**This paper is dedicated to my
unforgettable friend
Boris Isaevich Lamdon**.

The Development of Laws of Formal Logic of Aristotle

The essence of formal logic

The aim of every science is to discover the laws that could explain one or another phenomenon. Once these laws are discovered, then science proceed to study the other phenomena, which in the nature are of an infinite set. It is interesting to note that in the process of discovering a law, for example in physics, people make thousands of experiments, build proves, among them some experience, or evidence - useful for understanding a certain phenomenon, but other experiments or evidence proved fruitless. But it is found only with hindsight, when the law is already discovered. Therefore, with the discovering of the law it is enough to show 2 - 3 experiments or prove to verify its correctness. All other experiments were the ways of study and there is no need to repeat them, to understand how the law works. In the exact sciences, it is understood, and therefore the students studies only the information that is necessary to understand specific phenomena. By no means this is the case with the study of formal logic.

Formal logic, as opposed to other sciences: physics, chemistry, mathematics, biology and so on, studies not an infinite number of phenomena in nature, but only one how a man thinks, how he learns the world surrounding us, and how people understand each other. In other words, what laws govern the logic of our thinking, i.e., our reasoning and judgments in any science or in everyday life.

By the beginning of XVIII century four laws of logic were formulated : the law of identity, Law of Contradiction, the Law of Excluded Middle and the Law of Sufficient Ground. The first three laws were formulated by Aristotle in the 4 th century BC, as the 4th law was introduced by Leibniz at the beginning of 18 century. So far for more than 300 years, none of the philosophers discovered neither the 5th or 6th law of formal logic. During this time, all the "discovery" of formal logic were limited only to it's distortion and confusion.

If to consider a formal logic of Aristotle from the point of view of its essence , then **its center of gravity is its Laws**, that were discovered by Aristotle, based on analysis of the different types of syllogism, which Aristotle classified to track down those Laws. In his research, the syllogisms played the same role as the experiments in physics or chemistry for the discovery of regularities, to explain the process of certain events. Once these logical laws of thinking have been discovered, the syllogisms have fulfilled their role. And it would be foolish to assume that our knowledge in any science, is built only on Aristotle's syllogisms or others discovered later. Whatever syllogisms would not have been discovered since Aristotle, none of them had added something new in the laws of formal logic revealed by Aristotle and Leibniz. But philosophers still continue to analyze Aristotle's syllogisms, a historic mission of which ended more than 2000 years ago. Moreover, after the discovering of 4th of law of formal logic, the law of sufficient ground , the legality of any syllogism is easy checked from the viewpoint of the four laws of

formal logic, because all our judgments and inferences must be obeyed to these laws, to be true. Bertrand Russell is the one who belongs to this category of the philosophers, who in his book "History of Western Philosophy", examining the formal logic of Aristotle, has continued to pick weaknesses in his syllogisms, rather than focus his attention on the importance of the laws of formal logic in the human knowledge and to point out to the incompleteness of their definitions.

Here he writes about the formal logic: "Aristotle's most important work in logic is the doctrine of the syllogism... Apart from such inferences as the above, Aristotle and his followers thought that all deductive inference, when strictly stated, is syllogistic. By setting forth all the valid kinds of syllogism, and setting out any suggested argument in syllogistic form, it should therefore be possible to avoid fallacies. This system was the beginning of formal logic, and , as such, was both important and admirable. But considered as the end, not the beginning, of formal logic, it is open to three kinds of criticism:(1) Formal defects within the system itself. (2) Over-estimation of the syllogism, as compared to other forms of deductive argument. (3) Over-estimation of deduct5ion as a form of argument." (Bertrand Russell, "A History of Western Philosophy", p196-197, published by Simon&Schuster)

