

Preface

This volume collects some lecture notes from the 12th Reasoning Web Summer School (RW 2016), which was held during September 5–9, 2016, in Aberdeen, UK.

The Reasoning Web series of annual summer schools has become the prime educational event in the field of reasoning techniques on the Web, attracting both young and established researchers, since its first initiation in 2005 by the European Network of Excellence REWERSE. As with previous editions, this year’s summer school was co-located with the 10th International Conference on Web Reasoning and Rule Systems (RR 2016). For many years, the lecture notes of the Reasoning Web Summer School have been the top choices for new PhD students working on Semantic Web and KR to understand the state of the art in the field. Some even regard the RW lecture notes as a yearly updated version of handbooks for description logics (and related work). The 2016 edition of the school was organized by the University of Aberdeen, with support from the TeamAberdeen.

In 2016, the theme of the school was “Logical Foundation of Knowledge Graph Construction and Query Answering.” The notion of knowledge graph has become popular since Google started to use it to improve its search engine in 2012. The idea of knowledge graph comes from an early knowledge representation mechanism called “semantic networks.” RDF (resource description framework) is a modern version of semantic networks standardized by W3C, adding many of the limitations of classic semantic networks. OWL (Web Ontology Language) is a W3C standard for defining ontologies as rich schema of RDF graphs. OWL chooses description logics as underpinnings, and provides two levels of implementability:

- OWL 2 DL is the most expressive yet decidable language in the OWL (version 2) family.
- The three profile languages OWL2-QL, OWL2-EL, and OWL2-RL are tractable sub-languages of OWL2-DL.

One key feature of OWL is that it allows for faithful approximate reasoning services, by approximate OWL2-DL ontologies to those in its tractable sub-languages. This opens new doors for the possibility of handling large ontologies efficiently. A well-known example of such faithful approximate reasoners is the TrOWL reasoner, which even outperforms some well-known sound-and-complete reasoners in time-constrained competitions designed for sound-and-complete ontology reasoners.

The aim of the lecture notes is to provide a logical foundation for constructing and querying knowledge graphs. Our journey starts from the introduction of knowledge graph as well as its history, and the construction of knowledge graphs by considering both explicit and implicit author intentions (Chapter 1), where explicit intentions can be useful to generate reasoning-based authoring tests, so as to control the quality and costs of knowledge graph construction, while implicit intentions can help indicate, e.g., how reasoners can be optimized so as to better support knowledge graph authors. We

continue to discuss an important notion of inseparability, in Chapter 2, for constructing, revising, and reusing ontologies in a safe manner. Some of the notions of inseparability are also useful for ontology testing.

Now, given good-quality knowledge graphs, what the key aspects do we need to consider for querying them? We first explain, in Chapter 3, how to combine navigational queries, which are popular among graph databases, with basic pattern-matching queries, for SPARQL and beyond. Secondly, in Chapter 4, we introduce an infrastructure for allowing researchers to run experiments with linked data sets by querying, accessing, analyzing, and manipulating hundreds of thousands of linked data sets available online, so that researchers can worry less about some engineering issues related to data collection, quality, accessibility, scalability, availability, and findability. However, it is not always possible to clean up your knowledge graphs before querying them. Thus, in Chapter 5, we look into the problem of inconsistency-tolerant query answering over DL knowledge bases, explaining computational properties and reasoning techniques for various options of inconsistency-tolerant semantics. In addition, in Chapter 6, we provide a comprehensive survey on representation and reasoning with fuzzy RDF and OWL knowledge bases. In Chapter 7, we look into the knowledge graph construction and querying aspects together, by combining machine learning and reasoning in deployed applications, including some smart city applications. These chapters have been written as accompanying material for the students of the summer school. We hope they will be useful for readers who want to know more about the logical foundations of constructing and querying knowledge graphs.

Presentation slides of all the chapters of this book can be found at <http://www.abdn.ac.uk/events/rr-2016/rw-summer-school-2016/programme/>.

We thank everyone who made Aberdeen's summer school and these lecture notes possible. First and foremost, we thank the presenters of these lectures and their co-authors. We would like to thank our sponsors: Accenture Centre for Innovation, National Science Foundation (NSF), and EU FP7/Marie Curie IAPP project K-Drive. Furthermore, we would like to thank the local organization team at the University of Aberdeen: Martin Kollingbaum, Wamberto Vasconcelos, Diana Zee, and Nicola Pearce. Last but not least, we would like to thank the team of RR 2016, Umberto Straccia, Magdalena Ortiz, Stefan Schlobach, Rafael Peñaloza, Adila Krisnadhi, and Giorgos Stamou, for the great collaboration in putting together all the details of the two events.

September 2016

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Reasoning Web: Logical Foundation of Knowledge

Graph Construction and Query Answering

12th International Summer School 2016, Aberdeen, UK,

September 5-9, 2016, Tutorial Lectures

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2017, XIV, 259 p. 37 illus., Softcover

ISBN: 978-3-319-49492-0