

The (Non)emptiness Problem: Ontological Assumptions of Traditional Logic from Aristotle to George Boole

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The purpose of the paper is to provide an account of how the ontological assumptions of logic and the issue of empty terms were handled throughout history, starting with Aristotle and going up till George Boole and the emergence of modern formal logic.

Modern formal logic, rooted in Boolean algebra, uses the notion of the universe of discourse and does not allow for constructing interpretations of formal languages for empty universes. In contemporary discussions concerning the history of logic, it is widely assumed that the Aristotelian syllogistic did not allow for the use of empty terms as well. Jan Łukasiewicz in his 1951 *Aristotle's Syllogistic* [11] claimed that Aristotle supposes all terms in his syllogistic to be non-empty, and his view seems to be an orthodox way of interpreting Aristotle up till now. However, upon closer examination, this view was never held by Aristotle himself and it does not reflect the historical reality. The problem of empty terms is much more complex and as such was discussed extensively throughout history in relation to categorical statements and the Logical Square, a chapter in the history of logic that was not comprehensively described yet.

In the paper, I relate these discussions, claiming that the historical development of the problem of non-emptiness is closely related to the emergence of the modern notion of the universe of discourse. I cover four main areas: the logic of Aristotle and its interpretations, the logic of The Arabic World, medieval European logic, and later discussions up till the emergence of modern formal logic. Apart from a brief description of each of them, I claim that: 1) as Aristotle does not make any explicit statements about empty terms in his works concerned with syllogistic [3], the (non)emptiness of terms does not yet emerge as an issue. The dominant modern interpretation, in turn, stems from the time of the development of modern formal logic and attempts to render syllogistic using the modern notation [4], 2) the raised and open interest of Arabic philosophers in the issue (with Al-Farabi being the first one to openly speak about existential import, and Avicenna and Averroes following [2, 6]) can be explained by the language differences between Indo-European and Semitic languages, namely different ways of expressing existence and attribution, 3) in the conditional treatment of the existential assumptions proposed by William of Ockham [8] we can trace the origins of the modern notion of the universe of discourse (only that he admits only one possible universe, namely: things existing *in re*), which is then further developed by Leibniz [5], and, finally, Boole, 4) the whole issue became obsolete due to the triumph of empirical sciences during the Enlightenment [7] and thus abandoned and almost forgotten up till most recent. This, in turn, allowed for one-sided interpretations of Aristotle's ontological commitments in the first half of the twentieth century, 5) a renewed interest in ontological assumptions can be traced to the invention of Venn diagrams in 1881 [9] and their influence, as this method of representation makes the non-emptiness assumption seem like a natural choice and was used by Łukasiewicz [10] and other logicians which were

interpreting Aristotle in the first half of the twentieth century [1].

I further argue that the historical development of the issue of empty terms is twofold. Most importantly, we observe a rising awareness of empty terms as an issue that needs to be covered. Irrelevant or nonexistent in Aristotle, present in the Middle Ages, and substantial in the modern interpretations of Aristotle's work. The main difference I claim is that up till Łukasiewicz it was discussed either with respect to the validity of the Logical Square, as in the medieval and early modern period (as the problem of existential import, mostly), or with respect to categorical statements in general, as when the Boolean algebra emerged. Only with the works of Łukasiewicz and their popularity, the discussion turned to syllogistic as such and ontological assumptions of syllogistical reasoning started to be considered. Secondly, in parallel with the above, we can trace the origins of the universe of discourse idea, beginning in the works of Ockham and getting more and more pronounced, with *Logique de Port-Royal* giving intensional interpretation to extensions [5], Leibniz being the first one allowing the terms in his syllogistic to be systematically interpreted as things *in intellectu*, and finally Boole stating the idea more and more explicitly.

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