As we see, in his chapter "Aristotle's Logic" he did not mention at all about the importance of three laws of formal logic discovered by Aristotle. As I said earlier, the power of formal logic is its common to all sciences, based on its four laws, rather than on different types of syllogism. Russell's misunderstanding of this fact led him to an underestimation and distortion of formal logic. Such a perversion, and was introduced by the famous philosopher, B. Russell, in formal logic, as shown by his following explanation to the 3rd position above: " All the important inferences outside logic and pure mathematics are inductive, not deductive; the only exceptions are law and theology, each of which derives its first principles from an unquestionable text, viz, the statute books or the scriptures" (p. 199)
And in another place he writes:"Valid syllogisms, in fact, are only some among valid deductions, and have no logical priority over others. The attempt to give pre-eminence to the syllogism in deduction misled philosophers as to the nature of mathematical reasoning. Kant, who perceived that mathematics is not syllogistic, inferred that it uses extra-logical principles, which, however, he supposed to be as certain as those of logic. He, like his predecessors, though in a different way, was misled by respect for Aristotle" (p.199)
Rather than to say that even outside of logic and pure mathematics, four of law of formal logic, without any doubt remained valid, he emphasizes on the syllogisms that do not constitute the essence of formal logic and for this reason are not general to all science. His misunderstanding of role of the laws of formal logic in human thinking is confirmed by his paradox with the notion of set. Let us show how this paradox violates the basic laws of formal logic.
The paradox of Russell in the original form is linked to the notion of set or class. But the whole world knows it in another interpretation. Russell proposed the following popular version of discovered him paradox of set theory. Suppose there is a town with just one male barber; and that every man in the town keeps himself clean-shaven: some by shaving themselves, some by attending the barber. It seems reasonable to imagine that the barber obeys the following rule: He shaves all and *only* those men in town who do *not* shave themselves. Under this scenario, we can ask the following question: Does the barber shave himself ? Asking this, however, we discover that the situation presented is in fact impossible:

If the barber does not shave himself, he must abide by the rule and shave himself.

If he does shave himself, according to the rule he will not shave himself.

In this paradox, all the men in town are divided into two categories : those who shave themselves, and those who do not shave themselves. And barber is in one of these categories (one sufficient ground) , as he is a man from the town. But on the other hand, the man identified as a barber (another sufficient ground) with the functions that are contrary to the first two categories or sufficient ground:
he shaves all and *only* those men in town who do *not* shave themselves. Thus barber is determined in two ways for both categories:(1) as a man who shave himself and (2) as a barber, who shave all and *only* those men in town who do *not* shave themselves; or (1) as a man who does not shave himself and (2) as a barber, who shave all and *only* those men in town who do *not* shave themselves. The paradox violated the laws of formal logic: the law of identity and the law of sufficient ground. Violation of the Law of Identity takes place by introducing into the paradox of the two sufficient grounds: town men and town barber. And if our assumptions have violated the basic laws of formal logic, the conclusions would be incorrect.

For example, imagine a foreigner with an excellent memory, who memorized 5000 English words, but he absolutely does not know the rules of the English language. Rather than to say: "Today I read an interesting book", he said: "I book today read an interesting ." This sentence does not make sense to anybody because it has no meaning. It is well known that in order to learn new language one has to know besides the words, all the rules of language, another words to be familiar with the laws of the language which one tries to learn. The same thing is in any science, including formal logic. But it does not mean that the English language does not always work or it is not powerful enough to express any idea, because the foreigner breaks the rule of the language. But based on the same logic philosophers come to the conclusion that the formal logic is not perfect , when confronted with logical paradoxes that violating the laws of formal logic .

It is interesting to note that Russell is aware of the presence in the paradox of two sets of definitions, which poses a problem. Russell's own answer to the puzzle came in the form of a "theory of types." The problem in the paradox, he reasoned, is that **we are confusing a description of sets of numbers with a description of sets of sets of numbers**. " - but he does not associate it with a violation of the law of Identity , not to mention about the law of Sufficient ground, because in this case there would be nothing to talk about and there would be nothing new to be discovered, because this problem has been resolved by Aristotle over 2000 years ago.

