International Journal of Approximate Reasoning 93 (2018) 327–329

Contents lists available at ScienceDirect

International Journal of Approximate Reasoning

www.elsevier.com/locate/ijar

Editorial

Special issue on "Uncertainty Reasoning for the Web" ☆

This special issue is dedicated to the recent developments in the application of uncertainty reasoning and representation techniques to the current World Wide Web, paying particular attention to the Social Web, Semantic Web and Linked Data. The term *uncertainty* is intended here to encompass a variety of forms of incomplete knowledge, including incompleteness, inconclusiveness, vagueness, ambiguity, and others. The term *uncertainty reasoning* is meant to denote the full range of methods designed for representing and reasoning with knowledge when Boolean truth values are unknown, unknowable, or inapplicable. Commonly applied approaches to uncertainty reasoning include probability theory, Dempster–Shafer theory, fuzzy logic and possibility theory, and numerous other methodologies.

Uncertainty is an intrinsic feature of many important tasks on the Web, and a full realization of the World Wide Web as a source of processable data and services demands formalisms capable of representing and reasoning under uncertainty. Unfortunately, none of these needs can be addressed in a principled way by current Web standards. Although it is to some degree possible to use semantic markup languages such as OWL or RDF(S) to represent qualitative or quantitative information about uncertainty, there is no established foundation for doing so, and feasible approaches are severely limited. Furthermore, there are ancillary issues such as how to balance representational power vs. simplicity of uncertainty representations, which uncertainty representation techniques address the examples listed above (and similar problems), how to ensure the consistency of representational formalisms and ontologies, etc.

This special issue is a follow-up to previous collections of extended versions of selected papers from the International Workshop on Uncertainty Reasoning for the Semantic Web (URSW). In particular, three books corresponding to URSW 2005–2007 [1], URSW 2008–2010 [2], and URSW 2011–2013 [3] have been published. Rather than publishing a fourth book, we decided to set up a journal special issue. The contributions collected in this issue have been selected through an open call for papers, in addition to specific invitations to authors of papers presented at URSW 2014–2016 workshops.

We received 12 submissions to this special issue. All accepted contributions have been peer-reviewed by at least 2 reviewers using the normal processes of the International Journal of Approximate Reasoning (in some exceptional cases, a third opinion was taken into account). We finally accepted 8 papers that reflect the great diversity of the research in the field and consider different formalisms to manage the uncertainty, namely probability [4,5], possibility theory [6,7], fuzzy and many-valued logics [8–10], and evidence theory [11].

J. Schoenfisch and H. Stuckenschmidt [4] propose the first study of real-world SPARQL queries in the light of probabilistic data. Firstly, the authors study the safeness of real-world queries, showing that almost all of them are tractable and therefore have a polynomial complexity. Secondly, the authors report a prototype implementation of a probabilistic SPARQL query answering system over probabilistic knowledge bases based on ontology-based query rewriting. In order to evaluate their system, they design some benchmarks including probabilistic data. Their results suggest that probabilistic ontology-based data access could be feasible in practice.

R. Carvalho et al. [5] propose PR-OWL, a language to represent probabilistic ontologies with uncertain statements. While other probabilistic extensions of OWL have only propositional expressiveness, PR-OWL is based on multi-entity Bayesian networks and has first order expressiveness, proving to be a suitable tool for a broad range of applications. Apart from the syntax and semantics of the language, the authors discuss how to manage the main types of reasoning tasks that are typical in probabilistic logic scenarios.

A. Tettamanzi et al. [6] present a framework to assess ontology axioms from the observed evidences stored as facts in RDF datasets. Rather than assuming that a reference ontology is correct and checking which facts satisfy it, this approach treats ontologies like hypotheses and uses RDF triples to corroborate or falsify them. By combining the notions of possibility and necessity of an axiom, the authors define an acceptance/rejection index. The evaluation focuses on the case of class subsumption axioms, but the framework is general enough to be used also with other types of OWL 2 axioms.

☆ This paper is part of the Virtual special issue on Uncertainty Reasoning for the Web, Edited by Fernando Bobillo, Kenneth J. Laskey, Trevor Martin, Matthias Nickles.

https://doi.org/10.1016/j.ijar.2017.11.012

A. Abidi et al. [7] deal with the problems of volume and veracity of data on the Web. To manage veracity of data on the Web they propose modelling uncertain and imprecise RDF data through possibility theory. To manage volume of data, the authors study the problem of filtering the huge amount of (possibilistic) RDF data in an appropriate way under some predefined user preferences. In particular, the authors propose the notion of possibilistic Pareto dominance (p-dominance) of data and use it to extend the skyline operator (returning a small set of resources that satisfying some preferences) to the case of possibilistic RDF triples. The authors propose an algorithm to compute the skyline and evaluate empirically the size of the answers and the scalability of the approach.

S. Borgwardt et al. [8] study some aspects of fuzzy Description Logics, where the membership of individuals in classes are a matter of degree and axioms hold to some degree of truth. The authors show that fuzzy extensions of some Description Logic languages increase the complexity, contrary to what usually happens in the field (where it is common to restrict to the Zadeh family of fuzzy logic operators). In particular, even for the tractable language $\mathcal{EL}$, a fuzzy extension using finitely-valued Łukasiewicz logic jumps from PTime-complete to ExpTime-complete. They also provide the first example of undecidable fuzzy DL not including the negation operator, namely finitely-valued Łukasiewicz $\mathcal{EL}$.

