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Logic and Formal Ontology: Is the Final Formal Ontology Possible?

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Abstract

Many philosophers and logicians have contemplated the relationship between ontology and logic. The author of this paper, working within a Bolzanoan-Husserlian tradition of studying both ontology and logic, considers ontology as the science of the most general features of beings and the most general relations among them. He considers logic as the science concerning the most general statements of all (natural or artificial) languages and the most general relations among them from an inferential point of view. It is possible to see logic in a broader sense as the science of all kinds of relations among all kinds of entities, acts, and processes stating some (objective, subjective, artificial, or conventional) reality. These entities, acts, and processes are not individual; rather, they are idealized, such that their universals may be instantiated at all times and in all places. In formal ontology we search for the properties of those structures of the reality that are formally similar. So we may find some formal truths applying to all things and/or properties and/or processes in different areas of objective/subjective/fictional reality.

Surveying briefly the most important relations of logic and ontology in both analytic and phenomenological traditions, the author focuses on this central point: If reality is one as the unity of more or less interconnected and interactive beings of all physical, nonphysical and artificial types, the system of inference too may be one as the unity of more or less interconnected statements of all natural and artificial types. The universal system of inference may be divided into several relatively separate subsystems (having a more or less degree of connection) just as the unified reality has divided into several relatively separate fields (having a more or less degree of connection

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and interaction). According to such a model for corresponding realities and sciences within the unified reality and the unified science, the author assumes the possibility of beginning to construct both the comprehensive system of reference and the comprehensive formal ontology, both covering all possible members of their own field and being parallel and correspondent to each other; a long-run work, of course, very difficult to do.

Keywords. logic, ontology, formal ontology, Hussrlian formal ontology, comprehensive system of inference

Introduction: Philosophy and Logic

Philosophy, regardless of its literal meaning as "love of wisdom" has had different meanings according to different philosophers in the history of philosophy all around the world. It is possible to accept a definition that seems to summarize some common conceptions of the word: "Philosophy is a study of problems which are ultimate, abstract and very general. These problems are concerned with the nature of existence, knowledge, morality, reason and human purpose" (Teichmann, and Evans, 1). In the fields of inquiry enumerated within the definition above, philosophers investigate systematically the principles and presuppositions involved.

It is possible to show that, according to the definition of philosophy, logic may be considered as a part of philosophy or, at least, connected with it as a science providing with sound argumentation in any field or subfield of philosophical inquiry. Logic, in its most repeated definition (being studied in philosophy, mathematics, and computer science) has been regarded as the study of reasoning, reasoning in turn being "the cognitive process of looking for reasons, beliefs, conclusions, actions or feelings" (Kirwin, 748). Collins English Dictionary gives definitions summarizing some famous conceptions of logic as "the branch of philosophy concerned with analysing the patterns of reasoning by which a conclusion is properly drawn from a set of premises, without reference to meaning or context," or "any particular formal system in which are defined axioms and rules of inference," as well as "the system and principles of reasoning used in a specific field of study," and, lastly, "the relationship and interdependence of a series of events, facts, etc."

(http://www.wordia.com/logic) These definitions remind us of different definitions given by both Western and Islamic philosophers.

Philosophers have studied logic, though they might have had diverse positions concerning the relation between philosophy and logic, form regarding logic as a tool of reasoning to regarding it essentially connected to both world and any knowledge of the world. Mathematicians have been interested in logic as the science studying of valid inference within a formal language. Studying the reasoning in different languages, from natural language to formal ones. Thus we inherited a variety of logics, metalogics, and theories of logics such as informal logic, formal logic, symbolic logic, mathematical logic, and philosophical logic, with their own richness in subjects.

