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Anatol Reibold *Editors*

Semantic Applications

Methodology, Technology, Corporate Use

Springer Vieweg

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Preface by the Editors

"Why are there hardly any publications about semantic applications in corporate use?"

We asked ourselves this question a few years ago. Most publications about semantic technologies and the Semantic Web are primarily centered around the technology itself, just illustrating them either by toy examples or isolated applications. By developing semantic applications for corporate use, we gained some expertise ourselves, and we were highly interested in exchanging and sharing this knowledge with peers and learning from each other. Therefore, we established the Corporate Semantic Web community in Germany.

In the years 2014–2017, we organized annual Dagstuhl workshops. Making our learnings available to the wider community was our intention from the beginning, so we published our first book "Corporate Semantic Web – Wie semantische Anwendungen in Unternehmen Nutzen stiften" (in German) in 2015. Subsequently, we published two articles on emerging trends in Corporate Semantic Web in the Informatik Spektrum magazine. Due to the high interest in those publications, we decided on starting a new book project. We have deliberately chosen English as the language for this book in order to share our experience with a worldwide community. We dedicated the 2017 Dagstuhl workshop to this book because we wanted to create more than a loose collection of articles: a coherent work which demonstrates the various aspects of engineering semantic applications.

Semantic applications are slowly but steadily being adopted by corporations and other kinds of organizations. By *semantic applications* we mean software applications which explicitly or implicitly use the semantics (i.e., the meaning) of a domain in order to improve usability, correctness, and completeness. We would like to show how to develop semantic applications in a broad range of business sectors. This book is a collection of articles describing proven methodologies for developing semantic applications including technological and architectural best practices. It is written by practitioners for practitioners. Our target audience includes software engineers and knowledge engineers, but also managers, lecturers and students. All of our co-authors are experts from industry and academia with experience in developing semantic applications. One result of the intense community effort over the years is an increasingly aligned understanding of do's and don'ts in developing such applications.

Schloss Dagstuhl, “where Computer Science meets”, has been a wonderful host and is a true incubator for developing and sharing new insights. Therefore, our first thanks go to the friendly and competent staff members of Schloss Dagstuhl.

The most important contributors to this book are, of course, our co-authors: 45 experts in their fields and also in writing high-quality texts. Thank you very much for the great collaboration and for meeting (most) deadlines! We would like to thank in particular Wolfram Bartussek, Hermann Bense, Ulrich Schade, Melanie Siegel, and Paul Walsh, who supported us as extended editorial board. Especially, we would like to thank Timothy Manning for proofreading the entire book and literally suggesting hundreds of improvements!

Finally, we would like to thank the team at Springer, particularly Hermann Engesser and Dorothea Glaunsinger for supporting us over the last years and Sabine Kathke for guiding us in this book project. The collaboration with you has truly been friendly, constructive, and smooth.

Darmstadt and Berlin, Germany, December 2017
Thomas Hoppe, Bernhard Humm, and Anatol Reibold

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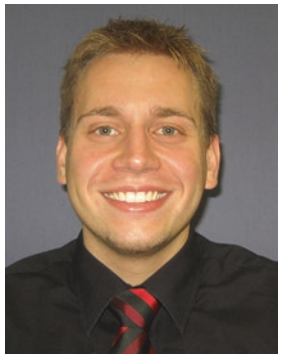

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Introduction to Semantic Applications

1

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Key Statements

1. Semantic applications today provide benefits to numerous organisations in business sectors such as health care, finance, industry, and the public sector.
2. Semantic applications use the semantics of a domain in order to improve usability, correctness, and completeness.

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3. Developing semantic applications requires methodological skills, e.g., ontology engineering, quality assurance for ontologies, and licence management.
4. Various technologies are available for implementing semantic applications, e.g., data integration, semantic search, machine learning, and complex event processing.

1.1 Introduction

Semantic applications today provide benefits to numerous corporations and other kinds of organisations worldwide. This book describes proven methodologies for developing semantic applications including technological and architectural best practices: from data to applications. The methodologies are backed up by a large number of applications that are in corporate use today.

Figure 1.1 gives overview of the book chapters and which methodologies, technologies, and applications in corporate use they cover.

