Constructing, Weighing and Evaluating Arguments to Solve Wicked Problems

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Abstract. Most work in AI on knowledge representation and belief revision is founded in philosophical realism, and its simplifying assumption that objects and relations in the real-world can be represented, one-to-one, in a knowledge base, at least approximately, and improved over time via learning. According to this perspective, knowledge can first be acquired and then applied to solve problems. Here we present components of a decision-support system based on an alternative argumentation-based approach to knowledge representation and problem solving. In this approach, knowledge is socially constructed and subject to debate during the problem-solving process, in dialogues, in a more iterative way.

Keywords: Argumentation · Issue-Based Information Systems · Practical Reasoning · Knowledge Representation · Belief Revision

In the classical symbolic AI approach to problem solving, knowledge is first acquired and represented, using some knowledge-representation language, and then applied to solve particular problems, using a knowledge-based or expert system. This approach is founded in philosophical realism, which assumes that objects and relations in the real-world can be represented, at least approximately, one-to-one in a theory or conceptual model (correspondence theory of truth). Over time, the theory can be revised and improved to take into account new information.

However, as Kunz and Rittel noticed in the early 1970s [8], in many problems domains, such as the law, politics and city planning, the task of formulating or framing the problem, acquiring knowledge about the problem domain and applying this knowledge to solve the problem are deeply intertwined and interdependent. In such domains, knowledge is socially constructed and subject to debate during the problem-solving process, in dialogues. Kunz and Rittel proposed argumentation as a more dynamic and iterative method suitable for solving such "wicked" problems. In this talk, components of a computational model of argument are presented which are designed for use in interactive decision-support systems for helping people to collaboratively solve such problems. The components provides support for automatically constructing (inventing, generating) arguments, using presumptive inference rules, called "argumentation schemes", as well as evaluating these arguments by resolving attack relations among arguments and weighing and balancing pros and cons to determine which options proposed as solutions to issues have the best support.

The mainstream line of research in the field of computational models of argument is based on Dung Abstract Argumentation Frameworks (AFs) [2, 1], which are focused on modeling and resolving attack relations among arguments. Dung intended AFs to be used in a pipeline model for solving problems, where arguments are first generated from a knowledge-base, evaluated, and finally used to determine which statements (propositions) can be accepted as true. Thus, these mainstream computational models of argumentation are also well within the foundations of philosophical realism, since they continue to assume that knowledge can be acquired and modeled in some objective way before problem-solving begins, without being subject to debate during the solving of particular problems.

Moreover, a common and arguably more typical form of human argumentation, where pros and cons are weighed and balanced to choose among alternative options, cannot be simply and intuitively reduced to attacks, as in Dung AFs. In [7, 5] we defined a new formal model of structured argument which generalizes Dung AFs to provide better support for argument weighing and balancing, enabling cumulative arguments and argument accrual to be handled without causing an exponential blowup in the number of arguments. Dung's pipeline model, which evaluates statements after arguments, sequentially, makes it impossible to make the acceptability or weight of an argument depend on the labels of their premises. To overcome this problem, in our model the weight of arguments and labels of statements can depend on each other, in a mutually recursive manner.

The role of a knowledge-base in our approach is played by a rule-based representation of a set of presumptive inference rules called *argumentation schemes* [9, 10, 3]. In [6] we introduced a high-level declarative programming language for representing argumentation schemes, where schemes represented in this language can be easily validated by domain experts, including developers of argumentation schemes in informal logic and philosophy, and serve as *executable specifications* for automatically constructing arguments, when applied to a set of assumptions. Since argumentation schemes are presumptive inference rules, both premises and conclusions of schemes can be second-order schema variables, i.e. without a fixed predicate symbol. Our language for representing argumentation schemes is based on Constraint Handling Rules (CHR), a declarative, Turing complete, forwards-chaining, rule-based programming language [4]. The expressiveness of our scheme language has been validated by using it to represent twenty of the most common argumentation schemes.

We conclude with a discussion about the extent to which this argumentation-based approach to knowledge-representation and problem-solving overcomes the simplifying assumptions of philosophical realism and provides better support for decision-making in domains with "wicked" problems.

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