As the inclusion of "the nature of existence" in the definition of philosophy shows, ontology (as the science of being/beings *qua* being/beings) is one of the most important parts of philosophy, for it studies the nature of, and basic categories of, being, or existence or reality in general. In ontology, one may treat the problem of existence of different possible or actual entities in different possible worlds and their possible or actual groupings in divisions and subdivisions in the framework of their commonalities and differences. Though pre-Socratic philosophers and Plato paid special attention to "being" or "existence," it was Aristotle who introduced ontology as an explicit discipline in his metaphysics as the knowledge dealing with both the different meanings of existence and that which is common to all existing things. As one may know, Ibn Sina placed ontology, as the study of existence as existence (or being as being), at the heart of Islamic philosophy in which the concept of existence is a more definite concept than it is in Platonic and Aristotelian Philosophy. Ibn Sina distinguished between necessity and contingency as a basic distinction between Pure Being (i.e. God's being) and the existence of all that is other than Pure Being, or, in other words, the distinction between the Necessary Being (*wājib al-wujūd*) and contingent being (*mumkin al-wujūd*) which relies on the Necessary Being (See, for example, Nasr and Amin Razavi, 70). Information scientists and computer scientists use "ontology" to refer to any description of a certain domain, reasoning about its properties, and formal representation of the knowledge using a set of concepts within that domain and the relationships between them. Gruber has explained

both the meaning and the rationale of the usage of the term: "An *ontology* is an explicit specification of a conceptualization. The term is borrowed from philosophy, where an ontology is a systematic account of Existence. For knowledge-based systems, what 'exists' is exactly that which can be represented" (Gruber, 2).

Various possible relationships between logic and ontology

Taking into account such a background, one may consider logic and ontology as two leading fields of philosophical inquiry in both its traditional and modern manifestations, having some interactions and overlaps in various problems. It has been an Aristotelian tradition to discuss some principles of logic in metaphysics, so that one may find comments on metaphysical treatments of logic in both *Metaphysics* and *Posterior Analytics*. In modern times, there have been various attitudes towards the relation between logic and ontology, varying from sharp distinction to essential interrelation. In his survey article on logic and ontology, Hofweber has tried to discuss some of the areas of overlap between the disciplines, despite the fact that "there is no single philosophical problem of the intersection of logic and ontology … because the philosophical disciplines of logic and of ontology are themselves quite diverse and there is thus the possibility of many points of intersection" (Hofweber 2004). His approach helps to make this discussion possible. In the beginning, Hofweber distinguishes between different philosophical matters that are covered by logic and ontology, to be able to discuss a selection of problems arising in the various areas of contact between them. History of philosophy shows that different philosophers, from Aristotle to Hegel and contemporary analytic and continental philosophers have used "logic" and "ontology" in different ways. Of course one will not be able to survey the history of the various concepts of logic and of ontology. Therefore Hofweber focuses "on the already very diverse debate in the more or less the twentieth-century English speaking philosophical tradition" (*ibid*).

According to Hofweber, one can distinguish four notions of logic:

- (L_1) the mathematical study of artificial formal languages

- (L_2) the study of formally valid inferences and logical consequence
- (L_3) the study of logical truths
- (L_4) the study of the general features, or form, of judgments

In (L_1), "logic is the study of certain mathematical properties of artificial, formal languages. It is concerned with such languages as the first or second order predicate calculus, modal logics, the lambda calculus, and categorical grammars" (*ibid*). Subdisciplines such as proof theory and model theory are responsible for studying the mathematical properties of these languages. Much of the work done in this area these days is mathematically difficult, and it might not be immediately obvious why this is considered a part of philosophy. The roots of logic in this sense are in philosophy and philosophical foundations of mathematics.

In (L_2), logic "deals with certain valid inferences and good reasoning based on them" (*ibid*). The validity of inferences arises from the formal characters of the inference itself, so that this validity, or the truth of the conclusion, is rooted in the truth of the premises. Accordingly, the notion of logical consequence is the main notion of logic in this sense.

In (L_3), often associated with Frege, logic is "the study of special truths, or facts: the logical truths, or facts" (*ibid*). The logical truths are the most general truths, being contained in any other body of truths described in any other science. Logic, in this sense, is both similar to physics or biology (since it searches for a certain body of truths), and different from them (because it is more general than them).

In (L_4), as a historically prominent conception, logic "is the study of the most general features of thoughts or judgments, or the form of thoughts or judgments" (*ibid*). In this sense, logic is concerned with such general features of judgments as the subject-predicate structure of them.

