ADVANCES IN PATTERN-BASED ONTOLOGY ENGINEERING

Studies on the Semantic Web

Semantic Web has grown into a mature field of research. Its methods find innovative applications on and off the World Wide Web. Its underlying technologies have significant impact on adjacent fields of research and on industrial applications. This book series reports on the state of the art in foundations, methods, and applications of Semantic Web and its underlying technologies. It is a central forum for the communication of recent developments and comprises research monographs, textbooks and edited volumes on all topics related to the Semantic Web.

Editor-in-Chief:
Prof. Dr. Pascal Hitzler
Department of Computer Science, Kansas State University, Manhattan, KS 66502, USA
Email: hitzler@k-state.edu

Editorial Board:
Eva Blomqvist, Linköping, Sweden; Diego Calvanese, Bolzano, Italy; Oscar Corcho, Madrid, Spain; Michel Dumontier, Maastricht, The Netherlands; Krzysztof Janowicz, Santa Barbara, CA, USA; Carole Goble, Manchester, UK; Frank van Harmelen, Amsterdam, The Netherlands; Markus Krötzsch, Dresden, Germany; Jens Lehmann, Bonn, Germany; Juanzi Li, Beijing, China; Diana Maynard, Sheffield, UK; Mark Musen, Stanford, CA, USA; Axel Ngonga, Leipzig, Germany; Heiko Paulheim, Mannheim, Germany; Valentina Presutti, CNR, Italy; Barry Smith, Buffalo, NY, USA; Steffen Staab, Koblenz, Germany; Rudi Studer, Karlsruhe, Germany; Hideaki Takeda, Tokyo, Japan; Ruben Verborgh, Ghent, Belgium

Volume 51

Previously published in this series:

Vol. 050 M. Mountantonakis, Services for Connecting and Integrating Big Numbers of Linked Datasets
Vol. 049 G. Cota, M. Daquino and G.L. Pozzato (Eds.), Applications and Practices in Ontology Design, Extraction, and Reasoning
Vol. 048 L. Asprino, Engineering Background Knowledge for Social Robots
Vol. 047 Ilaria Tiddi, Freddy Lécué, Pascal Hitzler (Eds.), Knowledge Graphs for Explainable Artificial Intelligence: Foundations, Applications and Challenges
Vol. 046 Daniel Dominik Janke, Study on Data Placement Strategies in Distributed RDF Stores
Vol. 045 Pavlos Vougiouklis, Neural Generation of Textual Summaries from Knowledge Base Triples
Vol. 044 Diego Collarana, Strategies and Techniques for Federated Semantic Knowledge Integration and Retrieval
Vol. 043 Filip Ilievski, Identity of Long-Tail Entities in Text
Vol. 042 Fariz Darari, Managing and Consuming Completeness Information for RDF Data Sources
Vol. 041 Steffen Thoma, Multi-Modal Data Fusion Based on Embeddings
Vol. 040 Marilena Daquino, Mining Authoritativeness in Art Historical Photo Archives. Semantic Web Applications for Connoisseurship
Vol. 039 Bo Yan, Geographic Knowledge Graph Summarization
Vol. 038 Petar Ristoski, Exploiting Semantic Web Knowledge Graphs in Data Mining
Vol. 037 Maribel Acosta Deibe, Query Processing over Graph-structured Data on the Web

ISSN 1868-1158 (print)
ISSN 2215-0870 (online)

Advances in Pattern-Based Ontology Engineering

Edited by

Eva Blomqvist
Linköping University, Sweden

Torsten Hahmann
University of Maine, USA

Karl Hammar
Jönköping University, Sweden

Pascal Hitzler
Kansas State University, USA

Rinke Hoekstra
Elsevier B.V., Netherlands

Raghava Mutharaju
IIIT-Delhi, India

María Poveda-Villalón
Universidad Politécnica de Madrid, Spain

Cogan Shimizu
Kansas State University, USA

Martin G. Skjæveland
University of Oslo, Norway

Monika Solanki
University of Oxford, UK

Vojtěch Svátek
Prague University of Economics and Business, Czech Republic

Lu Zhou
Kansas State University, USA

IOS Press

AKA

© 2021 Akademische Verlagsgesellschaft AKA GmbH, Berlin

All rights reserved. No part of this book may be reproduced, stored in a retrieval system,
or transmitted, in any form or by any means, without prior written permission from the publisher.