M. Dragoni and G. Petrucci [9] present an application of fuzzy logic to sentiment analysis in documents. The authors design a strategy based on trapezoidal fuzzy membership functions exploiting linguistic overlaps between domains to compute document polarity. The ideas of the paper have a clear application on Web documents and in Social Web content. Indeed, the approach is evaluated on a multi-domain dataset including Web documents and shows promising results.

B. Fazzinga et al. [10] address the problem of top-k query answering under user preferences in Datalog+/− ontologies, where user preferences are represented as numerical scores. In particular, the approach is able to take into account the preferences of a group of users by aggregating their individual preferences. Preferences are potentially contradictory and are assumed to have a many-valued interpretation to solve the disagreements. The authors evaluate the scalability of their approach, a generalization of the RankJoin algorithm, and compare empirically different aggregation strategies.

Finally, G. Rizzo et al. [11] propose a novel framework for the classification of ontology individuals (determining whether or not an individual belongs to a target class). In many common cases (particularly, under an Open World Assumption), training data are incomplete and/or unbalanced, so it necessary for the classification procedure to assign an uncertain membership to the target class. The main contribution is a framework for ensemble learning on Description Logics based on terminological random forests and evidence-based terminological decision trees (based on Dempster–Shafer theory). An empirical evaluation showed that the new framework outperforms previous similar approaches and is competitive against other learning systems.

We believe that the accepted papers are a good representation of state-of-the-art research approaches to uncertainty reasoning in the context of the Web, capturing different models of uncertainty and approaches to deductive as well as inductive reasoning with uncertain formal knowledge.

References

[1] Paulo C.G. da Costa, Claudia d'Amato, Nicola Fanizzi, Kathryn B. Laskey, Ken Laskey, Thomas Lukasiewicz, Matthias Nickles, Michael Pool (Eds.), Uncertainty Reasoning for the Semantic Web I, Lecture Notes in Artificial Intelligence, vol. 5327, Springer Verlag, 2008.
[2] Fernando Bobillo, Paulo C.G. da Costa, Claudia d'Amato, Nicola Fanizzi, Kathryn Laskey, Ken Laskey, Thomas Lukasiewicz, Matthias Nickles, Michael Pool (Eds.), Uncertainty Reasoning for the Semantic Web II, Lecture Notes in Artificial Intelligence, vol. 7123, Springer Verlag, 2013.
[3] Fernando Bobillo, Rommel Carvalho, Paulo C.G. da Costa, Claudia d'Amato, Nicola Fanizzi, Kathryn Laskey, Ken Laskey, Thomas Lukasiewicz, Matthias Nickles, Michael Pool (Eds.), Uncertainty Reasoning for the Semantic Web III, Lecture Notes in Artificial Intelligence, vol. 8816, Springer Verlag, 2014.
[4] Joerg Schoenfisch, Heiner Stuckenschmidt, Analyzing real-world SPARQL queries and ontology-based data access in the context of probabilistic data, Int. J. Approx. Reason. 90 (2017) 374–388.
[5] Rommel N. Carvalho, Kathryn B. Laskey, Paulo C.G. Costa, PR-OWL – a language for defining probabilistic ontologies, Int. J. Approx. Reason. 91 (2017) 56–79.
[6] Andrea G.B. Tettamanzi, Catherine Faron-Zucker, Fabien Gandon, Possibilistic testing of OWL axioms against RDF data, Int. J. Approx. Reason. 91 (2017) 114–130.
[7] Amna Abidi, Sayda Elmi, Mohamed Anis Bach Tobji, Allel Hadjali, Boutheina Ben Yaghlane, Skyline queries over possibilistic RDF data, Int. J. Approx. Reason. (2018), https://doi.org/10.1016/j.ijar.2017.11.005.
[8] Stefan Borgwardt, Marco Cerami, Rafael Peñaloza, The complexity of fuzzy $\mathcal{EL}$ under the Łukasiewicz t-norm, Int. J. Approx. Reason. 91 (2017) 179–201.
[9] Mauro Dragoni, Giulio Petrucci, A fuzzy-based strategy for multi-domain sentiment analysis, Int. J. Approx. Reason. 93 (2018) 59–73.
[10] Bettina Fazzinga, Thomas Lukasiewicz, Maria Vanina Martínez, Gerardo I. Simari, Oana Tifrea-Marciuska, Ontological query answering under many-valued group preferences in Datalog+/−, Int. J. Approx. Reason. (2018), https://doi.org/10.1016/j.ijar.2017.11.008.
[11] Giuseppe Rizzo, Nicola Fanizzi, Claudia d'Amato, Floriana Esposito, Approximate classification with web ontologies through evidential terminological trees and forests, Int. J. Approx. Reason. 92 (2018) 340–362.

Fernando Bobillo
Aragon Institute of Engineering Research (I3A), University of Zaragoza, Spain
E-mail address: fbobillo@unizar.es

Kenneth J. Laskey
MITRE Corporation, USA
E-mail address: klaskey@mitre.org

Trevor Martin
University of Bristol, UK
E-mail address: Trevor.Martin@bristol.ac.uk

Matthias Nickles
National University of Ireland, Galway, Ireland
E-mail address: matthias.nickles@nuigalway.ie

Available online 24 November 2017