Now, one may treat the relation between these four different senses of logic. There are many ways for connections between any couple of (L_1), (L_2), (L_3), and (L_4), as well as many ways in which four conceptions are quite different. The relation between (L_1) and (L_2) is controversial, while (L_2) and (L_3) "seem to be closely related

because a logical truth can be understood as one that follows from an empty set of premises, … the relationship between (L_4) and (L_2) will in part depend on whether one thinks the logical constants themselves contribute to content … and the relationship between (L_1) and (L_4) either comes down to the same as that between (L_1) and (L_2), if we understand 'form of thought' analogous to 'form of representation.'"

Afterwards, Hofweber gives a good discussion of different meaning of ontology. Among the various conceptions, one may select four conceptions as follows:

- (O_1) the study of ontological commitment, i.e., what we or others are committed to,
- (O_2) the study of what there is,
- (O_3) the study of the most general features of what there is, and how the things there are relate to each other in the metaphysically most general ways,
- (O_4) the study of meta-ontology, i.e., saying what task it is that the discipline of ontology should aim to accomplish, if any, how the question it aims to answer should be understood, and with what methodology they can be answered.

The relationship between these conceptions of ontology seems rather straightforward. The second conception (O_4) is responsible for saying how the other three conceptions are to be understood. It seems that (O_1) entails that our beliefs commit us to a certain kind of entity; thus we must accept an answer to a question about what there is (i.e., O_2), otherwise we have to revise our beliefs. In the case of accepting the existence of an entity in (O_2), there would be questions in (O_3) concerning the nature of such an entity and its general relations to other things accepted by us.

Now, having the conceptions (L_1)-(L_4) for logic and the senses (O_1)-(O_4) for ontology, one may search for areas of overlap between these parts of philosophy. Hofweber shows the connection between formal languages and ontological commitment through meeting of (L_1) with (O_1) and (O_4), so that (L_1) is tied to (O_1) as one may find in Quine's explanation of ontological commitment the meta-ontological view based on it (See Quine 1948, van Inwagen 1998).

In meeting (L_2) with (O_2), one may ask that "is logic neutral about what there is?" One of the important cases of the ontological implications of logic is the logicist program "in the philosophy of mathematics, in particular Frege's conception of logical objects," believing that arithmetic is reducible to logic so that "numbers are objects whose existence is implied by arithmetic. …Thus logic implies the existence of certain objects, and numbers are among them. Frege's position has been criticized as being untenable since logic has to be neutral about what there is. Thus mathematics, or even a part thereof, can't be both logic and about objects."

Hofweber deduces Carnap's rejection of ontology from a meeting of (L_1) with (O_4) and assuming the end of (O_2). As we know, Carnap tried to relate formal languages, ontology, and meta-ontology. He argued that, in formulating theories, scientists must use some formal languages as frameworks having clearly defined relationship to empirical evidence. Of course, Carnap held that there was no one correct framework truly mirroring the world as it is in itself, so that any preference of one framework over another is a practical problem. (Carnap 1956b)

There would be a correspondence between the structure of thought and the structure of reality according to meeting (L_4) with (O_3), so that one may argue that "there is a striking similarity between the most general forms of thought and the most general features of what there is." Of course, one ought to give a plausible philosophical explanation for such a supposed correspondence between thoughts and the realities of the external world. Moreover, one must explain the "structural similarity between the general features of thought and the general features of reality." This has its special history, from Parmenides to Kant and Hegel.

Logic and Formal ontology

In information science, formal ontologies have been built through a variety of difficult attempts to conceptualize reality. Trying to get a view of reality independent from domain and application urges one to make use of axioms to define the structure of ontology and build a formal ontology. Using a specific comprehensive conception of ontology, such ontologies are established on some formal foundation

ontology (or upper-level ontology, or top-level ontology) that treats general concepts being the same across all domains. Such an ontology supports the broad semantic interoperability between many different ontologies falling "under" it. It may be considered as a hierarchy of entities and rules, that tries to describe the general entities belonging to all domains, providing consistency control for ontology, so that one would be able to keep away any wrong ontological assumptions in the process of modeling a large-scale ontology.