ISBN 978-3-89838-762-0 (AKA, print)
ISBN 978-1-64368-174-0 (IOS Press, print)
ISBN 978-1-64368-175-7 (IOS Press, online)
doi: 10.3233/SSW51

Bibliographic information available from the Katalog der Deutschen Nationalbibliothek (German National Library Catalogue) at https://www.dnb.de

Publisher
Akademische Verlagsgesellschaft AKA GmbH, Berlin

Represented by Co-Publisher IOS Press
IOS Press BV
Nieuwe Hemweg 6B
1013 BG Amsterdam
The Netherlands
Tel: +31 20 688 3355
Fax: +31 20 687 0019
email: order@iospress.nl

LEGAL NOTICE
The publisher is not responsible for the use which might be made of the following information.

PRINTED IN THE NETHERLANDS

Preface

Eva Blomqvist, Linköping University, Sweden
Torsten Hahmann, University of Maine, USA
Karl Hammar, Jönköping University, Sweden
Pascal Hitzler, Kansas State University, USA
Rinke Hoekstra, Elsevier B.V., Netherlands
Raghava Mutharaju, IIIT-Delhi, India
María Poveda-Villalón, Universidad Politécnica de Madrid, Spain
Cogan Shimizu, Kansas State University, USA
Martin G. Skjæveland, University of Oslo, Norway
Monika Solanki, University of Oxford, UK
Vojtěch Svátek, Prague University of Economics and Business, Czech Republic
Lu Zhou, Kansas State University, USA

Ontologies are the corner stone of any data modeling or knowledge representation effort. Engineering an ontology is a complex task, where domain knowledge, ontological accuracy and computational properties need to be carefully balanced. As with any engineering task, the identification and documentation of common patterns can significantly bootstrap the design of ontologies, and increases the overall quality and reusability of the result. Such Ontology Design Patterns (ODPs) can provide ontology designers with a stronger connection to requirements and a better communication of their semantic content and intent in order to improve guidance for reuse. There is a clear need to have pattern catalogues that cover a wide range of patterns and domains. At the same time, Semantic Web applications can benefit from additional knowledge patterns and specialized software patterns for semantic applications. But to achieve the promised adoption and reuse, ontology design patterns also need to be shared by a community of practice using a common language for describing and discussing patterns and the modeling problems they address.

This book is a selection of extended versions of the papers published at the Workshop on Ontology Design and Patterns (WOP)[1] from 2017 to 2020. This workshop is a yearly event that covers issues related to quality aspects of ontology engineering and ontology design patterns (ODPs) for data and knowledge representation using Semantic Web technologies. WOP is organized annually, and is habitually co-located with the International Semantic Web Conference (ISWC), including WOP 2017 held in Vienna, Austria, WOP 2018 held in Monterey, USA, WOP 2019 held in Auckland, New Zealand, and WOP 2020, which should have been held in Athens, Greece originally, but was held virtually due to the COVID-19 pandemic. Every year, WOP successfully attracts a large

[1] http://ontologydesignpatterns.org/wiki/WOP:Main

number of researchers and professionals in the field of ontology engineering and ontology design patterns.

The topics covered by the papers collected in this book range from a method to instantiate content patterns, through a proposal on how to document a content pattern, to a number of patterns emerging in ontology modeling in various situations and applications. As a collection based on papers presented at the workshop, the topics rather naturally focus on the more recent advances in ontology design and patterns, hence the title. For a more foundational discussion of this line of research we refer the reader to a recent book [1] which is a compilation of tutorials and surveys on the state of the art regarding ontology modeling with ontology design patterns.

The editors would like to thank all members of the Program Committees of WOP 2017 through to 2020 who provided useful and constructive comments to the papers. They are Oscar Corcho, Matthew Horridge, David Carral, Agnieszka Ławrynowicz, Yingjie Hu, Krzysztof Janowicz, Adila Alfa Krisnadhi, Torsten Hahmann, Monika Solanki.

Finally, the editors would like to express their gratitude to IOS Press for the opportunity of publishing this volume and to the ISWC organizers who ensured a smooth running of the workshop from WOP 2017 to 2020.

