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Author(s): J. M. Bochenski

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J. M. Bochenski Logic and ontology

The scope of this article is to present a broad survey of the relations between logic and ontology as they have been conceived of in the history of Western thought. While it is true that Hindu philosophy offers a similar field of research, the impression is that we are not yet prepared to handle it in any synthetic way. We simply do not know enough about the details of the Hindu doctrines.

I

The question "how are logic and ontology interrelated?" is an ambiguous question, that is, it can refer either to logic and ontology themselves or to the metatheories of logic and ontology (that is, to the views about them). Furthermore, in the first case, both logic and ontology may be considered either objectively or subjectively.

(1) If the question refers to logic and ontology themselves considered objectively (that is, in their content), the disciplines are seen as sets of laws and/or rules, and so the problem is purely *logical.* It will be clear that its solution depends largely on the content of logic and of ontology as they were constructed at a given time.

(2) If the question refers to the same, but as seen subjectively (that is, in as far as they were conceived by some thinkers or groups of thinkers), then it is about empirical facts and is then a *historical* question: how did the fact that x held the ontology O influence the fact that he also held the logic L or inversely?

(3) Finally, if the question is concerned not with the two systems as they are but rather with the *metatheoretical* views about them (that is, with the corresponding philosophies of logic), the question is a quite different one. That this is so is indicated by the fact that often the same type of logic was philosophically interpreted in a different manner by two different schools. This question, in turn, can be considered either logically or historically.

It should be clear that the first question is fundamental. Therefore, the principal focus of this presentation will be upon it. The philosophy of logic and ontology will be treated only secondarily, while the historical question of the mutual factual influences of doctrines about them will be only marginally noted.

Now to state at once one of the principal conclusions of the present investigation, it must be confessed that there is considerable confusion about that basic question. Almost any imaginable answer has been proposed by one or

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another philosopher. To mention only two of the extreme views, respectable logicians have maintained that there is a complete identity of both disciplines (thus, Scholz) and that there is no relation whatsoever between them (thus, Nagel). The very fact that this is so requires an explanation. As is always so in such cases, this explanation must be *historical.*

One reason for the unfortunate state prevailing in investigations of this problem can readily be identified: ignorance. Most ontologists do not know even the ABC's of logic. But the inverse is also true: most logicians do not have the least idea what ontology might be. These deficiencies are often combined, on both sides, with value judgments of an unkind sort. Thus, to most ontologists, logic does not seem to be a serious discipline, although they concede that it provides (*hélas!*) some practical results for computer science. On the other hand, ontology is merely nonsense in the estimation of many logicians. It is little wonder that such scholars produce few worthwhile contributions regarding the relations of the two disciplines.

But this is not the whole answer. The present bifurcation did not always prevail. There have been ontologists who were well instructed in logic and who were even creative logicians in their own right; Thomas Aquinas and Uddyotakāra (seventh cent.) are examples. There were also logicians who knew a good deal about ontology; one need think only of Leibniz and of Whitehead. Nevertheless, confusion about our problem is widespread across the ages. Some explanation must be offered for this fact, and once again it has to explained historically.

Now history makes at least one thing quite clear: while ontology had a rather clear status in most periods so that there was a general agreement about what ontology is, the same has seldom been true about logic. This is indeed an astonishing fact, especially if one considers the rigor with which the latter has traditionally been developed and the loose language often employed by many ontologists. But a fact it is, nonetheless, and one that must be explained historically, as has been noted.

Let us remark that our concern here is with the *nature* of logic and of ontology, with what they *say,* with their *objects* and not with their *origins* nor with the *justification* each uses to establish its theorems. Now this distinction has been widely neglected—or so it seems. One approach to the problem can be stated as follows. One, logic is a sort of game based on conventional rules; as such, its statements do not and cannot pretend to be true in any meaning of the term. Two, ontology, on the contrary, is constituted by insight into reality; consequently, its statements are supposed to be true —and even certainly true.

Both assumptions, it is submitted, are *unwarranted.* (1) A logician *can* see his work in that fashion, and some logicians (though not many) have done so. But most logicians have *not.* In fact, it is well known that few

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scholars are as certain of the truth of their beliefs as logicians often are; there is even a saying that the expression "a modest logician" is a contradiction *in adiecto*. (2) Ontology was often—perhaps in most cases—conceived as being based on insight. But again, it *need not* be so conceived, and in many cases it was not. To mention only two instances in which it was not, philosophers of the neo-Thomist schools make extensive use of deductive inference in their ontology, while Whitehead offered his ontology as a set of explanatory hypotheses, comparable to those of the natural sciences, only more abstract.

Moreover, these assumptions are *irrelevant* to the present inquiry. The question is *not* how the statements of the two disciplines are justified nor what is their truth-value, but rather what they are about. In other words, it is not an epistemological but a logical question.