Here is place that we come to "formal ontology" through meeting (L_1) with (O_2) and (O_3) in Hofweber's article on logic and ontology: "The mathematical study of artificial formal languages" is applied to "the study of what there is" and "the study of the most general features of what there is, and how the things there are relate to each other in the metaphysically most general ways." Within such a conception of the term, a formal ontologist tries to give a mathematical theory of, or formulate mathematically the properties as well as the relations of, the entities in a domain, making use of proper axioms within a system of formal logic, like, for example, a form of the lambda calculus first order logic. Of course, formal ontologies are indifferent to what entities actually exist. No formal ontology comments on the certain things as the entities of a domain. They simply comment on the kinds of entities and their relations. It is the experience of reality that shows which entities there are. Hafweber sets forth three kinds of formal ontologies: representational (a framework representing information), descriptive (describing a certain domain of entities), and systematic (giving systematic theories of what there is, as well as relating all entities of a certain kind to each other).

Formal ontology was originated from a combination of logic and ontology. Historically speaking, the idea of formal ontology was brought about around the turn of twentieth century "in the work of Edmund Husserl. It coincides in many respects with … attempts to use formal methods to solve classical philosophical problems relating to the notions of being, object, state of affairs, existence, property, relation, universal, particular, substance, accident, part, boundary, measure, causality, and so on" (Poli and Simons, vii). Husserl was interested in formal treatment of the fundamental questions of ontology. He invented new tools of logic for use within this field of philosophical investigation. "Through Husserl's younger colleague,

Roman Ingarden, and in the light of related ideas of Lesniewski and other members of Lwow-Warsaw School, these ideas spread rapidly, particularly in the Polish scientific community" (Faye, Scheffler and Urchs, 11). Such a project may be seen as a long and ambitious one with its own peculiarities. "Formal ontology, then, is to result in a Leibnizian *characteristica universalis*, a great mirror, which will reflect all of the various existential, formal and material moments possessed by all of the various different kinds of beings which there are in the universe. Consideration of the history of formal ontology from the *Tractatus* through Carnap and Bermann to, say, Davidson and Cocchiarella, would raise, is whether the *logical* analysis of event/action discourse ought not to be recognised as having a methodologically secondary role in relation to the direct *ontological* analysis of events/actions as such. …The task of formal ontology, then, is to provide a formal logical language, a great mirror, which is sufficiently fine to reflect all of the distinctions which this laminated ontological space involves." (Smith 1978)

Surveying the history of formal ontology, it is possible to distinguish between main conceptions of the term used by leading authors. One may select two main interpretations among various ones: 1) analytic interpretation, "entirely in keeping with the mainstream of contemporary philosophy …as that branch of ontology which is analyzed within the framework of formal logic" (Poli 1993, 1), with Nino Cocchiarella as its leading exponent, who has written that "metaphysics ...--or what we might instead call formal ontology--is concerned with the study and development of alternative formalizations regarding the systematic co-ordination of all the 'modes' or 'categories of being' under the most general laws" (Cocchiarella, 30). According to this interpretation, formal ontology is the study of "the logical characteristics of predication and the various theories of universals;" 2) phenomenological interpretation, "developed from Husserl's early works, in particular *Logical investigations*" (Poli 1993, 1), mainly addressing, roughly speaking, the problems of parts and wholes and of dependence. "Despite their differences, these two varieties of formal ontology quite frequently overlap each other, although to date there has been no systematic study of the categories and layers that constitute formal ontology and no systematic analysis of the issues addressed by it" (Poli 1993, 2).