His critique of Aristotelean formal logic remind me the story about the curious man who visited Zoo and tried to pay attention to everything including tiny insects, but after his visit of Zoo, he started to boast about his knowledge of animals that he saw, and one of his listeners asked him did he see an elephant in the Zoo and he said that he did not noticed one.
As I have said early, to understand the importance of the law of sufficient ground in its aggregation it is necessary to understand very well the relationship of formal and dialectical logic, and Russell denied the existence of the latter: "Even if (as I myself believe) almost all of the teachings of Hegel is false, it is still important, which not only belongs to history, as it best represents a certain kind of philosophy, **which have other, less** coordinated and less than comprehensive." After this statement about the dialectical logic, and with such understanding of

formal logic, he can not be called not only as a great philosopher but even as a philosopher, because he did not introduce anything new to the development of formal logic of Aristotle, except of the distortion and perversion.

The connection between The Law of Identity and the Law of Sufficient Ground

Discovered, long time ago, the laws of formal logic, the law of Identity and the law of sufficient ground, are still interpreted with very limited understanding, as evidenced by their contemporary definitions, which is the reason for the existence, in a logical world, of confusion and doubts in existence of perfect formal logic to know the real world.

For Aristotle his logic is not a science, but an instrument (organon) of any science about inference and evidence. Thus four laws of formal logic are the basis of every science and of human reasoning. They are the most common laws of human thinking, but to be such, they should be formulated in a general form. For example, the first and most important law of logic - the law of Identity that Aristotle formulated in the treatise «Metaphysics» read as follows: «... to have more than one meaning - it means not to have any meaning, but if a word has no meaning, then any opportunity is lost to argue with each other, but in reality - and with himself, for it is impossible to think anything, if you do not think anything one ». In other words the law of identity states that all concepts, judgments, inferences must be defined uniquely and only on that condition they are meaningful.

But the law of identity in the form in which Aristotle formulated it, is not quite complete, because he does not say, **first, within what borders these unique concepts, judgments and conclusions remain valid - in other words, the limits of its application - and secondly, that all judgments and conclusions, defined uniquely, should be based on true facts, otherwise, all conclusions would be incorrect.**

The ancient philosophers took advantage of the first shortcoming of the law and created a series of logical paradoxes that supposedly showed the contradiction of formal logic, i.e. its imperfections. The essence of the paradox is that philosophers in their discussions managed to find a loophole and violate the law of identity described by Aristotle. For example, they determined the judgment as "the truth" in relation to one phenomenon and defined uniquely the same judgment as a "lie" in relation to the other phenomenon. The result is a contradictory conclusions. (A striking example is the Russell's paradox we discussed above).

A second drawback of the definition of the law of identity was noticed by Leibniz, who eliminated it in the 17 th century by discovering of the 4th law of formal logic: the law of sufficient ground. This law states that "not a single event can be valid, not a single statement can be truth without sufficient ground, why it is the case, and not otherwise."

This definition of the law given by Leibniz also is limited, because it only speaks of the real ground, on which claims are based to be valid, and it does not tell about the role of the sufficient ground as a limit, in which law of identity remains in force. But to refer to this property of sufficient ground it is necessary to be familiar with the dialectical logic, which at that time did not exist. In such form the law of sufficient grounds is interpreted and to this day. Currently, the law is as follows: "The true idea must be sufficiently substantiated" or "it is the law - a general logical principle, according to which a position is considered true only if it can be based on sufficient ground. " (Philosophical Dictionary, ed. Ivan T. Frolov. - 4 th izd.-M.: Politizdat, 1981. - 445 pp.).

Incomplete understanding of the law of sufficient ground by earlier and modern philosophers is

reflected in the simple fact that so far neither Aristotle's definition of Law of identity has not been amended to reflect its close relationship with the law of sufficient ground, nor the definition of the law of sufficient ground has not been amended to reflect its impact on the Law of Identity in terms of the limits of its applicability.

