Transformation-Based Approaches 92

*Kateryna Falkovych, Marta Sabou, Heiner Stuckenschmidt*

The perspective role of UML as a conceptual modelling language for the Semantic Web has become an important research topic. We argue that UML could be a key technology for overcoming the ontology development bottleneck thanks to its wide acceptance and sophisticated tool support. Transformational approaches are a promising way of establishing a connection between UML and web-based ontology languages. We compare some proposals for defining transformations between UML and web ontology languages and discuss the different ways they handle the conceptual differences between these languages. We identify commonalities and differences of the approaches and point out open questions that have not or not satisfyingly been addressed by existing approaches.

## Knowledge Representation and Transformation in Ontology-based Data Integration 107

*Silvana Castano, Alfio Ferrara*

This chapter describes an ontology architecture for the integration of heterogeneous XML data sources. In this architecture, the information about DTDs and their contents is represented at a semantic level, by means of a semantic mapping scheme and a mediation scheme. We first describe information transformation techniques for designing such ontology schemes for heterogeneous XML data. Then, we present a rule-based approach for deriving a DAML+OIL representation of the ontology, to enable ontology interoperability in Semantic Web.

## A Logic Programming Approach to RDF Document and Query Transformation 122

*Joachim Peer*

The Resource Description Framework (RDF) is an attractive tool for managing any kind of data, especially if multiple heterogeneous vocabularies are involved. However, a standard way of either transforming RDF documents or transforming RDF queries does not exist yet. Several concepts have been proposed so far, each concentrating on different goals. In this chapter we present a concept following a Logic Programming approach, providing the amount of expressivity needed to build generic services for management of RDF data. We will focus on several transformation problems not satisfactorily discussed yet and we will provide an overview of the algorithms and data structures needed to solve these problems.

## RDFT: A Mapping Meta-Ontology for Web Service Integration 137

*Borys Omelayenko*

The Semantic Web needs to possess advanced techniques for mapping various web services to enable open enterprise integration on the Semantic Web. These services contain message sequences and messages derived from substantially different underlying domain models and cannot be straightforwardly mapped or converted. In this chapter we propose a mapping meta-ontology built on top of RDF Schema and targeted for describing and inferencing about the links between different services. The ontology contains the main web service concepts needed for the integration: events, messages, XML constructs. They are linked with bridges representing different relations between the concepts and several other mapping constructs. The few relations described in the chapter allow the most essential mappings and validation tasks to be performed.

## Transforming UML Domain Descriptions into Configuration Knowledge Bases 154

*Alexander Felfernig, Gerhard Friedrich, Dietmar Jannach, Markus Stumptner, Markus Zanker*

In this chapter we emphasize how we can integrate Web-based sales systems for highly complex customizable products and services by making use of the descriptive representation formalisms of the Semantic Web. Building on the equivalence between the consistency based definition and the description logic based definition of configuration, we are capable of transforming our application domain-independent meta-model for modeling configuration knowledge into the emerging standards of the Semantic Web initiative, such as DAML+OIL. Furthermore, we discuss how these standardized description languages can be used to derive capability descriptions for semantic configuration Web services.