II

Before we engage in our historical enquiry, a few points of a systematic nature may be called to mind. In the course of history, the understanding of these doctrines has often been inadequate. Thus it will be useful to state them at the very beginning.

One of these concerns the way in which general logic is divided. A first distinction may be made between logic proper and the philosophy of logic; the latter is a set of statements (metatheorems) about logic itself. Logic proper may be divided into pure and applied logic. Pure logic is formal logic, and, while every science may be said to be applied logic, logicians have always and still cultivate two sorts of such applications. These have, therefore, come to be considered as parts of general logic: logic as applied to language (that is, logical semiotics) and logic as applied to reasoning (that is, general methodology of thought). A logician need not interest himself in galaxies or bacteria, but he has to talk or write—also, seemingly, to think, at least from time to time.

From the foregoing consideration, it should be clear that the central and basic part of general logic is formal logic. Philosophy of logic is a speculation about formal logic, while applied logic merely consists in applications of the same. For that reason, the present inquiry will concentrate on formal logic.

The second doctrine that merits mention is the semantic distinction of object language and metalanguage. Object language is one in which we talk about translinguistic entities; such is the case in the discourse of zoology, which is about cows and crocodiles and not about the words "cow" or "crocodile." By contrast, metalanguage is a language in which we talk about another language and its parts. Grammar is written in metalanguage, zoology in object language.

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Finally, we must distinguish between laws and rules. A law is a statement saying what there *is;* a rule is not a statement, but rather an indication or prescription of how one can or should *act.* Thus, "the door is closed" is a statement, while "close the door" is a rule. In logic, a rule must be formulated in metalanguage; logical laws may be either object- or meta-linguistic. The cardinal difference between laws and rules in logic is that laws alone have a truth value (that is, are true or false). Rules can be valid or correct, but not properly true or false.

Regarding our understanding of the mutual relations between rules and laws in logic, the Stoics have provided us with an important insight. They would say that an argument (a substitution in a rule) is valid if and only if a conditional (a statement) having the product of the premises as antecedent and its conclusion as consequent is true. Thus, the rule known as the *modus ponendo ponens*—"from 'if *p* then *q*' and '*p*' infers '*q*' "—is valid if the following conditional is true: "if, if *p* then *q,* and *p,* then *q.*" This principle allows for a complete translation of a logic stated in terms of laws into one formulated as a set of rules and inversely. This point is important for the sake of the inquiry at hand. For ontology is a system of laws, while logic has often been formulated as a set of rules; such a difference complicates any effort at direct confrontation between the two disciplines. But the principle enunciated above permits us to translate rules into laws and therefore facilitates the comparison.

III

One fact about logic which is of central importance is that, in almost all instances, it has developed out of dialectics—that is, out of a set of rules for discussion and reasoning. This comment is not intended to exclude other factors that were operative. Greek logic, for example, is greatly indebted to Plato's metaphysical and mathematical speculations, Hindu logic to the grammarians, and mathematical logic, of course, to the mathematicians. Nevertheless, the predominant factor seems to have been dialectics in the old meaning of that term, the art of discussing.

The term "dialectics" has indeed many uses. During long periods—so with the Stoics and the Early Schoolmen—it was synonymous with "logic." However, as referring to the pre-Aristotelian practice, it stands for a set of rules meant to be followed in discussions and, moreover, rules which are not formulated abstractly nor are universally valid. Both the Aristotelian *Topics* and the *Nyāya-sūtra* are first attempts to formulate such rules; yet, they still often lack universal validity. In both those works one can see clearly how formal logic developed out of such rules—the *Nyāya-sūtra*'s syllogism with five members is, in particular, a splendid illustration of that fact. As far as

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Chinese "logic" is concerned (and we could say the same about that of the Hebrews), it gives the appearance of being more dialectics which never rose to the level of formal logic, as it did in both Greece and India.

This explains, at least partially, the fact that a certain view of the relations between logic and ontology has persisted in history. According to this view, logic and ontology have little or nothing to do with each other: ontology is a theory of what there is, while logic teaches us how to argue successfully. If this view is accepted, it is not easy to see what relations there could be between the two. In any case, if that assumption is made, they are certainly very different disciplines.

But the truth is that there *is* formal logic and that formal logic is *obviously* not mere dialectics. This is so, in the first instance, because formal logic often formulates laws, not rules; of itself this would not be decisive, since a law can be translated into a rule, given a sufficient apparatus. What is more important is the fact that, since Aristotle, every logic contains a number of laws which have not been established to serve any practical inference or discussion and will, in all likelihood, never be thus applied. In point of fact, it is astonishing how little formal logic is used not only in everyday arguing, but even in the sophisticated inferences of higher mathematics. It is perhaps no exaggeration to say that what we have in the Stoic fragments, plus a few rules derived from the *Prior Analytics,* suffice for such purposes. And still logicians have developed vast systems of laws or rules without any regard to their practical use in reasoning. The great body of doctrines contained in Frege, Schröder, the *Principia,* and so on was not constructed to supply mathematicians with rules of reasoning in their fields (every mathematician knows these rules rather well on his own), but in order to establish the foundations either of mathematics or of a philosophy of mathematics. Indeed, we find that something similar occurred as early as in the *Prior Analytics*. Valla was quite correct in pointing out that no one has ever reasoned in Bocardo or Felapton.

