Argument and Computation and the Legacy of the Lvov-Warsaw School

The part of the work published as "The Development of Argument and Computation and Its Roots in the Lvov-Warsaw School" (co-authored with Chris Reed), *Studies in Logic, Grammar and Rhetoric 23*(36), 2011, pp. 15-37

Marcin Koszowy

August 7, 2013

The main goal

The goal of the inquiry is to expose those research areas of the Lvov-Warsaw School (LWS) which correspond to the contemporary study of argument and computation. As a possible point of departure for bridging the gap between these two research traditions main reasons for applying methods of automated reasoning (esp. the MIZAR system) in argument analysis are discussed.

Logical ideas of the LWS and the computational models of argument

Which logical ideas of the LWS may be employed in the area of building computational models of argument? Among many issues discussed within the logical studies carried out in the LWS, there are two topics which may be of interest in the context of investigating the issues on the overlap between argumentation theory and computer science:

- the concepts of logic and reasoning — for these concepts illustrate the tendency to combine formal analysis of arguments with the pragmatic characteristics of the context of argument use;
- the impact of some logical ideas of the LWS on computer science — for it indicates possibility of applying further the language and methods of logic to building computational models of reasoning; among these ideas there are (see Trzęsicki, 2007, pp. 19-29): Polish notation (parenthesis-free notation) invented by Jan Łukasiewicz, multi-valued logics (also created by Łukasiewicz), the system of natural deduction invented by Stanisław Jaśkowski (independently of Gerhard Gentzen), discursive logic developed by Stanisław Jaśkowski, impact of some ideas of Jerzy Łoś on inventing temporal logic by Arthur Norman Prior, categorial grammar developed by Kazimierz Ajdukiewicz, and the theory of recursive functions elaborated by Andrzej Grzegorczyk.

Since one of the goals of designing computational models of argument is providing computer-aided procedures of argument analysis, in what follows, a possible application of a system of automated reasoning in representing arguments will be given. A key idea applied in designing systems of computer-aided reasoning is Stanisław Jaśkowski's system of natural deduction. For it constituted a theoretical inspiration for designing MIZAR — the system of a computer-aided representation and verification of mathematical knowledge. Some applications of MIZAR in argument representation will be suggested.

A possible point of departure of the logical studies of argument within the tradition of the LWS is conceiving an argument as a pair of nonempty sets of propositions. For example, arguments are structures $\langle \Sigma, \Gamma \rangle$, where Σ is the set of premisses and Γ is the set of conclusions. Among the relations between Σ and Γ there are: direction of argumentation, direction of entailment, and direction of justification (see Trzęsicki 2011).

A tendency to include pragmatic concepts (such as convincing the audience) into the characteristic of arguments is Witold Marciszewski's definition of argument as such a reasoning whose aim is to influence an audience:

> A reasoning is said to be an argument if its author, when making use of logical laws and factual knowledge, also takes advantage of what he knows or presumes about his audience's possible reactions (Marciszewski, 1991, p. 45).

The remark that the knowledge about the audience's reactions plays a key role in any successful persuasion is a point of departure for seeking theoretical foundations for the art of argument not only in formal logic, but also in accounts of human cognition and the mind-body relations, as present in philosophy and in cognitive science. In what follows the basic features of this approach will be discussed.

Possible applications

An example of developing an account of argument from the point of view of computing is Marciszewski's approach to an argument (1991). This account is rooted in a conception of reasoning as computing, which is the most briefly expressed with Leibniz's call: *Calculemus*! Within Marciszewski's approach, the concept of information processing constitutes a theoretical foundation of the art of argument. Information is treated as a theoretical entity recorded in a material vehicle. Two kinds of records of information are distinguished: *external* (information is not part of a communicating system) and *internal* (information is part of a communicating system). Next, two ways of information processing are distinguished: *direct processing* (performed without recording), and *indirect processing* (performed with producing records).

Those two distinctions allow to give an answer to the question: what is the place of arguments on the map of information-processing phenomena? Arguments are located in the area of indirect processing of consciousness with external records, and then in processing internal records by the corresponding acts of consciousness (Marciszewski, 1991, p. 46).

The next theoretical tool for dealing with the structure of arguments is the framework of transforming a sequence through appending new elements. Within this framework one may distinguish a sequence which belongs to a definite (1) domain. Items in that sequence are created by applying a definite (2) operation (a many-one or one-one

transformation). The sequence tends to (3) a bound either in virtue of that operation itself or by our decision as to the point to stop. When generating a next element of the sequence by employing a definite operation, a trait of preceding elements is preserved - this trait is called (4) an invariant. Within this framework, arguments ruled by formal logic are characterized as follows: (i) a domain consists of propositions; (ii) operations are defined by inference rules; (iii) a bound is a conclusion one seeks for; (iv) a preserved trait (invariant) is a logical value called truth.

This framework may serve as a useful heuristic model in analyzing logical fallacies by comparing deductively invalid inference schemes with this model. Since the universal laws of information processing are common to all information-processing systems (both to human beings and to computers), this model is claimed to be applicable in analyzing various information processing phenomena, despite of the fundamental differences between human being and cipher machine (p. 48). However, the discussed model is not claimed to be a unique legitimate tool for analyzing arguments, for it does not deal with defeasible inference schemes.

