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Introduction to the Special Issue on Logic Rules and Reasoning: Selected Papers from the 4th International Joint Conference on Rules and Reasoning (RuleML+RR 2020)

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1 Introduction

This volume contains a selection of the best papers of the 4th International Joint Conference on Rules and Reasoning (RuleML+RR) held from 29 June to 1 July 2020 virtually due to pandemic. The event was originally scheduled to be held in Oslo and hosted by the Norwegian University of Science and Technology with the support of the University of Oslo and SINTEF AS. RuleML+RR 2020 was organized as part of the DeclarativeAI 2020, which also included the DecisionCAMP 2020, the Reasoning Web Summer School (RW 2020), the 14th International Rule Challenge, and the RuleML+RR Doctoral Consortium.

RuleML+RR is a joint conference of two well-established international organizations active in the area of knowledge representation and learning. RuleML Inc was founded in 2000, and the Web Reasoning and Rule Systems Association were founded in 2009. The first annual RuleML conference was held in 2002, and the first RR conference was held in 2007. RuleML+RR is organized as a joint conference of the two organizations since 2017.

The 2020 edition of the conference was marked the 20th anniversary, since RuleML was founded in 2000 by Harold Boley and colleagues. Harold Boley passed away in 2020, and this special issue is dedicated to his memory.

1.1 Obituary for Dr Harold Boley

Harold Boley studied in Hamburg and then worked at DFKI, the German Institute for Artificial Intelligence, from there he transitioned to the University of New Brunswick, where

he taught Semantic Technologies, Declarative Programming, and Multi-Agent Systems and supervised graduate and undergraduate students. He also held a position at the National Research Council Canada. Harold was most well known for his work in the Web rule standards world (Boley *et al.* 2001). He chaired the RuleML Organization, maintained the RuleML Blog, and co-organized the annual RuleML Symposium, which was held without interruption since 2002, first as a workshop, and since 2005 as a stand-alone conference. In 2017, RuleML merged with Web Reasoning and Rule Systems conference into RuleML+RR. Besides his high involvement in the rule community, Harold contributed to various standardization efforts related to RuleML. Among the various RuleML achievements, he also contributed to OASIS LegalRuleML (Palmirani *et al.* 2011), as well as the publication of the W3C Rule Interchange Format (RIF) and the Semantic Web Rule Language (SWRL) (Horrocks *et al.* 2004). Harolds research was in the area of Semantic Web rule languages and applications, with a particular focus on rule-based knowledge representation and reasoning. He was also involved in efforts joining rules and ontologies, for example, with sorted Horn logics in Relfun, with a hybrid combination of Datalog and Description Logics, and the Positional-Slotted Object-Applicative (PSOA) logic (Boley 2015), which integrates object-relational data and knowledge for rules and combines those with taxonomies (subclass ontologies). His most recent work focused on the translation of (PSOA) RuleML and Prolog with the PSOATransRun translator implementation and the visual rule language Grailog for visualizing PSOA RuleML (Thom *et al.* 2020).

1.2 RuleML+RR 2020 in numbers

This special issue presents selected papers from RuleML+RR 2020, which were further revised and extended. The technical program of the main track of RuleML+RR 2020 included 13 regular presentations of peer-reviewed research papers, which were selected from 30 submissions by a program committee consisting of nearly 60 academics. Additionally, the conference program included four invited talks, one of which was also represented by a full invited paper in the proceedings.

1.3 Overview of articles in this special issue

From the papers accepted to RuleML+RR 2020, a selection of four contributions with the highest reviewing scores and strong support was identified, and their authors were invited to submit an extended version of their papers to the Journal of Theory and Practice of Logic Programming. These articles underwent several rounds of a review process, during which each submission was reviewed by three referees; the authors incorporated the provided feedback, and the submissions were reviewed again until the reviewers were satisfied with the quality of the content.

"Swift Markov Logic for Probabilistic Knowledge Graphs" by Luigi Bellomarini, Eleonora Laurenza, Emanuel Sallinger and Evgeny Sherkhonov provides a framework for probabilistic reasoning in Vadalog-based Knowledge Graphs. The article starts with a general introduction, which describes the needed background and bridges the gap by explaining and giving the practical consequences of warded semantics. Accessibility of the material present in the article is also improved by the use of practical, intuitively understandable, examples from the banking domain. The approach has been tested on a number of real-world and synthetic KGs.

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"Tackling the DM Challenges with cDMN: A Tight Integration of DMN and Constraint Reasoning" by Simon Vandevelde, Bram Aerts, and Joost Vennekens describes an extension to the Decision Model and Notation (DMN) standard, namely Constraint Decision Model and Notation (cDMN), with key features being constraint modeling, quantification, and the use of concepts such as types and functions. cDMN extends DMN with the purpose of allowing more complex domain knowledge to be represented, while retaining the usability of DMN. The proposed extension has been tested using complex problems and against other state-of-the-art DMN-like solvers, posted on the DM Community website. It has been shown that cDMN increases the expressiveness of DMN, allows solving more complex problems, and maintains a good level of readability and compactness.

"Declarative Approaches to Counterfactual Explanations for Classification" by Leopoldo Bertossi deals with the domain of Answer Set Programming, specifically it proposes answer-set programs that specify and compute counterfactual interventions as a basis for causality-based explanations to the outcomes from classification models, such as decision trees. The main contribution is the specification and computation of maximum-responsibility counterfactual explanations. The approach presented in the article also considers semantic and domain knowledge as well as probabilistic methods.

"Answering Fuzzy Queries over Fuzzy DL-Lite Ontologies" by Gabriella Pasi and Rafael Peñaloza addressed the under-studied problem of answering conjunctive queries and threshold queries w.r.t. ontologies in fuzzy DL-Lite. The main contribution is a method for answering degree queries which works even if the TBox is graded, thus allowing for fuzzy TBox axioms. Despite its narrow topical focus, the article could appear to a wider audience based on the inclusion of multiple illustrative examples as well as the potential for the results to extend to other Horn description logics.

Acknowledgments

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Moreover, we are grateful to everybody who helped make RuleML+RR 2020 a success, including the conference chairs, PC members, authors, speakers, and participants. This includes organising institutions Norwegian University of Science and Technology, SINTEF AS, University of Oslo, and Norwegian Centre for Research-driven Innovation (SIRIUS). Finally, we would like to pay tribute to Harold Boley, a friendly colleague, AI researcher, and initiator of RuleML meetings and community, who passed away in December 2020.

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