IV

The history begins with Aristotle, as so many philosophical questions do. Nor is it a question of that history merely beginning with him. For in many cases one gets the impression that where "the Master of those who know" (Dante) failed to perceive or to formulate a problem, his successors had a difficult time at formulating or solving it. Among these problems is that of the relations between logic and ontology.

The following is a brief description of both disciplines as they appear to the unbiased reader in the Aristotelian corpus. There is a book, or rather a collection of writings, called "Metaphysics" by Andronikos Rhodos. There

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is also a collection of works which received the name "Organon" from the commentators. None of these names derive from Aristotle himself. There can be no doubt, however, that we find in his writings a considerable number of doctrines belonging to what will subsequently be called "logic" and "ontology" respectively.

As regards ontology, Aristotle talks about a "first philosophy" and a "divine science." He says that they are about being as being; what we see here is an attempt to define this discipline. But as far as logic is concerned, we find no name for it in his writings. (The Greek λογικός means "probable" there; what corresponds to our "logic" is perhaps ἐκ τῶν κειμένων, meaning "out of the assumptions".) Still less is there any attempt to define the subject matter of logic.

If, however, we turn from his philosophy of logic and of ontology to the theories themselves (that is, to the systems Aristotle developed), it is relatively easy to describe what he would have meant by "ontology" and "logic" respectively, if he had had such terms.

Regarding ontology, we should first note that Aristotle, unlike many later thinkers, did not believe that there is an entity or even a meaning unambiguously associated with the term "being." In one of those passages which can certainly be esteemed as a stroke of genius, Aristotle explicitly states that "being" is an ambiguous term; he justifies this assertion by a sort of embryonic theory of types. And yet, we find extensive discussions of the characteristics of entities in general in the *Metaphysics* and elsewhere. On closer inspection, we discover that his ontological doctrines can be divided into two classes.

First of all, in the fourth book of his *Metaphysics,* Aristotle undertakes to state and discuss the "principles"—namely, noncontradiction and the excluded middle. (Aristotle made explicit use of the principle of identity in his logic, but never made it the object of a similar study.) Next we have a number of analyses of concrete entities. Of these the most conspicuous are the doctrine of act and potency and the table of the categories (also studied in the Organon, but obviously belonging to the "first philosophy"). The last named could be and has often been viewed as a classification of entities. But it seems more consistent with Aristotle's thought to consider it as a sort of analysis of a concrete entity into its various aspects.

The theory is thoroughly realistic in that ideal entities, such as the Platonic forms, are considered as derivative from the real, on which the analysis concentrates. There is no ontology of the ideal in Aristotle. Moreover, only one text in which he seems to speak about objective meanings is known, and that may be a later addition.

In summary, the Aristotelian ontology appears to be a study (1) of (isomorphically, we would say) common properties of all entities and (2) of

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the aspects into which they can be analyzed. Both sorts of studies are about *real objects*. One distinctive characteristic of this ontology is its conspicuous lack of existential statements, which is contrary to what we find in what is now commonly called "metaphysics."

If we pass on to Aristotle's logic, the situation becomes more complex; for we can distinguish several Aristotelian logics, at least two of which are very different from each other: the early systematization of the Platonic "dialectical" λόγοι in the *Topics* and the formal logic of the *Prior Analytics*.

The differences between them are quite fundamental. First, the first logic is a set of rules, while the second is, substantially, a system of laws. Furthermore, while the first is developed in everyday language, the second uses variables (an artificial language, at least to that extent). Third, whereas the first logic covers a wide variety of structures, the second is, by and large, limited to a very particular type of sentences—those of the form "*B* is *A*," with quantifiers and negators. Fourth, while the second logic is axiomatized, the first is not.

Because of that duality and the widespread notion that both logics are part of one system, the Organon wrought great havoc in the development of logic —and this in two ways. It seemed to legitimate the theory that logic is basically an "art of thinking," a technique of discussion and nothing more; the *Topics* is a description of precisely such a technique. Also, because the sentences examined in the second logic were restricted to those of the "*B*-is-*A*" type, any efforts to broaden the scope of logic were handicapped—in spite of some lucid remarks in the *Prior Analytics* themselves.