The main features of the proposed approach to arguments are: placing arguments in the framework of information processing and analyzing arguments in terms of external records, especially of formalized proofs as a paradigm of information processing. These goals are realized by systems for automated reasoning, automated deduction, and automated proof checking. An example of such a system is MIZAR – the project which started in 1973 one the initiative of Andrzej Trybulec. MIZAR is (1) a formal language for writing formalized mathematical definitions and proofs, (2) a computer program used for verifying mathematical proofs (see Trybulec 1993, Matuszewski & Rudnicki 2005). Since 1989 the focus of the project has been also to develop a database for mathematics (*Mizar Mathematical Library* – MML). Marciszewski (1994) describes MIZAR as:

> (i) a natural deduction system of (ii) Multi-Sorted predicate logic with Equality, for short MSE, (iii) that simulates the language of proofs, esp. that used by mathematicians, in a simplified and standardized form, adjusted to computer processing, and (iv) that is combined with a proof checker, i.e. a program checking proof validity (Marciszewski, 1994).

In order to make the connections between the methods of analyzing reasoning in the legacy of the LWS and the methods of building computational models of argument more explicit, we shall discuss two main theses concerning possible applications of MIZAR in proposing a kind of a computational model of argument. The theses hold that:

- the MIZAR language is a useful tool of representing the structure of arguments;
- the MIZAR methods of automated proof-checking are applicable in identifying formal logical fallacies.

Some possible applications of systems of automated reasoning in analyzing fallacies may be justified by indicating twofold profits: (i) representation of argument schemes by means of a computer-aided knowledge representation enriches the palette of devices of mathematical knowledge representation, and (ii) expressing the structure of arguments in MIZAR may be instrumental in exposing the key similarities between the project of automated reasoning and the study of computational models of natural argument.

However, some applications of MIZAR, focus exclusively on deductive inference rules and deductive invalidities of reasoning. In order to combine this formal approach with the broader pragmatic account of arguments (as presented in section 2.2), further research on the applications of MIZAR may be carried on. One of the main goals of such an inquiry would be to analyze, by means of the MIZAR language, a set of those tools of argumentation theory which are (at least to some extent) formalizable, and which take into account the context of argument use. Among the tools of argumentation theory which fit to those requirements there are argumentation schemes. The research on representing the main argument schemes in MIZAR would be in accord with the attempts at formalizing some argumentation schemes, such as the ad hominem argumentation scheme (Walton, 2010). The fact that some argumentation schemes are generalized rules of inference (Prakken, 2010; see also Bex & Reed, 2011) constitutes an additional justification for such an inquiry, because representing inference rules is also possible in MIZAR. Hence, the task for further inquiry would consist in expressing in the MIZAR language those schemes which have the form of generalized inference rules.

References

[1] Bex, F., & Reed C. (2011). Schemes of inference, conflict, and preference in a computational model of argument. *Studies in Logic, Grammar and Rhetoric 23(36)*.

[2] Gibson, A., Rowe, G., & Reed, C. (2007). A Computational Approach to Identifying Formal Fallacy. In *Working Notes of the 7th Workshop on Computational Models of Natural Argument (CMNA 2007)*, (pp. 26–30), Hyderabad.

[3] Marciszewski, W. (1991). Foundations of the art of argument. *Logic Group Bulletin, 1*, Warsaw Scientific Society, 45–49.

[4] Marciszewski, W. (1994). A Jaśkowski-style system of computer-assisted reasoning. In J. Woleński (Ed.), *Philosophical Logic in Poland*, Dordrecht: Kluwer. Revised version: A system of suppositional logic as embodied in the proof checker Mizar MSE. *Mathesis Universalis, 3*. Retrieved from `http://www.calculemus.org/MathUniversalis/3/index.html`.

[5] Matuszewski, R., & Rudnicki P. (2005). MIZAR: the first 30 years. *Mechanized Mathematics and Its Applications, 4 (1)*, 3–24.

[6] Prakken, H. (2010). On the nature of argument schemes. In C. Reed and C. Tindale (Eds.), *Dialectics, Dialogue and Argumentation. An Examination of Douglas Walton's Theories of Reasoning and Argument* (pp. 167–185), London: College Publications.

[7] Trybulec, A. (1993). Some features of the Mizar Language. In *Proceedings of the ESPRIT Workshop*, Torino. Retrieved from `http://mizar.uwb.edu.pl/project/trybulec93.ps`.

[8] Trzęsicki, K. (2007). Polish logicians' contribution to the world's informatics. *Studies in Logic, Grammar and Rhetoric, 11 (24)*, 15–34.

[9] Trzęsicki, K. (2011). Arguments and their classification. *Studies in Logic, Grammar and Rhetoric 23(36)*.

[10] Walton, D. (2010). Formalization of the Ad Hominem argumentation scheme. *Journal of Applied Logic, 8*, 1–21.