Guest Editors' Introduction: Rule Representation, Interchange, and Reasoning in Distributed, Heterogeneous Environments

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In recent years, rule-based technologies have enjoyed remarkable adoption in two areas: 1) business rule processing and 2) Web-centered reasoning. The first trend is caused by the software development life cycle, which needs to be accelerated at reduced cost. The second trend is related to the Semantic Web and Service-oriented technologies, which aim to turn the Web into a huge repository of cross-referenced, machine-understandable data and processes. For both trends, rules can be used to extract, derive, transform, and integrate information in a platform-independent manner. While early rule engines and environments were complex, expensive to maintain, and not very user friendly, the current generation of rule technology provides enhanced usability, scalability, and performance, and is less costly. A general advantage of using rules is that they are usually represented in a platform independent manner, often using XML. This fits well into today's distributed, heterogeneous Web-based system environments. Rules represented in standardized Web formats can be discovered, interchanged, and invoked at runtime within and across Web systems, and can be interpreted and executed on any platform.

This special section is focused on state-of-the-art approaches, solutions, and applications in the area of rule representation, reasoning, and interchange in the context of distributed, (partially) open, heterogeneous environments, such as the semantic Web, intelligent multiagent systems, event-driven architectures, and service-oriented computing. In response to the call for papers, we received a total of 52 submissions, out of which 7 were recommended submissions from the best ranked papers presented at the RuleML-2007 [1] and RuleML-2008 [2] "International RuleML Symposia on Rule Interchange and Applications" held in October 2007 and 2008, respectively, in Orlando, Florida. After careful and rigorous reviews, we have selected 8 papers, 3 of them being extended papers from RuleML Symposia, based on the quality and relevance of the papers.

The first paper is "Defeasible Contextual Reasoning with Arguments in Ambient Intelligence" by Antonis Bikakis and Grigoris Antoniou. It proposes a solution for contextual reasoning in ambient intelligence based on the multicontext systems paradigm, in which local context knowledge of ambient agents is encoded in rule theories (contexts), and information flow between agents is achieved through mapping rules that associate concepts used by different contexts. To handle imperfect contexts, multicontext systems have been extended with nonmonotonic features, local defeasible theories, defeasible mapping rules, and a preference ordering on the system contexts. On top of this, an argumentation framework and a distributed algorithm for query evaluation have been developed that exploit context and preference information to resolve potential conflicts.

The second paper is "A Rule-Based Trust Negotiation System" by P.A. Bonatti, J.L. De Coi, D. Olmedilla, and L. Sauro. It presents PROTUNE, a rule-based Trust Negotiation (TN) framework. TN frameworks have been proposed as a better solution for open environments such as the Web, in which parties may get in touch and interact without being previously known to each other. PROTUNE offers certain advantages that arise from an advanced rule-based approach in terms of deployment efforts, user friendliness, communication efficiency, and interoperability. The generality and technological feasibility of PROTUNE's approach are assessed through an extensive analysis and experimental evaluations.

The third paper is "Efficient Lazy Evaluation of Rule-Based Programs" by Peter Van Weert. It proposes a combination and cross-fertilization of the LEAPS production rule lazy matching algorithm (an extension to the Rete algorithm) with Constraint Handling Rules (CHR), a high-level, declarative programming language, similar to production rules. While obviously related, CHR and production rules research have mostly evolved independently from each other. The paper provides a lucid, comprehensive overview of CHR's rule evaluation methodology, and surveys recent contributions to the field of lazy matching. An empirical evaluation confirms that Rete-based engines would surely benefit from incorporating similar techniques and optimizations.

The fourth paper is "A Configurable Rete-OO Engine for Reasoning with Different Types of Imperfect Information"

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by Davide Sottara, Paola Mello, and Mark Proctor. It proposes an extension of RETE networks, which supports only boolean, first order logic, capable of handling several types of schemes for reasoning with imperfect information. The architecture depends on a number of configuration parameters which could be set by the user. The paper then shows how an appropriate combination of parameters can be used to emulate some of the most common, specialized engines: 3-valued logic, classical certainty factors, fuzzy logic, many-valued logic, and Bayesian networks.

The fifth paper is "Integrated Rule-Based Learning and Inference" by Ioannis Hatzilygeroudis and Jim Prentzas. It presents the construction process and the inference mechanism of neurules, a kind of integrated rules integrating neurocomputing and production rules, and explores their generalization capabilities. The construction process, which also implements a corresponding learning algorithm, creates neurules from a given empirical data set. The inference mechanism of neurules is integrated; it combines neurocomputing with symbolic processes. As shown via experiments, the neurules integrated inference mechanism is more efficient than the inference mechanism used in connectionist expert systems. Furthermore, neurules generalize much better than its constituent neural component (adaline unit) and is comparable to the back-propagation neural net.

The sixth paper is "A Deductive Spreadsheet System for End-Users" by Marcelo Tallis and Robert M. Balzer. It presents a spreadsheet-based framework for authoring logic implication rules that try to exploit the characteristics that make spreadsheet programming accessible to end-users in order to make deductive problem-solving methods available to them. In the proposed framework, rule authors describe the semantics of a binary relation by constructing a functional spreadsheet model that computes the image of that binary relation, which is then translated into a collection of logic implication rules. The framework has been implemented on top of Microsoft Excel, adopting the World Wide Web Consortium (W3C) standard ontology language OWL + SWRL formalisms.

The seventh paper is "A Novel Combination of Answer Set Programming with Description Logics for the Semantic Web" by Thomas Lukasiewicz. It presents a novel combination of disjunctive programs under the answer set semantics with description logics for the Semantic Web. The combination is based on a well-balanced interface between disjunctive programs and description logics, which guarantees the decidability of the resulting formalism without assuming syntactic restrictions. It is shown that the new formalism extends both disjunctive programs and description logics. Furthermore, the paper describes algorithms for reasoning, consistency checking and literal entailment under the well-founded semantics in the new formalism, and gives a precise picture of their computational complexity.

The eighth paper is "A Guide to the Basic Logic Dialect for Rule Interchange on the Web" by Harold Boley and Michael Kifer. It is a guide to the essentials of RIF-BLD, its syntax, semantics, and XML serialization. The W3C Rule Interchange Format (RIF) is a forthcoming standard for exchanging rules among different systems and for developing intelligent rule-based applications for the Semantic Web. The RIF architecture is conceived as a family of languages, called dialects. A RIF dialect is a rule-based language with an XML syntax and a well-defined semantics. The RIF Basic Logic Dialect (RIF-BLD) semantically corresponds to a Horn rule language with equality. RIF-BLD has a number of syntactic extensions with respect to traditional textbook Horn logic, which include F-logic frames and predicates with named arguments. RIF-BLD is also well-integrated with the relevant Web standards. It provides IRIs (Internationalized Resource Identifiers), XML Schema datatypes, and is aligned with RDF and OWL.

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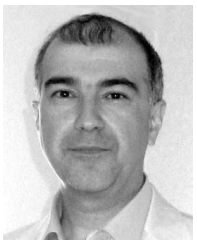

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