We now recognize that it makes no sense to speak about Aristotelian logic in general: there is no *one* logic, but rather *several* different ones. And, depending on which of them a thinker considers as the "true" logic, his view of this discipline and of its relations with ontology will be different. For, if logic is to consist of a set of rules for discussion, then it is an ὄργανον, a tool of the sciences, a general methodology of inference and discussion. But if it is a set of laws, such as is presented in the *Prior Analytics,* then it is obviously much more than that. It is a μέρος of philosophy, a most general theory of objects.

Aristotle does not say what those objects are. Moreover, he formulated logical laws in terms which are open to many different interpretations. Thus, a syllogism is a λόγος, which may mean the same as "discourse," "sentence," "thought," "proposition," "objective relation," and so on. What we would call a "sentence" or "statement," Aristotle named πρότασις (literally "what is proposed"), which may in turn have many meanings. And this πρότασις can be analyzed into ὅρους, an expression perfectly translated by Boethius as "terms" (*termini*) ; the latter may also mean anything and suggests only that terms are a sort of "frontier" or "border" of the statement.

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All of which is only to say that in Aristotle we have no commitment whatsoever to any philosophy of logic nor even the slightest attempt to describe its object. Aristotle founded logic and in a masterly way produced a small and rather strange part of it; he did not constitute a philosophy of logic. Many contemporary logicians may indeed claim his authority for their touching innocence in all such matters.

In summary, then, Aristotle left: (1) an ontology conceived as a theory of *real* entities in general and of their most general aspects; this discipline is defined; (2) two quite different systems of logic: a technology of discussion and an object-linguistic formal logic; (3) a considerable overlapping of both disciplines (for example, the "principles," the categories, etc.); (4) not even a hint, direct or indirect, as to what formal logic might be about; in other words, no philosophy of logic at all.

It should be clear that in *that* frame of reference, the question of the relations between logic and ontology cannot even be clearly stated. For we do not know what logic is nor which of the two logics has to be considered nor where are the boundaries between it and ontology.

And yet that is the frame of reference within which most of the Western discussions of our problem will develop. That is, so it seems, the explanation of the confusion reigning in our field.

V

With the Stoics, we find a clear choice between the alternative conceptions of logic: they opt for "dialectics," the art of arguing. This does not mean that they remained at the level of the *Topics*. On the contrary, their logic of propositions, magnificently developed, is *formal* logic. But it is conceived as being a set of rules of arguing.

Moreover, the Stoics were the first to formulate a consistent theory of the object of logic. Logic is, according to them, radically different from ontology of the Aristotelian type. There is, it is true, no ontology in their philosophy, and what corresponds to the Aristotelian table of categories is considered to be a part of logic. But the subject matter of logic, the meanings, is sharply distinguished from what is real. For, whereas everything which is real, including mental entities, is a body in the Stoics' view, the meanings are not bodies. They are ideal entities.

Thus the first known philosophy of logic emphasizes the radical difference and independence of logic as regards ontology.

The Scholastics make no use of the term "ontology" and discuss subjects which will subsequently be called "ontological" in the context of their commentaries on Aristotle's *Metaphysics*. As compared with the latter, there are some important developments. For example, much consideration is given to

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the semantic status of "being." We are aware of several positions adopted regarding this problem: while the Thomists considered "being" as analogous (that is, basically a systematically ambiguous term), others, such as the Ockhamists, held that it was purely ambiguous; Scotists, on the other hand, claimed that it is a "genus" (that is, not an ambiguous expression). Depending on the position assumed, some philosophers will develop a general theory of being, while others will not. In addition, we find a few new chapters in ontology: above all, the doctrine of the distinction between essence and existence, the theory of the "transcendental" properties of all entities, and, of course, a rich technical elaboration of every doctrine. With these exceptions, the subject matter of ontology is the same as that found in Aristotle.

When we turn to logic, the situation is quite different. While incorporating and developing a number of Aristotelian doctrines, Scholastic logic is very much un-Aristotelian insofar as its method and approach are concerned, but also, to a large extent, as regards the content. It is completely metalinguistic and consists of rules. But it is unlike Stoic logic as well, for its explicit concern is not with mere meanings but rather with what were called *propositions* (meaningful sentences). Semantics undergoes tremendous development during this period.

This being so, several important facts which are relevant to our problem emerge. First of all, a sharp distinction between logic and ontology is explicitly established: the former is metalinguistic, the latter, object-linguistic; logic formulates rules, ontology, laws. Secondly, given this distinction and the nature of the Aristotelian corpus, a curious duplication of doctrines appears: problems are treated twice, once in logic and then again in ontology. As Ockham noted, there are two principles of noncontradiction: one ontological, stated in object-language, and another logical, formulated in metalinguistic terms.

The Scholastics also formulated various philosophies of logic. They had several common views. For one, logic, while being primarily a methodology of reasoning and arguing, is said to be also a theory of certain entities. Second, they all shared the assumption that logic is not about "first intentions," which are dealt with in ontology, but rather about "second intentions." However, these terms assumed very different meanings in the context of different schools.