Kinds of Formal Ontology

In reflecting on the kinds of formal ontology, first of all "it is necessary to distinguish the use of the term 'formal ontology' on the part of analytic philosophical logicians such as Cocchiarella from Ingarden's use in [his] StEW [= *Der Streit um die Existenz der Welt*], even though there is a welcome overlap between the two sets of activities"(Smith 1978, n. 11). While is used in analytic philosophy implying the use of *formal methods,* Ingarden divided ontology into formal, existential, and material ontology, in accordance with the type of ontological moments on the side of the entities studied. Entities "may be *formal* (differences, e.g. between individual and higher-order objects, their properties and relations, and the states of affairs they co-constitute); *existential* (where we distinguish between various mode of being, e.g. real, ideal, or purely intentional being); or *material*, (a matter of temporality, causality, etc.)" (*ibid*). Although there is no incompatibility between these two approaches, it is clear that "the idea of a formal ontology is placed in a network of conceptual oppositions: it admits of different senses according to which of its two constituent elements is given priority. If the emphasis is placed on 'ontology' then the principal distinction is between 'formal' and 'material' (that is between 'formal ontology' and 'material ontology'); if instead the emphasis falls on 'formal', the contrast is between 'ontology' and 'logic' ('formal ontology' vs. 'formal logic'). This situation raises some important questions: When one speaks of 'ontology', how can its formal aspects be distinguished from its material ones? When we talk about the 'formal', how can we distinguish between logic and ontology?" (Poli and Simons, vii) Frege too has spoken (particularly in his "The Thought" ["Der Gedanke"]) of a 'realm of sense', a 'realm of reference', and even of a 'realm of word and sentence.'

Roberto Poli has distinguished three kinds of ontology: descriptive, formal and formalized ontology, each of which having two appearances: domain-dependent and domain-independent. A domain-dependent ontology deals categorically with closed regions of being, while a domain- independent ontology may be properly called general ontology. "Descriptive ontology concerns the collection of such prima facie information either in some specific domain of

analysis or in general [but] formal ontology distills, filters, codifies and organizes the results of descriptive ontology (in either its local or global setting). According to this interpretation, formal ontology is formal in the sense used by Husserl in his *Logical Investigations*. Being 'formal' in such a sense therefore means dealing with categories like *thing, process, matter, whole, part, and number*. These are pure categories that characterize aspects or types of reality and still *have nothing to do with the use of any specific formalism*" (Poli 2003, 184; Poli's italics). Poli recognizes that the similarity between two terms 'formal' and 'formalized' is not so fortunate. Therefore, he suggests that it may be better to use 'categorical' instead of 'formal'. Of course, despite their differences, these three levels or kinds of ontology are not separate. In many respects they affect each other. Descriptive findings may bear on formal categories; formalized outcomes may bear on their twin levels, etc. To set out the differences and the connections between the various ontological facets precisely is a most delicate task" (*ibid*, 5).

Husserlian Formal Ontology

Logic, ontology, and formal ontology are interconnected in most of Husserl's works. For Husserl, in some Bolzanoan tradition, logic is a theory of science, being concerned with meanings, with the associated acts that instantiate the meanings, and, particularly, with the collections of meanings constituting scientific theories.

Husserl's ontology has paid great and lasting attention to concepts or entities such as categories, numbers, manifolds, universals, and propositions. His Logical Investigations is an exemplary book, containing most of his ontological ideas. The ontology presented in it exhibits a conception of a formal discipline of ontology that is similar to formal logic. A formal discipline applies to all domains of entities, being independent of the peculiarities the fields of knowledge and, therefore, separate from "regional" or "material" disciplines which apply to specific domains of entities.

According to a Husserlian conception of logic and scientific theory, it is possible to have a scientific theory whenever there is "an appropriate unity and organization on the side of the objects (states of

affairs, properties) to which the relevant acts refer ... so that the unity which is characteristic of the]scientific theory[must involve both (1) an interconnection of truths (or of propositional meanings in general), and (2) an interconnection of the things to which these truths (and the associated cognitive acts) are directed" (Smith and Smith, 28). Comparing formal logic with formal ontology in the Husserlian treatment, it is clear that "where formal logic relates in the first place to meaning categories such as proposition, concept, subject and predicate, its sister discipline of formal ontology relates to object categories such as object and property, relation and relatum, manifold, part, whole, state of affairs, existence and so on" (ibid). Accordingly, in building up the structures there is a parallelism between the concepts of formal ontology and those of formal logic, so that the process of construction of a structure has its own laws. Such a parallelism between two kinds of concepts belonging to logic and ontology, and their being independent of any specific subject-matter, allow us to understand the properties of any given structure in accordance with the properties of all structures having similar forms. It is not surprising that Husserl would argue that "certain branches of mathematics are partial realizations of the idea of a formal ontology in this sense. The mathematical theory of manifolds as set forth by Riemann and developed by Grassmann, Hamilton, Lie, and Cantor, was to be a science of the essential types of possible object-domains of scientific theories, so that all actual object-domains would be specializations or singularizations of certain manifold-forms" (ibid, 29).