To eliminate all this shortcomings of the law of sufficient ground, we should formulate it as follows: **Law of Sufficient Ground must be not only true but also must be a qualitative basis, in relation to which concepts, judgments and inferences are defined uniquely.** As such, the Law includes, on the one hand, the definition given by Leibniz, on the other hand, it sets the boundaries of Law of Identity.

Taking this into consideration, the **law of Identity formulated as follows: All concepts, judgments and inferences that are used , should be identified uniquely in relation to the same qualitative ground.** As such, the Law includes, on the one hand, the definition given by Aristotle, but on the other hand, its direct relationship with the law of sufficient ground, which sets the boundaries of Law of Identity. Such a formulation of laws of formal logic makes it invulnerable to attack of the philosophers who believe it is not always perfect for a full disclosure of truth.

The Law of sufficient Ground and its role in science.

About how the law of identity and sufficient ground operate in discussions and in science, I explained in my articles "Mystery of Logical paradoxes solved", "Formal and Dialectical Logic as a unity of opposites or the development of classical philosophy", which the reader can find on the Internet, so I will not stop here on this issue.

To understand the laws of formal logic, in full volume, i.e. how they work in any science, can not be confined only to the formal logic, it is necessary to see a clear linkage between formal and dialectical logic, while many opponents of dialectical logic diminish or deny its importance, arguing that all the discoveries in science have been made on the basis of formal logic, without any assistance from the dialectical logic. Perversity of this claim just shows that many philosophers and scientists do not understand the simple fact, that formal logic includes in itself the most important element of dialectical logic: the law of sufficient ground. This is sufficient ground is a nothing more than a qualitative foundation on which we construct our knowledge with the help of formal logic, and qualitative foundation is the subject of dialectical logic in terms of its development. In other words, the dialectical logic shows us what the laws govern the development of qualitative ground and its transition into its opposite. But with help of the Laws of the formal logic we discover the content of this qualitative ground in any science.

The "development" of formal logic in the form of perversion

When Aristotle introduced the variables in his syllogisms then he wanted to emphasize the fact that his syllogisms are common to all the reflections in any science. And in this respect, it turns out that he was not completely correct. For example Russell writes: "The syllogism is only one kind of deductive argument. In mathematics, which is wholly deductive, syllogisms hardly ever occurs. Of course it would be possible to re-write mathematical arguments in syllogistic form, but this would be very artificial and would not make them any more cogent." (p.198) Thus, while Aristotle understood that formal logic is common to all sciences, but this fact he attributed to his

syllogisms but not to the laws of formal logic that were discovered on the basis of his analysis of these syllogisms.

But the introduction by Aristotle of variables in their ratiocinate is an initial point from which a little misinterpretation and perversion of logic of Aristotle began , although, on the other hand, it is the introduction of these variables that created a good preconditions for the emergence of other formal logics, which are the particular case of the formal logic of Aristotle.

Philosophers, based on these variables in syllogisms erroneously concluded that the logic of Aristotle is purely formal, since it deals only with the forms of the type if A is inherent in B , and B is inherent in C, then A is inherent in S. About this, the well-known Russian philosopher V.F. Asmus writes: "Aristotle - the founder of formal logic. He became as such as the result of his fundamental discovery. Exploring the structure of syllogism, he introduced letters instead of terms, i.e., introduced variables in the logic." In this comment Asmus admitted two mistakes. First, Aristotle became the founder of formal logic, not because he used the variables in their ratiocinate, but because on the basis of their study, he discovered three laws of formal logic. Secondly, he did not see, as all other philosophers, that the variables used by Aristotle, contain in themselves the content. When Aristotle said that A characteristic of B, he stressed the fact that the content in the form of A characteristic to the content in the form of B, regardless of in what form this statement stands. The predicate itself "inherent" refers to the essence of forms A and B. Let us take, as the example, a modern interpretation of the law of Identity . In the modern interpretation of the law symbolically is expressed as A is A or A = A. The shortcomings of such a formulation of the law of identity are evident under close consideration. First, in any language and in many sciences, there are words that have multiple values. For example in the Russian language, the word "matter" has two meanings, as the material world, or as a fabric. If we substitute A by the word "matter", then we get the matter is matter. But in this expression is not evident what kind of matter, we are referring to in the first and second instance. This expression reflects formally the equality of the concepts without their relationship to their content. And in this case, the law of Identity, as we see, is not reflected by this expression. The reader can do the same reasoning to the expression of A = A.