The Thomistic theory is essentially as follows. Logic is about entities like classes, negations, and similars which do not exist in the real world, but only in knowledge. They are not mental entities but objects known by the mind, although they depend on the mind for their existence. They are called "second intentions" (secondary contents of knowledge) in opposition to "first intentions" (contents directly abstracted from reality); they are constructs. Their construction is not arbitrary, however: they have a "founda-

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tion in the thing," in real entities. In other words, the Thomistic view is a logical idealism, but one which is linked with the ontological acknowledgment of the priority of real entities.

Ockham's view, on the other hand, has often been construed as being psychologistic because Ockham denies the distinction between the mental concept and its content. However, this does not seem to be an accurate portrayal of his position. Logic is not about mental entities as mental but about mental terms insofar as they are symbols of other terms (that is, insofar as they are metalinguistic symbols). Moreover, in the subsequent development of his school, logic is said to study only such of these terms as indicate the syntactic structure of the phrase. We have here a typical logical nominalism.[1]

In both of these cases logic and ontology are quite distinct sciences. Ontology deals with realities, logic with either ideal entities or with syntax. It is true that, in the Thomistic view, ontology must supply the foundations for logic to a certain extent, since logical entities are derived from real ones. This is by no means the case with the nominalists, for whom logic seems to be a discipline quite independent of any ontology.

The modern era, prior to the rise of mathematical logic, is an alogical and a largely unontological period. It opens with the Humanists; in their view, if logic has any usefulness at all, it is only as a set of rules for everyday arguments: it is an inferior sort of rhetoric, as Valla put it. Later on, when the scientific spirit began to rise, even the most rationalistic thinkers, such as Descartes, would not dare to reconsider the Humanists' total condemnation of "scholastic subtleties," including formal logic. Gradually, the so-called conventional logic was formulated.

The latter consists of extracts from Scholastic logic which omit almost every logical matter not connected with the theory of the assertoric syllogism (thus, the logic of propositions among others) and with the addition of a number of methodolological doctrines. Logic is quite clearly conceived of as "dialectics," "the art of thinking," as the authors of the influential *Logique du Port-Royal* titled it. Philosophically, there is a novelty: widespread psychologism, according to which logic has as its object mental entities and activities (concepts, judgments, reasonings).

There is, of course, one great exception—Leibniz, a logician of genius and an important thinker in the field of ontology. His ontology has been popularized by Wolff; in the latter's work the term "ontology" is clearly defined as designating the most general part of metaphysics, dealing with "being in general" (quite in the Aristotelian spirit). Leibnizian logic is mathematical and should rather be considered together with more recent logics, for its influence on the seventeenth, eighteenth, and nineteenth centuries was almost negligible. Leibniz also established his own philosophy of logic, which can

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only be understood in light of his logic. Our discussion of this will be deferred as well.

But, apart from Leibniz, the situation of our problem is not much different from that found in the Stoics and Scholastics: as logic is concerned with the mental behavior of men and ontology with being in general, the separation of the two is just as sharp as in the older schools. Indeed, this separation is reinforced by the fact that logic is now thought of as being a purely practical discipline and not as a theoretical one.

The whole course of the evolution between Aristotle and Boole may be summarized as follows. Ontology, whenever present, is on the whole of the Aristotelian type: a general theory of real entities. Regarding logic, the great majority of thinkers opt for the *first* Aristotelian logic, that of the *Topics;* they cultivate this discipline as a methodology of thought. While it is true that some Scholastics admitted a theory founding such a methodology, their logic nevertheless belongs to the type outlined in the *Topics,* not to that of the *Prior Analytics.* With such an assumption as a basis, whatever philosophy of logic they developed—whether conceived as a theory of meanings, of second intentions, of syntax or of mental entities, it was always radically different from ontology.

VI

The rise of mathematical logic brought about a considerable number of innovations in logic. Some of these were so radical that they were often viewed as a complete break with the whole tradition. In fact, there is such a break with the views of logic developed since Aristotle, with all Stoic, Scholastic and psychologistic systems. Yet mathematical logic can be viewed, in many respects, as a return to and a development of something which lies beyond that intervening tradition: namely, the basic insights of the late Aristotle in the *Prior Analytics.*

In this mathematical logic, we may distinguish methodological aspects and material results.