Having the kinds of formal ontology in mind, it is better to focus on the connections between the formal and material on the one hand, and the connections between the ontological and the logical on the other hand. In introducing his distinction between formal and material ontology, Husserl asserts that the former is descriptive and involves analytic a priori judgments, and that the latter involves synthetic a priori judgments. In its most general sense formal ontology concerns itself with characterizing the simple "something." Depending on how this "something" is conceived, Husserl adds, the "field of formal ontology should be the 'formal region' of the object in general" (*Formale und transzendentale* Logik 1929, art. 38)" (Poli 1993, 2).

Material ontology has two interpretations: the genetic interpretation, dealing with the field of perception and its foundations, and the descriptive interpretation in which material ontology is ontic, concerning "the highest material genera, i.e. the material categories in which single ontologies are rooted (Ideen zu einer reinen Phenomenologie 1913, vol. 1, art. 75). The sphere of material ontology in this sense is the laws of non-independence which delimit the ontological regions. For the genetic interpretation, material ontology precedes formal ontology; for the descriptive interpretation it is the other way round (1913, art. 10)" (ibid). Here is the place that we are encountered with the fundamental distinction between formal and material ontology, i.e., the distinction between analytic *a priori* and synthetic *a priori*.

Some remarks and elements of a dream for the final formal ontology

There is no satisfactory detailed explication and explanation of different dimensions of Husserlian formal ontology, particularly of the stratified connections between material ontology in the genetic interpretation, material ontology in the regional interpretation, and formal ontology. In making any distinction, one must recognize the separation between logic and ontology, not confusing characteristics of formal logic with those of formal ontology on the one hand, and the formal meanings of the concepts used with material ones. Moreover, it is necessary to clarify the elements and capacities of Husserlian formal ontology to reach a point appropriate for deciding on the possibility of a formal ontology capable of both covering all possible entities in all possible worlds and, at the same time, unifying all of them.

In founding a massive structure such as formal ontology, one must pay a particular attention to the relations of language, reality, knowledge, logic, and ontology with each other within a network of mutual and collective relations. Language, in its both natural and artificial forms, reflects the relations between some real (objective/subjective) or fictional entities through the words connected to each other in some statements, having their own relations in the framework of a formal logical system of inference. Logic, as a system

of inference through reasoning, finds or gives the rules of such an inferential relation among different appropriate sentences of a language. The truth of the sentences is the result of their contents or their being inferred from some previous true sentences, whereas only their forms share in inferential processes. Different natural sciences deal with different fields of the natural reality. Given that there are some nonphysical fields of reality (from, e.g., artificial to spiritual) there may be some nonphysical sciences dealing with those nonphysical fields. Because of some weak or strong connections and interactions among all fields of (physical and nonphysical) reality as the parts of the spectrum of the unified reality (from some possible relatively independence to some weak or strong dependence), all sciences must and can have some connections and interactions with each other directly or indirectly, individually or via some interdisciplinary science, in the network of some multidisciplinary science or in the space of some (coming) unified science or super-science. Such an approach towards ontology and logic sets up some correspondence between them. This correspondence is not a simplistic one in the framework of some picture theory (of truth or meaning). Logic as the science of inferential relations among true statements (and encompassing some more or less related studies too) is done by mental agents through some complicated processes that cognitive science must elucidate without being trapped by some superficial psychologism. Such a looking at language, logic, and truth makes the net-like collection of true statements independent of the knower and the judger, allowing to begin the construction of both the comprehensive system of reference and the comprehensive formal ontology, both being parallel and correspondent to each other.

