Argumentation and Computing

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INTRODUCTION

Argumentation is usually thought of as a domain within philosophy, or rhetoric. Yet, it has made inroads in the works of computer scientists, especially, yet not only, the logicists among them. *Information Ethics and Security,* in the title of this encyclopedia, respectively belong in ethics (in general) and in the forensic sciences (security is both preventative and about discovering traces of perpetrators). Deontic logic—that is, logic for representing obligations and permissions (Åqvist, 2002; Abrahams & Bacon, 2002) being used, for example in databases or in security—has been an early (1970s) and conspicuous stream within "AI & Law," a domain in which models of argumentation have featured prominently since the 1990s (e.g., Ashley, 1990; Prakken & Sartor, 1996).

To ascertain (other than trivially) ethical status, or to make a point of law—or to persuade in politics (Atkinson, Bench-Capon, & McBurney, 2005) or to reach a negotiated settlement (Zeleznikow, 2002)—argumentation is paramount. Besides, natural-language generation makes use of argumentation at the rhetorical level, as do tutorial dialogues (Carenini & Moore, 2001). For organizing and handling arguments, there exist both general tools (e.g., *Carneades* – Gordon & Walton, 2006) and specialized ones: *MarshalPlan* is for law (Schum, 2001). There also is the category of graphic or multimedia tools for visualizing the relations among arguments (van den Braak, van Oostendorp, Prakken, & Vreeswijk, 2006); these include *Araucaria* (Reed & Rowe, 2004), *QuestMap* (Conklin & Begeman, 1988; Carr, 2003), *ArguMed* (Verheij, 1999), and *Room 5* (Loui et al., 1997).

In order to avoid this merely being an overview, we try to give readers some operational knowledge. This article should be read along with the next article, "Argumentation with Wigmore Charts, and Computing," which more specifically focuses on a given method. Notational variants exist (both in formulae and in graphs). There is a panoply of alternative computer tools and formal models, and it is not our purpose here to be exhaustive in listing them.

BACKGROUND

A concise, apt overview of achievements follows:

Potential for exploitation of research in the philosophical theory of argumentation, in informal logic, and in dialectics, have been recognised relatively recently by researchers in artificial intelligence, but already fruits of such cross fertilisation are beginning to ripen. Recent successes include agent system negotiation protocols that demonstrate higher levels of sophistication and robustness; argumentation-based models of evidential relations and legal processes that are more expressive; models of language generation that use rhetorical structures to produce effective arguments; groupwork tools that use argument to structure interaction and debate; computer-based learning tools that exploit monological and dialogical argument structures in designing pedagogic environments; decision support systems that build upon argumentation theoretic models of deliberation to better integrate with human reasoning; and models of knowledge engineering structured around core concepts of argument to simplify knowledge elicitation and representation problems. Furthermore, benefits have not been unilateral for AI, as demonstrated by the increasing presence of AI scholars in classical argumentation theory events and journals, and AI implementations of argument finding application in both research and pedagogic practice within philosophy and argumentation theory. (CMNA, 2006)

Computational models of argumentation come in three categories: logic based (highly theoretical), pragmatic *ad hoc* treatments which are not probabilistic, and probabilistic models of argument (the latter, not treated in this entry). Recent paper collections include, for example, Dunne and Bench-Capon (2005) and Reed and Norman (2003). Classics include the HYPO system (Ashley, 1990), which was continued in the CABARET project (Rissland & Skalak, 1991) and the CATO project (Aleven & Ashley 1997).

Arguments themselves come in different categories, such as deontological (in terms of right or wrong) or teleological (what acting or not acting in a given way may bring or not bring about) (MacCormick 1995, pp. 467-468). In a disputation with *adversary arguments,* the players do not actually expect to convince each other, and their persuasion goals target observers. ABDUL/ILANA simulated the generation of adversary arguments on an international conflict (Flowers, McGuire, & Birnbaum, 1982). *Persuasion arguments,* instead, have the aim of persuading one's interlocutor, too. Persuasive political argument is modeled in Atkinson et al. (2005). AI modeling of persuasion in court was discussed by Bench-Capon (2003).

For the class of such computational models of argument which are based on logic (neat, theoretical models), a good survey from which to start is Prakken and Sartor (2002):

Argumentation is one of the central topics of current research in Artificial Intelligence and Law. It has attracted the attention of both logically inclined and design-oriented researchers. Two common themes prevail. The first is that legal reasoning is defeasible, i.e., an argument that is acceptable in itself can be overturned by counterarguments. The second is that legal reasoning is usually performed in a context of debate and disagreement. Accordingly, such notions are studied as argument moves, attack, dialogue, and burden of proof. (p. 342)

Prakken and Sartor (2002) usefully:

...propose that models of legal argument can be described in terms of four layers. The first, logical layer defines what arguments are, i.e., how pieces of information can be combined to provide basic support for a claim. The second, dialectical layer focuses on conflicting arguments: it introduces such notions as 'counterargument', 'attack', 'rebuttal' and 'defeat', and it defines, given a set of arguments and evaluation criteria, which arguments prevail. The third, procedural layer regulates how an actual dispute can be conducted, i.e., how parties can introduce or challenge new information and state new arguments. In other words, this level defines the possible speech acts, and the discourse rules governing them. Thus the procedural layer differs from the first two in one crucial respect. While those layers assume a fixed set of premises, at the procedural layer the set of premises is constructed dynamically, during a debate. This also holds for the final layer, the strategic or heuristic one, which provides rational ways of conducting a dispute within the procedural bounds of the third layer. (Section 1.2)

VARIOUS APPROACHES TO ARGUMENT STRUCTURE

A graphical notation for the relation among a multitude of arguments was proposed by a prominent American legal scholar, John Henry Wigmore (1863-1943). He introduced a complex graphical notation for legal argument structuring (Wigmore 1937). *Wigmore Charts* were usefully simplified in Anderson and Twining (1991, cf. Anderson, 1999). Schum (2001) used them in *MarshalPlan*. Prakken (2004) has adopted them as well, visualizing the argument structure by using *Araucaria* (Reed & Rowe, 2004). In the next article, "Argumentation with Wigmore Charts, and Computing," we teach how to use Wigmore Charts. Arguably, they deserve widespread use.

In computer science, for representing an argument, use of Toulmin's (1958) argument structure is relatively widespread, certainly more so than Wigmore Charts have been. A chart with Toulmin's argument components is given in Figure 1, whereas an example of application is given in Figure 2.

In Toulmin's model, an argument consists of a single premise ("Datum" or "Data"), of the Claim (which is the conclusion), of a Qualifier which states the probative value of the inference (e.g., *necessarily,* or *presumably*), of the Warrant—which is a kind of rule which supports the inference from the premise to the conclusion of the argument—and of the Backing (an additional piece of data which provides support for the warrant), as well as of a Rebuttal (which is an exception).

Gordon and Walton (2006) described a formal model, implemented in *Carneades,* using a functional programming language and Semantic Web technologies. In the model underlying this tool, instead of Toulmin's single datum, there is generally a set of prem-