As to the first, four principal characteristics can be named:

(1) In most cases (and exclusively up until the 1930s), mathematical logic is a set of object-linguistic laws, not a system of metalinguistic rules. In that respect it is a break with the tradition, but at the same time a return to the way of formulating logic found in the *Prior Analytics.*

(2) It is, by that very fact, completely dissociated from every "dialectic." It is not an "art of thought," but a theory of a sort of objects. Because of this, it is anti-Stoic, very different from "classical" logic and largely also from Scholastic systems. But, once again, it resembles that of the *Prior Analytics.*

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(3) It is "symbolic" logic. Not only does it employ variables like Aristotle did, but also its constants are artificial as well. In this we have a complete break with all past systems both Western and Hindu, a revolution comparable with that effected in physics by Galileo. And yet the very fact that Aristotle operates with variables and that, while speaking everyday language, he tortures it into strange formulae, makes one think that even in that respect mathematical logic is closer to his basic attitude than to that of conventional logic.

(4) Finally, mathematical logic builds up rigorous axiomatic systems. It makes use of formalism, another radical innovation in logic. The idea of strict axiomatization, although found in Stoics and to a certain extent among the Scholastics, is absent in most traditional logic. Again, however, it is an Aristotelian idea, which has been formulated and practiced in the *Analytics*.

These methodological innovations permitted the construction of systems with striking characteristics—so striking, indeed, that many philosophers familiar only with logics of the decadent or of the Scholastic type promptly declared that it is not logic at all. Such a comment would then have to be applied to the *Prior Analytics* themselves, for, as we have shown, most of the innovations mentioned are either a return to the practice of Aristotle in that work or a development of his intuitions. But one cannot simply dismiss the *Prior Analytics* as a nonlogical work, and no one does.

Now if mathematical logic is logic, then in it we finally have a body of statements of a quite precisely defined type and also a method of dealing with them that is no less precisely stated. Regarding our problem, this is enormous progress: we now know more clearly what we are talking about.

About our problem of logic's relations with ontology, we can say that the constitution of mathematical logic has had ambivalent consequences. A number of its characteristics emphasize the differences between the two disciplines, while others point curiously toward an identity never suspected by any logician, except by Leibniz.

To direct our consideration to the method used, it should be clear that of its methodological characteristics two do distinguish it clearly from every known ontology: namely, its "symbolic" nature and its axiomatization. For no ontology has ever been formulated in an artificial language, and none has ever been worked out axiomatically as logic now is. Here and there, there have been inferences in ontology and consequently something which may be called "micro-axiomatization," but nothing comparable to the vast and rigorous systems of mathematical logic. Most ontology is and has always been descriptive, if not phenomenological.

This permits us to draw one important conclusion: *as they are now constituted, logic and ontology use different methods.* Whatever be their respective objects, their respective procedures are different.

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But if we turn our attention to that object, it appears that the rise of mathematical logic has resulted in a considerable rapprochement between the two disciplines. Certain of the methodological aspects and several of the material results of the new logic point in that direction.

Among the methodological characteristics, the first two mentioned earlier —its statement in the form of laws and the elimination of "dialectics"—made logic resemble ontology exteriorly. For ontology is also stated in the form of laws, not of rules, and has little to do with any "art of thinking." Ockham could make a distinction between the logical principle of noncontradiction (stated in metalanguage) and the ontological (object-linguistic) principle because, for him, logic was necessarily a system of metalinguistic rules. But such a distinction is no longer possible for the simple reason that logic formulates the said principle exactly as ontology does, as a law about every entity. Both disciplines now appear to be sets of statements about "being in general," that is, about entities whatsoever—as a "physics of the object in general," as one logician has it.

As to the material results of the new logic, the very fact of a rigorous elaboration of logic unveiled striking similarities between its basic fabric and that of ontology. This is all the more astonishing in view of the fact that most of the creative logicians often had no knowledge whatsoever of ontology. As examples of such similarities the following may be mentioned:

(*1*) *The theory of types.* As formulated in object language, this theory is strikingly similar to the old *ontological* views about "being." It states that there is no such class as that of all entities—or that being is not a genus, which is another way of saying the same. The terms "being," "class," and so on are ambiguous. Moreover, certain of the basic types (the first and the second) are curiously similar to the Aristotelian categories of substance and quality. There is still more: in order to overcome the serious handicap resulting from the theory of types, Russell had to talk about "systematic ambiguity." Now this happens to be a literal translation of the medieval *aequivocatio a consilio* (analogy), for *aequivocatio* is the Latin for "ambiguity" and *a consilio* means "deliberate," "systematic." All this comes from a logician whose knowledge of the history of ontology was nearly nil.

(*2*) *The primitives.* Because they were axiomatized, it became explicit what primitive concepts logic needs for its systematization. An inspection of the *Principia,* for example, indicates that the following undefined concepts underlie the whole fabric:

1. proposition (corresponding variables "*p*," "*q*," etc.)
2. individual ("*x*," "*y*," etc.)
3. property ("ϕ," "ψ," etc.)
4. relation ("*R*," "*S*," etc.)