Now, having a general topographical outline in mind, I mention some elements possessed by an ideal final formal ontology:

1. All facts from all sciences (in the broadest sense that may be possible) must be stated in natural language in the form of a number of (true or false) sentences.
2. The most comprehensive system of reasoning and inference relating the appropriate sentences in some hyper-science or ensemble of sciences must be constructed for deducing some conclusion.

3. The appropriate symbolic/artificial language must be constructed substituting for natural language; this symbolic/artificial language will have its own symbols/signs and its own grammar, such that two or more symbols/signs may be combined to make a sentence; such sentences have the potentiality to be substituted for natural sentences (being true or false) stating some fact of some science or super-science.
4. Every natural sentence of a typical educated man in every science has its own corresponding symbolic/artificial sentence in symbolic/artificial language in the framework of its own grammar.
5. Theories of sciences appear as a collection of (true/false) atomic and/or molecular sentences capable of being put in the form of symbolic sentences of logic and of entering into a logical reasoning.
6. The sentences of the sciences relate things and/or properties and/or processes while sentences of logic are the forms of those sentences of the sciences. The theories of the sciences relate a number of (contentful) sentences of the sciences, while the inference systems of logic relate a number of formal sentences.
7. The sciences written in symbols or signs have their theories in mathematical forms relating things and/or properties and/or processes through some contentful symbols or signs that may interact with each other in a mathematical procedure of reasoning and deducing.
8. Scientific sentences are sentences not about individuals but about universals, or about idealized singulars as representatives of many particular sentences, each of which being an example or extension of the idealized singular, such that the subject of the sentence (being objective or subjective or fictional) is not a particular thing or process but rather a natural kind.
9. It seems that both logic and ontology are to be considered *a priori* as long as they are formal. Entrance of empirical material-evidence makes them *a posteriori*. These two categories, namely *a priori* and *a posteriori*, render such evidence analytic and synthetic respectfully.

10. Sentences of the science are contentful, having their own empirical evidence as their contents. So they are synthetic (true or false) propositions. Only the forms deduced from the forms are *a priori* and analytic irrespective of their contents.
11. It is not possible to find the formal truths of formal ontology from experiences referring to the objective world.

Some Questions concerning the possibility of the final logic and the final formal ontology

1) Do the sentences in question appear in the logical system of reasoning formal and content-neutral?
2) What is the relation between formal sentences of logic and contentful sentences of sciences?
3) Is ontology contentful or devoid of content?
4) There are some rules for logical inference and there will be some other rules in the future. Are these rules arbitrary or they are law-governed. What are these possible laws? Are they arbitrary or natural-necessary? What about ontological relations?
5) Are all ontological sentences capable of being put into logical sentences?
6) Are we allowed to think that logic is the general system of inference of some new sentence (as conclusion) from some sentences (as premises) in a (natural/artificial) language, each sentence relating certain things and/or properties and/or processes (or relating certain signs as being capable of representing things and/or properties and/or processes) to each other?
7) Are we able to enumerate all possible sentences in a natural of artificial language relating different things and/or properties and/or processes?
8) If so, is it possible to consider it as abstraction of all types of the relations between all different things and/or properties and/or processes?
9) In formal ontology we may search for the properties of those structures that are formally similar. What are these structures? What is the meaning of "formally similar"? Is it

possible to find such structures and their properties? What will be the difference between formal sentences of logic and sentences of such formal ontology?

10) Are we entitled to regard mathematical reasoning as special case of general logical reasoning from a universal formal-ontological point of view?
11) Within the framework of parallelism of logic and ontology, is it plausible to regard both logic and formal ontology *a priori* in the same sense?
12) Are there formal truths of both logic and formal ontology? Does formalness cause them to be applied to all things and/or properties and/or processes?
13) Given that our formal ontology has been built, is it really *a priori*? It may be formal, but how have the formal truths of formal ontology been found?
14) Are we allowed to say that the possibility of achieving the most comprehensive symbolic system of inference is to be considered as achieving the *Logica Universalis*?

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