In this chapter, we give an introduction to semantic applications and provide an overview of the most prominent methodologies, technologies, and applications in corporate use.

1.2 Foundations

Since not everybody is acquainted with the terminology in the field of semantic applications, we provide definitions of the most important terms used in this book. These definitions are neither intended to be complete nor perfectly consistent with scientific definitions. They are intended to show the intuition behind some of the major terms.

Semantics tries to capture and normalise the relationships between words (respectively terms, phrases, symbols etc.) and their meaning. For example, the word "cancer" can have the meaning of a disease or a zodiac sign. The concrete meaning of a term in a formalisation is usually determined by its context, i.e. the other terms used for its definition and the terms related to it. Such formalisations are often called ontologies.

In the context of semantic applications, an *ontology* is an explicit representation of the semantics of the used terms, usually restricted to a specific application domain [1]. The term *ontology* has been defined as a "formal, explicit specification of a conceptualisation" [2], emphasising that the terms are explicitly chosen on a particular level of granularity, or as a "formal, explicit specification of a shared conceptualisation" [3] additionally emphasising that its purpose is to share the meaning of terms between different stakeholders. For example, an ontology for medicine may define melanoma as a disease, Warfarin as a medication, and the relationship between both indicating that Warfarin can be used for treating melanoma. In fact, Fig. 1.1 shows a simple ontology, specifying applications, business sectors for corporate use, methodologies and technologies, and indicating relationships to chapters of this book.