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5. existence (the existential quantifier)
6. One constant relation: the stroke
7. class, or the circumflex over a name variable (for example, "$\hat{x}$")
8. the basic relation between a functor and its argument (for example, "ϕx")

Now it is certain that some of these primitive concepts have never appeared in ontology, as, for instance, the first and the seventh. In addition, it happens that the stroke was unknown to ontologists. But all the other concepts listed above are typically *ontological* concepts, to which parallels can be discovered both in the Aristotelian and in the Nyāya-Vaisesika ontology. For example, the logical individual corresponds to the Aristotelian substance; it is, in fact, the entitly which cannot be predicated of anything and of which everything else is predicated—which is Aristotle's οὐσία. The property bears a curious resemblance to the quality. Relation is another Aristotelian category. Existence is not a category, but, since the Middle Ages and also in twentieth-century thought, it has become one of the major topics of ontology. Finally, if the fundamental relation between a functor and its argument is conceived in a far broader way (in the manner of Frege), it can be seen as the counterpart of the Aristotelian doctrine of act and potency. The parallelism here goes still further, for the argument is a variable in the lower (and basic) calculus of predicates (that is, it remains undetermined, which is exactly the case of potency), while the functor is conceived as a constant (that is, the determinate and determining aspect, which is exactly the case of the act).

(*3*) *Finally, there is the* stroke. This has the property such that all propositional functors can be defined by it. Now the negator is one of these propositional functors. And while there is no negation nor negators in the real world (*pace* Messrs. Heidegger & Co.), it is less certain that the stroke does not represent something which is really to be found in that world. The stroke stands for "not both together," and it appears as if this is a real fact about all finite entities. Thus, to adopt Sartre's example, nothing can be both my friend Pierre and a chair in the cafe. And so, it may be that the most important constant of logic does not require a meaning which belongs to the sphere of the ideal, as the negator certainly does. Here again, logic seems to approximate ontology to a considerable extent, where the latter is conceived of as a theory of real entities.

All of these considerations strongly indicate the conclusion that logic, as it is now constituted, has a subject matter similar to that of ontology. In fact, this thesis has been sustained by Leibniz (with the addition "ontology of all possible worlds") and again, in his spirit, by Heinrich Scholz. It might be no longer a question of the two disciplines merely overlapping, but rather of a coextension of their fields.

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VII

Such is the situation as it appears to one who considers logic and ontology, as they are today, with an unbiased eye. Yet recent times have brought a revival of the medieval philosophies of logic, in particular, of logical nominalism and of logical idealism. Both of these deny the identity of logic and ontology as regarding their objects, as did their Scholastic predecessors. We may now turn to these modern philosophies and examine their claims in the light of the new situation in logic itself.

Recent logical *nominalism* is a return to the comparable medieval theory on two accounts: it takes logic to be about language and considers it as a mere technique, not as a theory; thus, logical laws are "empty" and convey no information at all.

On both accounts, however, the position of contemporary nominalists is much weaker than that of their Scholastic predecessors. For as logic is now constituted, it is evidently not about language and is evidently a theory and not a mere technique. And so, in order to justify their philosophy, logical nominalists are compelled to involve extensive interpretation, which alternative theories of logic do not require. Moreover, modern techniques (Quine's Criterion) make it possible to show with precision what objects must be admitted once a certain language is used. The application of these techniques to logic strongly indicates the falsification of the nominalists' doctrine that logic is "empty." All the particular arguments of this school have been submitted to devastating criticisms, to which, as far as we can tell, no adequate answer has been forthcoming. In all likelihood, then, it is no accident that the vast majority of the creative logicians of our century rejected logical nominalism.

On the other hand, the rise of mathematical logic has considerably strengthened the position of logical *idealism.* It is, in fact, not easy to construct a developed logic without a theory of classes and without class variables; in any case, very few logical systems lack such a theory. But once class variables are admitted, it becomes apparent that logic is also about classes. Now classes are typical ideal entities, the typical instance of what Thomists call "second intentions." Therefore, it seems that the actual state of logic lends considerable weight to the claim of logical idealism. *The object of logic appears as being at least partly different from that of traditional ontology.*

But perhaps this is not the whole story. Do *all* logical constants refer to or mean *exclusively* ideal entities? Such is surely the case of "Cls." But what about other constants? Can we say, for example, that the existential quantifier stands *only* for ideal existence, of the sort we attribute to numbers and to similars? It seems that this is not the case. The existence of which the logician speaks is a very, very abstract existence; it applies equally to real as well as to ideal entities.

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And perhaps this is what logic is about: a most abstract theory of objects whatsoever (where "whatsoever" is not restricted either to real or to ideal entities alone). It seems that this was Leibniz' doctrine, except that, instead of talking about ideal entities, he spoke about possible ones (which is, I submit, an error, for a class is not even a possible real entity). John of St. Thomas, a logician (it must be added, a rather modest logician) of the second neo-Thomism (seventeenth cent.), provided a better formulation of the same thought. According to him, the object of logic is *ens supertranscendentale*—that is, abstracted from both *ens reale* (real entities) and *ens rationis* (ideal entities). These formulations seem to derive strong support from the actual state of formal logic and from the refined techniques developed in that framework for philosophical use.

