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Rules and Reasoning

5th International Joint Conference, RuleML+RR 2021
Leuven, Belgium, September 13–15, 2021
Proceedings

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Preface

These are the proceedings of the 5th International Joint Conference on Rules and Reasoning (RuleML+RR 2021). RuleML+RR merged the efforts of two well-established conference series: the International Web Rule (RuleML) symposia and the Web Reasoning and Rule Systems (RR) conferences.

The RuleML symposia have been held since 2002 and the RR conferences since 2007. The RR conferences have been a forum for discussion and dissemination of new results on web reasoning and rule systems, with an emphasis on rule-based approaches and languages. The RuleML symposia were devoted to disseminating research, applications, languages, and standards for rule technologies, with attention to both theoretical and practical developments, to challenging new ideas, and to industrial applications. Building on the tradition of both RuleML and RR, the joint conference series RuleML+RR aims at bridging academia and industry in the field of rules, and at fostering the cross-fertilization between the different communities focused on the research, development, and applications of rule-based systems. RuleML+RR aims at being the leading conference series for all subjects concerning theoretical advances, novel technologies, and innovative applications about knowledge representation and reasoning with rules.

To leverage these ambitions, RuleML+RR 2021 was organized as part of the event Declarative AI 2021: Rules, Reasoning, Decisions, and Explanations, that was held during September 13–15, 2021. This event was hosted by KU Leuven, Belgium. With its general topic “Declarative Artificial Intelligence” a core objective of the event was to present the latest advancements in AI and rules, rule-based machine learning, reasoning, decisions, and explanations and their adoption in IT systems. To this end, Declarative AI 2021 brought together co-located events with related interests. In addition to RuleML+RR this included DecisionCAMP 2021 and the Reasoning Web Summer School (RW 2021).

The RuleML+RR conference included three subevents:

1. Doctoral Consortium – an initiative to attract and promote student research in rules and reasoning, with the opportunity for students to present and discuss their ideas, and benefit from close contact with leading experts in the field.
2. International Rule Challenge – an initiative to provide competition among work in progress and new visionary ideas concerning innovative rule-oriented applications, aimed at both research and industry.
3. Industry Track – a forum for all sectors of industry and business (as well as the public sector) to present, discuss, and propose existing or potential rule-based applications.

The program of the main track of RuleML+RR 2021 included the presentation of 17 full research papers and two short papers. These contributions were carefully selected by the Program Committee (PC) from 39 high-quality submissions to the event. Each

paper was carefully reviewed and discussed by at least three members of the PC. The technical program was then enriched with the additional contributions from its sub-events as well as from DecisionCAMP 2021, a co-located event aimed at practitioners.

At RuleML+RR 2021 and DecisionCAMP 2021, two invited keynotes were presented by experts in the field:

- Ryan Urbanowicz (University of Pennsylvania, USA): Interpretable Machine Learning with Rule-based Modeling
- Alon Halevy (Facebook AI, USA): Symbolic AI in a Machine Learning World

The chairs sincerely thank the keynote speakers for their contribution to the success of the event. The chairs also thank the Program Committee members and the additional reviewers for their hard work in the careful assessment of the submitted papers. Further thanks go to all authors of contributed papers for their efforts in the preparation of their submissions and the camera-ready versions within the established schedule. Sincere thanks to the chairs of the Doctoral Consortium, the Rule Challenge, and the Industry Track, and to the chairs of all co-located Declarative AI 2021 events. The chairs finally thank the entire organization team including the Publicity, Proceedings, and Sponsorship Chairs, who actively contributed to the organization and the success of the event.

A special thanks goes to all the sponsors of RuleML+RR 2021 and Declarative AI 2021: Artificial Intelligence Journal, Springer, Leuven.AI, DMCommunity, KU Leuven, University of Surrey, University of Milano-Bicocca, RuleML Inc, RR Association. A special thanks also goes to the publisher, Springer, for their cooperation in editing this volume and publication of the proceedings. We are grateful to the sponsors of the RuleML+RR 2021 as they also contributed towards the awards: the best paper award, the best presentation award, the best student paper award, the Rule Challenge award, and the Harold Boley award for the most promising paper.

September 2021

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Abstracts of Kenote Speakers

Interpretable Machine Learning with Rule-Based Modeling

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Abstract. Explainability has become achievable for most machine learning methodologies, but interpretability remains the gold standard for model transparency [1]. Unlike explainability, interpretability is a property that is unique to specific machine learning methods based on how models are represented and constrained. Unfortunately, methods regarded as interpretable, e.g. decision trees, may not achieve the same level of predictive performance, particularly when applied to problems with complex underlying patterns of association. Rule-based machine learning with algorithms such as ‘Learning Classifier Systems’ (LCS) offer an attractive alternative to other popular ML modeling techniques [2,3]. They have been demonstrated to be able to model extremely complex associations as well as provide opportunities to do so in an inherently interpretable manner [4]. This makes their application particularly promising in fields such as medicine, where achieving high predictive performance must be paired with model transparency to foster trust, promote knowledge discovery, identify/avoid sources of bias, and maintain accountability [5]. Learning classifier systems utilize an evolutionary algorithm search to discover a set of human-readable IF:THEN rules that collectively comprise the trained model. This allows them to capture simple as well as complex associations with outcome including epistatic feature interactions and heterogeneous associations, i.e. subgroups of instances within which a distinct feature or set of features are predictive of outcome [2]. This talk examines the unique properties of learning classifier system algorithms, as well as a variety of strategies that have been proposed to improve and facilitate their interpretability with respect to understanding individual predictions, model feature importance, and characterizing underlying patterns of associations.

Keywords: Machine learning · Interpretable · Explainable · Learning classifier systems

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Symbolic AI in a Machine Learning World

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Abstract. The key technical problems that online social networks focus on today are detecting policy violating content (e.g., hate speech, misinformation) and ranking content to satisfy their users' needs. By nature, these problems are somewhat vague and need to handle multi-modal content in many languages, and therefore do not naturally lend themselves to AI techniques based on declarative representations and reasoning. However, the machine learning techniques that are employed also have some drawbacks, such as the fact that it is hard to update their knowledge efficiently or to explain their results. In this talk I will outline a few opportunities where methods from symbolic AI, combined appropriately into the machine learning paradigm, can ultimately have an impact on our goals. As one example, I will describe Neural Databases, a new kind of database system that leverages the strength of NLP transformers to answer database queries over text, thereby freeing us from designing and relying on a database schema.

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