Research Report for Graduate Symposium: Euler-type Diagrams and Syllogistics

Claudia Anger

Institute of Theoretical Philosophy
FernUniversity in Hagen, Germany
Claudia.Anger@fernuni-hagen.de

Abstract. I present an investigation about the philosophical principles of syllogistics, modern Euler-type diagrams, and notations. I will elicit the principles of syllogistics in detail to derive the basic conditions according to which the adequacy of diagrammatic systems and notations is to be judged.

Keywords: Syllogistics, Euler-type Diagrams, Notations.

The Thesis Topic. I present a theoretical investigation about the philosophical principles of syllogistics. From these principles I will derive the basic conditions to which the adequacy of modern Euler-type diagrammatic systems and notations will be judged. By modern Euler-type diagrams I mean those which work with closed curves and are based on the ones which Euler used in his *Letters to a German Princess*. These diagrams make assertions about classes or sets. The modern Euler-type diagrams and notational systems that are normally researched today are the ones which usually accompany the diagrammatic systems after 1994, the year of Sun-Joo Shin's paradicmatic book *The Logical Status of Diagrams*. In this book she showed for Venn diagrams that diagrammatic systems can be provable sound and complete as well as systems of symbolic logic. Hammer did the same with Euler diagrams. Thus, my research starts with Eric Hammer's Euler Circles (1995). The notations usually used are taken from predicate logic and set theory. In addition, there are the new description logic and natural logic systems to be judged.

The question of the thesis is: Which modern Euler-type diagrammatic systems and notations are best suited for representing syllogistic modes of inference? This leads to the following subordinate questions: How can these diagrams be designed uniquely with respect to uncertain information without losing visual clarity and still withstanding syllogistic principles? Uniqueness in the representation is important for a proof. How can one arrive at valid conclusions with the help of Euler-type diagrams? Another question is which modern notations are most suitable for syllogistics. Special attention is to be paid to a recent trend in research which is devoted to a return to natural reasoning. To what extend can new systems of notation, e.g., the drafts of description logic and natural logic, ensure a coherent interpretation of syllogistics?

The philosophical part of this research is about the principles of syllogistics. Before deriving these principles, I will first give an idea of different interpretations of categorical sentences that are the basis of syllogistics. The syllogistic principles elaborated are, for example, the principle of excluded middle or the problem of uncertain information. This is diagrammatically represented as an operational constraint of "overdetermined alternatives" as Shimojima calls them. Another operational constraint are "free rides" [10]. Furthermore, a problem is the aspect of empty classes. However, syllogistics was not originally designed to deal with empty classes. Therefore, especially the still common predicate logic must be critically questioned.

A key problem in syllogistics is that the emergence of uncertain information, which often cannot be avoided in particular sentences, causes great difficulties in the diagrammatic representation. In a valid syllogism, only the conclusion follows by logical necessity, but possible secondary information is sometimes uncertain – especially in the case of particular sentences – and depends among other things on the underlying notion of quantity. It is a challenge to represent uncertain information diagrammatically unambiguously as uncertain. One possibility is an or-relation.

Furthermore, extended syllogistics will be treated in the work, which include, e.g., indirect modes, singular judgements, contraposition or infinite sets. Various diagrammatic solution possibilities will be examined for syllogistic adequacy. Also, it is very important to find an appropriate relation basis for syllogistics. If this is too broad, the systems are confusing and loose the special advantage of diagrammatic systems, i. e. visual clarity. This advantage should be maintained in diagrammatic systems and not given up for better provability. Special attention shall be paid to a recent trend in research, which is devoted to a return to naturalness. The beginning of this trend was made by Gentzen already in 1934; Patzig showed in 1959 that Aristotelian syllogistics contain a system of logical necessity. Finally, Corcoran proved in 1974 that syllogistics is a system of natural deduction and not an axiomatic system. Natural deduction according to Gentzen and Corcoran is a type of natural reasoning oriented to the mathematical proof structure. The latter assumes that there is an inherent logical structure to Aristotelian syllogistic which includes a natural deductive system. It is a matter of easier understanding, better traceability of logical inferences, and shorter proofs.

The Approach Being Taken. The structure of the thesis is top-down. First, different interpretations and principles of syllogistics are presented, which are also associated with different numbers of valid syllogistic inferences. Second, the principles of Euler-type diagrams are presented and examined with respect to the representability of syllogistics. Third, some basic information about logical notations is given. Fourth, the currently used predicate logic and set theoretic notations are discussed and evaluated, as well as the new drafts of description logic and natural logic.

The Work That has Been Completed. Since I am still pretty much at the beginning of my PhD thesis, I have not yet fully completed any area. But some specific problems are already recognizable now, e.g., the problem of uncertain information and how these can be represented diagrammatically.

Expected Contributions of the Work. The dissertation shall evaluate modern notations and diagrammatic systems with respect to their adequacy for the representation of syllogistics. Further on, appropriate consequences for the logical parameters in artificial and natural intelligence or also in other fields such as philosophy of mind must be drawn from this.

Acknowledgements. Special thanks go to my supervisor, PD Jens Lemanski, FernUniversity in Hagen.

References

1. Bernhard, P.: Euler-Diagramme. Zur Morphologie einer Repräsentationsform in der Logik. Mentis, Paderborn (2001).
2. Corcoran, J.: Aristotle's Natural Deduction System. In: J. Corcoran (ed.) Ancient Logic and its Modern Interpretations, pp. 85–131. Reidel, Boston et al. (1974).
3. Euler, L.: Briefe an eine deutsche Prinzessin über verschiedene Gegenstände aus der Physik und Philosophie. Translated from the French. 2nd edn. Junius, Leipzig (1773).
4. Hammer, E.: Logic and Visual Information. CSLI Publications, Stanford, California (1995).
5. Hammer, E., Shin, S.-J.: Euler's Visual Logic. History and Philosophy of Logic,19, 1–29 (1998).
6. Howse, J., Stapleton, G., Taylor, J.: Spider Diagrams. LMS Journal of Computation and Mathematics 8, 145–194 (2005).
7. Lemanski, J.: Euler-type Diagrams and the Quantification of the Predicate. Journal of Philosophical Logic, 49, 401–416 (2020).
8. Mineshima, K., Okada, M., Takemura, R.: A Diagrammatic Inference System with Euler Circles. Journal of Logic, Language, and Information, 21(3), 365–391 (2012).
9. Nilsson, J. F.: In Pursuit of Natural Logics for Ontology-Structured Knowledge Bases. In: Proceedings of the 7th International Conference on Advanced Cognitive Technologies and Applications (COGNITIVE 2015), pp. 42-46. IARIA (2015).
10. Shimojima, A.: Operational Constraints in Diagrammatic Reasoning. In: G. Allwein, J. Barwise (eds.) Logical Reasoning with Diagrams, pp.27–48. Oxford University Press, New York (1996).
11. Stapleton, G.: Delivering the Potential of Diagrammatic Logics. In: J. Burton; L. Choudhury (eds.) DLAC 2013, Diagrams, Logic and Cognition. Series CEUR Workshop Proceedings (1132), pp. 1–8, http://ceur-ws.org/Vol-1132/paper1.pdf, last accessed 2020/09/22.
12. Tennant, N.: Aristotle's Syllogistic and Core Logic. History and Philosophy of Logic 35(2), 120–147 (2014).