But if this is the case, what are the relations between logic and ontology? Two major conclusions were suggested: firstly, that their *method* is different; secondly, that their *object* is partly different. The force of this "partly" is that the object of ontology, real entities, is included in that of logic. Or, if one prefers, that while ontology as it is usually practiced is the most abstract theory of *real* entities, logic in its present state is the *general* ontology of both real and ideal entities.

The following view suggests itself. Ontology could be conceived as continuing the work done in logic. But *as it is*—and even a broadened ontology, which would include ideal entities as well—is a sort of prolegomenon to logic. It is a nonformal, intuitive inquiry into the basic properties and basic aspects of entities in general. Logic is the systematic, formal, axiomatic elaboration of this material predigested by ontology.

VIII

Up to now our first problem, the logical relations between logic and ontology, had primacy in our considerations, while the third problem, the various views about these relations, was treated in a subsidiary fashion. At this point, a few remarks may be added concerning the second problem: did the fact that a thinker held one sort of ontology have any *factual* influence on his acceptance and construction of a certain type of logic?

Several remarks can be made from a historical perspective. The first of these is that obviously every logician, at least every logician stating his logic as a theory, had to make a choice of some primitives. Whatever might have been the reason he did so, he thereby committed himself to a certain analysis of entities in general (that is, to a certain ontology).

Secondly, it must be confessed that in many cases these assumptions were made with little reflection. Logicians were so accustomed to this ontological analysis, carried by language and in constant and universal use, that often

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they did not reflect on it. They had no ontology, if ontology is conceived as a reflection on the structures of entities.

A third remark is that this was not always the case. A number of logicians *did* have a consciously formulated ontology and applied this with equal consciousness to the construction of their systems. The classical instance of this is that of Lukasiewicz, who began with a clearly ontological view and elaborated it in his trivalent logic. This is also quite clearly the case of Leibniz, whose ontological doctrines were decisive for his logic. The attitude of Heyting, who has built a formal logical system to express his intuitionistic views, may be considered as having more import for mathematics than for ontology. But cannot mathematics be viewed as a regional ontology? If so, Heyting's logic would be another case of a logical system which formalized and developed ontological insights. Last but not least, there is Leśniewski, whose strange "ontology" and "mereology" has been constructed to express his radically realistic views. In many cases, then, logic has been merely the technical elaboration of an ontology.

However, and this is the fourth remark, history provides us with a great number of cases in which thinkers holding different ontologies constructed similar, if not identical, systems of logic. There is, for example, a striking similarity between the logics developed by the Buddhists and the Nyāyayīkas. The same can be said of thinkers like Burleigh (an extreme Platonist, so it seems) and Buridan (an equally extreme nominalist, that is, ontological realist). Again, the logics of Church and of Quine are very similar indeed, although their authors hold different ontologies.

A closer inspection of the differences, say, between the Buddhists and the Nyāyayīkas or the medieval Platonists and the nominalists discloses that these differences consist principally in *existential* statements: while one school admitted a certain sort of entity, the other did not. On the contrary, the analysis of entities in their various aspects and of the most general properties of these entities, whatever they might be, seems to have been the same or very similar in rival ontologies. But, as we indicated above, ontology was traditionally conceived of as being the analysis of such aspects and properties —and not, at least primarily, as being a set of existential statements.

Our survey of the history of the Western problem of the relations between logic and ontology may be summarized as follows. This history begins with an ambiguous situation, due to the fact that Aristotle, the founder of both logic and ontology, left two very different logics. Subsequently and during the intervening twenty-four centuries, thinkers assumed that logic was of the first or "dialectical" type; the corresponding philosophies maintained, again almost without exception, the doctrine of a radical separation between logic and ontology. The rise of mathematical logic altered this situation. In opposition to the whole post-Aristotelian tradition, this new logic opted for the

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logic of the *Prior Analytics*. It also formulated the statements and systems of logic in a manner that was considerably more precise. In both respects it acted in favor of a rapprochement between the two disciplines, which had at no time in their previous history appeared to be so closely linked—if, at the same time, so much opposed as regards their respective methods.

NOTE

1. *Logical* nominalism should not be confused with *ontological* nominalism, in spite of the fact that they were often linked together. Logical nominalism holds that logic is about language; ontological nominalism argues that there are no ideal entities. Thus, an ontological nominalist need not be a logical nominalist. He can, for example, think that logic is about real (not only linguistic) entities. And a logical nominalist could, conceivably, admit that there are ideal entities and, consequently, he would not be an ontological nominalist.

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