References

[1] Hitzler P, Gangemi A, Janowicz K, et al., editors. Ontology engineering with ontology design patterns - foundations and applications. (Studies on the Semantic Web; Vol. 25). IOS Press; 2016.

Contents

Preface v
Eva Blomqvist, Torsten Hahmann, Karl Hammar, Pascal Hitzler, Rinke Hoekstra, Raghava Mutharaju, María Poveda-Villalón, Cogan Shimizu, Martin G. Skjæveland, Monika Solanki, Vojtěch Svátek and Lu Zhou

Chapter 1. Patterns for Referring to Multiple Indirectly Specified Objects (MISO): Analysis and Guidelines 1
Vojtěch Svátek, Ján Kl'uka, Miroslav Vacura, Martin Homola and Marek Dudáš

Chapter 2. Generic Ontology Design Patterns: Roles and Change Over Time 25
Bernd Krieg-Brückner, Till Mossakowski and Mihai Codescu

Chapter 3. Seed Patterns for Modeling Trees 48
Aaron Eberhart, David Carral, Pascal Hitzler, Hilmar Lapp and Sebastian Rudolph

Chapter 4. A Logical Design Pattern for Change Over Time: Applications in Transportation Planning 68
Megan Katsumi and Mark Fox

Chapter 5. Two ODPs Towards the Notion of Influenceable Features of Interest 89
Iker Esnaola-Gonzalez, Jesús Bermúdez, Izaskun Fernandez and Aitor Arnaiz

Chapter 6. A Design Pattern Describing Use of Personal Data in Privacy Policies 107
Harshvardhan J. Pandit, Declan O'Sullivan and Dave Lewis

Chapter 7. Formal Relations over Ontology Patterns in Templating Frameworks 120
Christian Kindermann, Daniel P. Lupp, Martin G. Skjæveland and Leif Harald Karlsen

Chapter 8. An Argument for Generating SHACL Shapes from ODPs 134
Harshvardhan J. Pandit, Declan O'Sullivan and Dave Lewis

Chapter 9. Secure Product Lifecycle Management with CO-PLM 142
Falko Schönteich, Andreas Kasten and Ansgar Scherp

Chapter 10. An Ontology Design Pattern for Representing Recurrent Situations 166
Valentina Anita Carriero, Aldo Gangemi, Andrea Giovanni Nuzzolese and Valentina Presutti

Chapter 11. Ontology Design Patterns for Representing Context in Ontologies Using Aspect Orientation 183
Ralph Schäfermeier, Heinrich Herre and Adrian Paschke

Chapter 12. Encoding Repetitive Structures in Ontologies 204
Christian Kindermann, Bijan Parsia and Uli Sattler

Chapter 13. A Pattern-Based Enrichment of Wikidata from Open Data Using OD2WD 227
Muhammad Faiz, Gibran M.F. Wisesa, Adila A. Krisnadhi and Fariz Darari

Chapter 14. An Ontology Design Pattern Recommendation System 258
Maleeha Arif Yasvi and Raghava Mutharaju

Chapter 15. Ontology Design Principles for Model-Driven Applications 273
Karl Hammar

Chapter 16. An Ontology Design Pattern for Geovisualization Content Description 279
Auriol Degbelo

Chapter 17. SHACL-Based Ontology Design Patterns for Evidence-Based Decision-Making 292
Mario Verhaeg, Lloyd Rutledge and Bastiaan Heeren

Chapter 18. Towards a Modular Ontology for Space Weather Research 299
Cogan Shimizu, Ryan McGranaghan, Aaron Eberhart and Adam C. Kellerman

Chapter 19. Syntactic Regularities Based on Language Abstractions 312
Christian Kindermann, Bijan Parsia and Uli Sattler

Chapter 20. Towards Easy Reusability in the Semantic Web 331
Johannes Lipp, Lars Gleim and Stefan Decker

Chapter 21. An Ontology Design Pattern for Modeling Bias 337
Amrit Mohan Kaushik and Raghava Mutharaju

Chapter 22. OTTR: Formal Templates for Pattern-Based Ontology Engineering 349
Martin G. Skjæveland, Daniel P. Lupp, Leif Harald Karlsen and Johan W. Klüwer

Chapter 23. The Core OTTR Template Library 378
Martin G. Skjæveland

Author Index 395