Structured Arguments Unchained

Trevor BENCH-CAPON, Katie ATKINSON
Department of Computer Science, University of Liverpool, UK

Within computational argument, structured argumentation currently relies heavily on *modus ponens*. For example, ASPIC+ chains arguments together to form inference trees [5], Definition 3.6. Arguments are structured into premises and a conclusion, with the conclusion being acceptable if the premises are acceptable. The base case is that the conclusion is in the knowledge base. Otherwise, arguments are chained together, supporting premises by showing that they are themselves the conclusion of a sub-argument. This corresponds to a standard AI formalism: arguments are derived from a standard knowledge base, comprising rules (strict and defeasible in [5]) and facts (*axioms* and *premises* in [5]), with the arguments corresponding to applications of rules. Where the premises are themselves derived as consequences of rules, they form sub-arguments, giving rise to a tree of arguments, corresponding to chaining the rules.

Attacks in ASPIC+ may be *rebuttals* (where the arguments have contradictory conclusions); *underminers* (where the conclusion of the attacker is the negation of a premise of the other argument) and *undercutters* (where the conclusion of one argument is that the rule used in the other is not applicable).

Argument schemes offer a similar pattern. The schemes given in [7] take the form a set of premises, a defeasible conclusion, and a set of *critical questions* which can be used to challenge the applicability of the scheme, or the truth of the premises or the conclusion in the particular context. Attacks on instantiations of argument schemes are based on these *critical questions*. Critical questions can give rise to any of the three kinds of attack [6].

Premises, Rule and Conclusion is indeed a common form of argumentation, but actual argumentation can take other forms. This is apparent from Natural Deduction systems (such as [4]) in which *modus ponens* is only one of many rules.

- A common way of arguing is *reductio ad absurdum*. Here we need a pair of arguments with at least one premise in common and with the conclusion of one argument the negation of the other. This enables us to conclude that (at least) one of the premises is false. Further arguments may be needed to establish which of the premises is to be considered false.
- A second example is argument from cases. Here we offer a disjunction which exhausts all possibilities, and then a set of arguments showing that the conclusion can be shown from each of the disjuncts.
- We should also consider *modus tolens*. This does not invariably apply to defasible arguments, and in ASPIC+ is handled by explicitly adding the contrapositions to the knowledge base [2] where it is desired, especially for strict rules. It may, however, be useful to see it as a separate kind of argument.

- Another rule of Natural Deduction is *Conditional Proof*, in which an argument from an assumption to a conclusion is taken to establish the rule that *if assumption, then conclusion*. This could be used to attack an undercutter.

We suggest therefore that we need to extend the definition of argument in ASPIC+ (and similar frameworks) to cater for arguments with these very different structures. That this matters can be seen from the following example. Suppose we have a knowledge base comprising two rules:

sr1: $p \wedge q \rightarrow r$. **sr2**: $p \wedge s \rightarrow \neg r$ and p, q and s as premises.

Now, using the ASPIC+ definition, we get two arguments:

A: premises $\{p, q\}$ and conclusion r and **B**: premises $\{p, s\}$ and conclusion $\neg r$

ASPIC+ yields two arguments in a relationship of rebuttal. Whether we accept r or $\neg r$ will depend on whether A is preferred to B or *vice versa*. But the more normal response to A and B is that they show that the common premise p cannot be true. So we at least need the option of denying p and seeing the *reductio* argument (C) as undermining both A and B. Had p not been a premise, but established by a fourth argument D, then C would have been a rebuttal of D. Thus ignoring the possibility of arguments such as C can lead to the wrong conclusions in some cases.

These additional forms of argument greatly expand the possible strategic considerations in various kinds of dialogue, perhaps especially persuasion dialogues. Moreover, by including these forms of argument which are closely related to rules in Natural Deduction systems e.g. [4], we bring computational argument closer to informal argumentation.

Some of these diferent kinds of arguments have been noted before: [3] discussed *reductio* and [1] reasoning by cases. These, however, treated the structures separately, and the proposed solutions are directed towards the specific case under consideration, and so they do not address the whole problem generally. What is required is a thorough, uniform, treatment, able to be integrated with the existing ASPIC+ framework, of arguments which have arguments as premises, and arguments with other structures (such as *conditional proof*, which has an argument as conclusion), and how these interact with each other and existing argument/subargument chains.

References

[1] M. Beirlaen, J. Heyninck, and C. Straßer. Reasoning by cases in structured argumentation. In *Proceedings of the Symposium on Applied Computing*, pages 989–994. ACM, 2017.

[2] M. Caminada and L. Amgoud. On the evaluation of argumentation formalisms. *Artificial Intelligence*, 171(5):286–310, 2007.

[3] J. Dauphin and M. Cramer. ASPIC-END: Structured argumentation with explanations and natural deduction. In *Theory and Applications of Formal Argumentation*, pages 51–66. Springer, 2017.

[4] E. J. Lemmon. *Beginning logic*. CRC Press, 1971.

[5] S. Modgil and H. Prakken. The ASPIC+ framework for structured argumentation: a tutorial. *Argument and Computation*, 5(1):31–62, 2014.

[6] B. Verheij. Dialectical argumentation with argumentation schemes: An approach to legal logic. *Artificial intelligence and Law*, 11(2-3):167–195, 2003.

[7] D. Walton, C. Reed, and M. Fabrizio. *Argumentation schemes*. Springer, 2008.