

Automated Argument System based on Logic of Multiple-Valued Argumentation

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ABSTRACT

We demonstrate the basic features and advantages of Automated Argument System based on Logic of Multiple-Valued Argumentation by applying it to three convincing arguments: (i) Argument-based recommender system, (ii) Schedule management system and (iii) An integrated system of semantic web reasoning and argument-based reasoning.

Categories and Subject Descriptors

I.2.11 [Distributed AI]: Intelligent agents

General Terms

Design

Keywords

Multiple-valued Argumentation, multi-agent system, learning, knowledge acquisition

1. INTRODUCTION

Arguing is a powerful tool we use individually and socially in the daily life. This is also true in agents' world. Computational argumentation has been accepted as a social computing mechanism or paradigm in the multi-agent systems community.

Argumentation is by nature a logic of reasoning under uncertain or changing information environment. Logic of Multiple-valued Argumentation (LMA) was built on top of Extended Annotated Logic Programming EALP [7]. It is a very generic logic of multiple-valued argumentation in the sense that it allows to specify various types of truth values depending on application domains and to deal with uncertain arguments under the specified truth values.

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We are going to demonstrate our system with three convincing arguments: (i) Argument-based recommender system, (ii) Schedule management system and (iii) An integrated system of semantic web reasoning and Argument-based reasoning. In doing so, we connect three sites on the Internet: Hakodate conference site, Niigata University in Niigata and Shibaura Institute of Technology in Saitama, where arguing agents and a mediator agent reside in.

2. OUTLINE OF EALP AND LMA

EALP (Extended Annotated Logic Programming) is an expressive logic programming language we formalized for argumentation. The basic language constituents are literals associated with annotations as truth-values or epistemic states of agents. LMA is A Logic of Multiple-valued Argumentation constructed on top of EALP. In this logic, three notions of negation: epistemic, ontological and default negation play a crucial role in argumentation since they turn to yield a momentum or driving force for argumentation. We have soundness and completeness for LMA under the x-point semantics based on the acceptability of arguments and the dialectical proof theory [7]. LMA was implemented in C++/Java and Prolog, where each agent has its own knowledge base in EALP, and a complete lattice of truth values and argument engine are shared among agents concerned (see Figure 1).

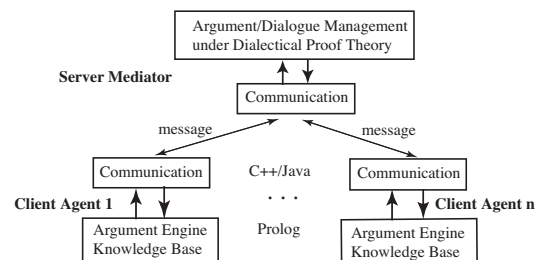


Figure 1: Argument system architecture

3. ARGUMENTS IN DEMONSTRATION

3.1 Argument-based recommender system

Chesñevar and Maguitman propose ArgNet, a recommender system that integrates a traditional web search engine with a defeasible argumentation framework [2]. We demonstrate an improved version of ArgNet by using our LMA in place of their two-valued argumentation framework, so that LMA with its truth-values specialized to $FOUR = (\{\perp, \mathbf{t}, \mathbf{f}, \top\}, \cdot)$ allows for uncertain argumentation.

3.2 Schedule management system

Schedule management problems are typical targets for which agent systems have been developing their capabilities such as interaction, negotiation, cooperation and so on. We demonstrate a new approach to realizing a schedule management system as LMA-based argumentation system. Then participating agents use not only calendar information but also preferential knowledge base of their own in EALP. The truth values used is a complete lattice of the unit interval of reals $\mathbb{R}[0, 1]$.

3.3 An integrated system of semantic web reasoning and argument-based reasoning

We will demonstrate an integrated system of semantic web reasoning and argument-based reasoning.

Semantic Web has started to attract much attention as the next-generation web technology. In 2004, the W3C recommended the OWL Web Ontology Language as standard ontology languages for the Semantic Web, which has three increasing expressive sublanguages, namely OWL lite, OWL DL, and OWL full. On the other hand, as shown by Horrocks and Patel-Schneider [6], ontology entailment in OWL Lite and OWL DL reduces to knowledge base (un)satisfiability in the description logics such as the DL $SHIF(D)$ and the DL $SHOIN(D)$ respectively. Though tableaux theorem proving techniques have been commonly used with respect to reasoning ontologies expressed by description logics (or DL, for short), quite recently, many logic programming approaches have been proposed such as Heymans et al.'s method [5], Baral's method [1] and so on which make use of *answer set programming* (or ASP, for short) [4].

In such progress of the Semantic Web technology, we have implemented a prototype system for the Semantic Web reasoning which can handle ontologies expressed by the DL $SHOIN(D)$ or OWL DL, and can be accessible to and from LMA-based argument system (specialized to two values $\{f, t\}$) on the Web (see Figure 2). It consists of three components, that is, ontology translations done in two steps and ontology reasoning via ASP as follows:

1. Translation of ontology expressed by OWL DL into the one expressed by the DL $SHOIN(D)$ (or vice versa) though the current prototype does not support XML schema primitive datatypes as well as datatype roles.
2. Translation of ontology expressed by DL into *Disjunctive Logic Programs* (or DLPs, for short) based on Heymans et al.'s method or Baral's method,
3. Query evaluation w.r.t. knowledge base (i.e. ontologies) expressed by a DLP using the ASP solver *dlv* [3].

The translation of the first component is established by using XSLT. With respect to the second component, let $KB = Tbox \cup Abox$ be a knowledge base which is a finite set of axioms expressed by $SHOIN(D)$. Then an axiom F is a *logical consequence* of KB , denoted $KB \models_{DL} F$, if every model of KB satisfies F .

Heymans et al. considers the DL $ALCHODQ(\sqcup, \sqcap)$ which differs from the DL $SHOIN(D)$ by its lack of transitive

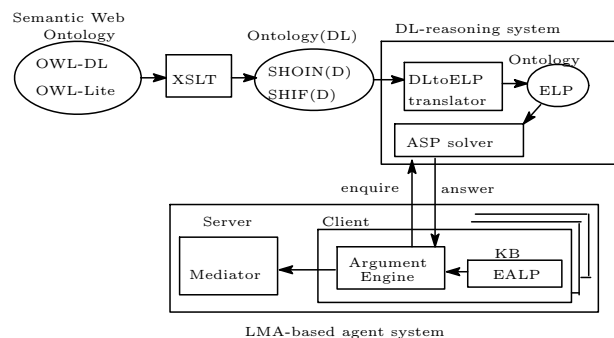


Figure 2: WebArg system architecture

roles, inverse roles, and data types. In their method, $ALCHODQ(\sqcup, \sqcap)$ knowledge base are expressed by *conceptual logic programs* (or CLPs, for short) whose syntax is the restricted DLP. CLPs extend Answer Set Programming with, possibly in finite, open domains, which leads, in general, to undecidable reasoning. Thanks to restricting the syntax of DLPs, reasoning with the resulting CLPs can be reduced to finite, normal Answer Set Programming, for which efficient ASP solvers (e.g. *dlv*) [3] are available.

In the demonstration, we show how the semantic web reasoning briefly described above interacts with LMA-based argumentation system. It then attempts to construct arguments with both the usual knowledge base and the ontology knowledge provided by the semantic web reasoner.

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