But if we use the word "inherent" instead of "is" or "=" in the terms, we address the above-described problem. A is inherent in A. If we replace A by word "matter", then we get matter is inherent in matter. In this case, regardless of what we mean by matter, its content should be inherent in matter, i.e. content in both "matter" must match, otherwise it is not inherent.

Since expansion of our knowledge comes from the new discoveries in science, then the same concepts in science can have several meanings depending on what grounds they are determined. For example, in geometry Euclid the sum of the angles of triangle equals to 180 degrees, in the geometry of Lobachevsky the sum of the angles of triangle is less than the sum of 180 degrees, and in geometry of Riemann the sum of the angles of triangle more than 180 degrees. Here's the difference in the contents of the same concepts, modern interpretation of the law of Identity A is A or A = A does not captures it. Indeed, if we say that "the sum of internal angles of triangle = the sum of internal angles of triangle ", the equality of statements in terms of their form, is obviously. But the content of the left hand side of equality may be 180 degrees, meanwhile the content in the right hand side of equality may be less than 180 degrees. Here we have obvious violation of the law of Identity, because, as I said earlier, this is a formal equality of terms that completely ignores their content.

Therefore, the modern interpretation of the law of Identity deprived concepts, judgments and inferences of their contents. Furthermore, under this approach, the formal logic of Aristotle lost its connection with the dialectical logic, because philosophers took away the contents from their concepts expressed in the variables. What kind of nonsense: form without content. In mathematical logic the expression "A = A" has a well-defined meaning, which no one disputes, but the expression loses its meaning outside of mathematical logic.

Conclusion

1. The essence of the formal logic of Aristotle is not in the analysis of classified him syllogisms, but in his discovery of 3 laws of formal logic, based on this analysis: the Law of Identity, Law of Contradiction, the Law of Excluded Middle. Leibniz developed the logic of Aristotle , by discovering the fourth law of sufficient grounds.
2. The Law of Contradiction and the Law Excluded Middle are the consequence of the law of identity.
3. The development of Formal logic of Aristotle is not to find other syllogisms, but rather to expand the content of the law of Identity and the Law of sufficient ground, based on an understanding of the relationship of formal logic of Aristotle and dialectical logic, discovered by me in my article "Formal and Dialectical Logic of unity opposites or development of classical philosophy. "
4. In the form in which I have formulated the Law of Identity and the Law of sufficient Ground, the classical formal logic gets its logical conclusion.

5. The modern interpretation of the law of Identity "A is A" or "A = A" is a gross distortion of the law of Identity , because it eliminates completely the content of the variables and brings a formal logic on the level of mathematical logic, to which was granted a superiority over formal logic of Aristotle. In an addendum to that, when the modern philosophers emphasize in the formal logic of Aristotle, on its syllogisms and not on its laws, they represent artificially classical formal logic as one of the possible forms of thinking, denying its common to all sciences, and thus creating a space for the "discovery" of other types of logic that are not only "successfully" can compete with the formal logic of Aristotle, but also to surpass it in the field of thinking.

ABSTRACT

By the beginning of XVIII century four laws of logic were formulated : the law of identity, Law of Contradiction, the Law of Excluded Middle and the Law of Sufficient Ground. The first three laws were formulated by Aristotle in the 4 th century BC, as the 4th law was introduced by Leibniz at the beginning of 18 century. So far for more than 300 years, none of the philosophers

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By doing this we eliminate in the formal logic those loopholes on which all existing paradoxes (in our daily life , physics, math and so on) are based.