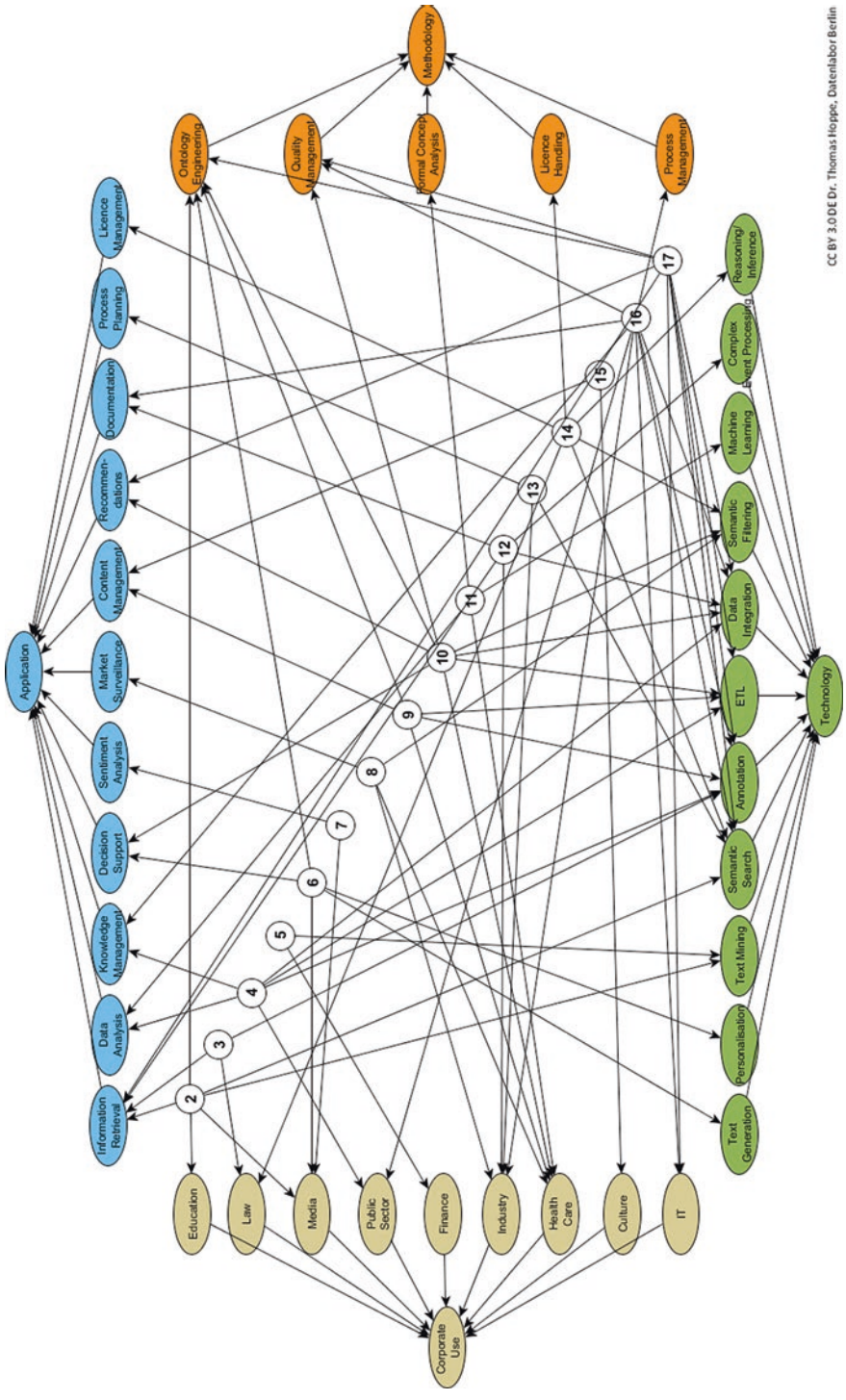

Fig. 1.1 Overview of the book chapters (White circles indicate chapter numbers. The arrows exiting the white circles indicate the methodologies, technologies, applications and corporate domains covered by each chapter.)

Various forms of ontologies are used under different terms, depending on the complexity of relationships provided. Lassila and McGuiness [4] differentiate between "lightweight ontologies" and "heavyweight ontologies". Lightweight ontologies in particular include controlled vocabularies, thesauri and informal taxonomies. *Controlled vocabularies* are, in their simplest form, just a list of prominent terms used in an application domain, e.g., "melanoma" in the medical domain. *Taxonomies* add hierarchies of broader/narrower terms to controlled vocabularies, e.g., melanoma is a type of cancer, which is a disease. *Thesauri* add additional information to the terms in taxonomies, including prefered names (e.g., "melanoma"), synonyms ("malignant melanoma", "cutaneous melanoma"), and relations to other terms (e.g. "see also skin cancer"). Heavyweight ontologies extend thesauri by giving the informal hierarchical broader/narrower term relation (i.e. is_a relation) a formal foundation and extending the expressiveness by additional fine grained relations (e.g., gene CRYBG1 is associated with melanoma), definitions (e.g., "melanoma is a malignant neoplasm comprised of melanocytes typically arising in the skin"; Source: National Cancer Institute Thesaurus), properties, and metadata. The focus of ontologies is not only the terminology of a domain, but also the inherent ontological structure, i.e. which objects exist in the application domain, how they can be organised into classes, called *concepts*, and how these classes are defined and related.

Ontology engineering is the discipline of building ontologies. It includes methodologies and best practices, e.g., incremental ontology development in tight collaboration with domain experts, and ranges from text analysis of available documents and information sources, over the extraction of information from various data sources, to the modelling of an ontology. *Ontology modelling* covers either the adaptation of existing ontologies, the merging and aligning of several ontologies covering different domain aspects, or modelling the needed ontology from scratch. As a key methodology, ontology engineering is covered in further detail in Sect. 1.4.1.

A *semantic application* is a software application which explicitly or implicitly uses the semantics of a domain. This is to improve usability, validity, and completeness. An example is semantic search, where synonyms and related terms are used for enriching the results of a simple text-based search. Ontologies are the centerpiece of semantic applications.

Information retrieval usually subsumes different approaches for obtaining information based on a specific information need from a collection of information sources. Besides pure textual information, it also usually covers image, speech and video retrieval. Nowadays, the most prominent examples of information retrieval applications are general-purpose search engines, such as Google, Yahoo, and Bing. Today, such search engines include semantic search, making them semantic applications. For example, entering "When was JFK born?" in the Google search will result in an information box containing "John F. Kennedy/Date of birth: May 29, 1917". In contrast to general-purpose search engines, domain-specific search applications have a narrower focus but provide more semantic depth. Examples are hotel and travel portals, partner search, job portals, used vehicles websites, etc.