The Logics of the Rational World

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Abstract

As long as the logic represents a rational activity then we can justify the idea that the development of some methodological problems supposes, in fact, an analysis of the language. In this way, through the different approaches of logics, are emphasized important moments in the understanding and using process specific to the argumentative course of action. It deals with some combination among the historical ways of approach, through which the use of the concept "logics" reminds of evaluations, reevaluations and contextual-scientifical delimitations. Therefore, to reflect on an idea of what argumentative discourse means, in effect requesting the validity of the communication act itself.

Keywords: *traditional logic, logical-mathematical formalism, paraconsistent logic, temporal logic, monotonous reasoning.*

Using a formal(ised) language determines simplicity, rigor and precision in the process of logical analysis. In fact, the formative role of logics resides exactly in the development of the critical dimension of thinking. Also, at the level of the argumentation strategies, the understanding activity represents a means by which the obtained results can be evaluated from both an objective and subjective point of view. Thus the understanding activity can neither be analyzed nor become concrete at the level of the discursive act in as much as one uses certain arguments which afterwards prove their usefulness. It has to do after all with transmitting and receiving the discursive content. Such a discourse is however, at an interpersonal level an argumentative one. In other words, it reminds of words and interpretations. Moreover, the argumentative discourse also sends to the descriptive-temporal dimension inciting sometimes even to some action. This aspect expresses the fact that an argumentative discourse represents an "instrument" through which some reasoning is conferred to a certain state of fact.

That is why, I think, and this idea can be supported that the argumentation in the concretization process itself pertains to the ways of using the language. In this way, the spiritual-social conditions favored throughout years the evolution of logics especially. The logic (at its primary stage and in a conceptual form differs from what we have today) becomes, thus, pragmatic, due exactly to those who "used" it in a certain historic context. Therefore, it is specific to this field to make reasonings. The conceptual elements within these arguments can be found among the thinkers from the Ancient Orient, those from Ancient Greece and Rome.

Gradually the traditional logic (characteristic to the ancient period) and that coming soon after (characteristic to the modern period) has not been sufficient to argument and explain certain ideas and theories that remind of the scientific practice. "The science revolution" determined an upside down of the old conceptions, but not always radically. The traditional problems are retaken and reanalyzed from totally different perspectives (inter-, multi- and even transdisciplinary). The idea of mathematical logic can be found again in the period when mathematics succeeds in developing itself due to the appearance of the infinitesimal calculation stressed out by Isaac Newton (1642-1727) and Gottfried Wilhem Leibniz (1646-1716). The coming up of the modern logic (the symbolical logic or mathematical logic as it is also called) finds its origin in the paper, "The Mathematical Analysis of Logic" (1847), by the Irish thinker George Boole (1815-1864) where logic is analyzed as a component of mathematics. At the same time, one should not forget, from this viewpoint the researches done by Augustus de Morgan (1806-1871), P.S. Poreţki (1846-1907) and John Venn (1834-1923)[1].

The new paradigms have generated the development of some formal logical systems. A situation of this kind which is promoted by a new type of logic can be found at thinkers such as Charles S. Peirce (1839-1914), Gotlob Frege (1848-1925)[2], Bertrand Russell (1872-1970) and Alfred North Whitehead (1861-1947). Of course one should not forget the role played by the thinker John Stuart Mill (1806-1873) at the development of logic with the paper, "A System of Logic" (1843). According to this thinker logic is conceived by relating to psychological aspects. Through this psychologism they tried to demonstrate that logic is subordinated to psychology.

As a reaction to this trend the logicism appeared (understood as antipsychologism) through which they tried to show that the psychological factors

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[1] These thinkers are considered the founders of *the algebra of logic*.
[2] Gotlob Frege tried to build an arithmetic axiomatically; he also succeeded in creating the first scientific system of propositional logic.

have no role in giving arguments and demonstrating some theories and problems specific to the formal logic. From this perspective, Edmund Husserl's phenomenological conception is relevant (1859-1938), according to which the theorems and the demonstrations of formal logic does not suppose at all the intervention of some psychical factors. In fact, this reaction belonging to Edmund Husserl is aimed at Christoph von Sigwart (1830-1904), German logician and philosopher who considered that logic has to have some psychological substantiation. However, in Edmund Husserl's case we can find some aspects through which the psychological elements are in correlation with the logical elements (specific to the mathematics of those times) when, for example, we can analyze the process through which one reaches the concept of "number".

Gradually we can see in the scientific research field the connection between mathematics and logic through the specific reasoning models [3]. An example in this case can be that of logical-mathematical formalisms through which the scientific theory can be explained and explicated in a certain research field (justifiable context). From this perspective many extensions of logic through some architectonics totally different from the classical one have been tried. "In old times people thought that there were fundamental laws of logic such as the principle of non-contradiction, the principle of the excluded tierce and the identity principle. Today different logics are built that do not follow these principles. The intuition logic does not follow the principle of the excluded tierce[4], the paraconsistent logic does not respect the contradiction principle and Schrödinger's logic does not obey

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[3] An argument that can be brought in support of this idea is the fact that as a result of modern researches it has been said that the logical operations are set within some mathematical structures. In this sense, it has been demonstrated that the propositional logic represents a Boolean algebra due to its algebra structures.

[4] In trivalent logic the excluded tierce principle is not valid and the existence of *the excluded quart principle* is admitted which can be formulated through $p \vee \overline{p} \vee \overline{\overline{p}} = 2$ ("2" represents the value of true along with the values „*0*"- false and „*1*"- undefined in the system of trivalent logic), in Nicolae Both, *The Algebra of Logic with Applications,* Dacia Publishing House, Cluj-Napoca, 1984; in fact *the excluded quart* principle(*quartum non datur)* has been formulated with the help of the "dubitative" functor (marked with D) by Clarence Irwing Lewis and C.H. Langford when they dealt with the analysis of Jan Lukasiewicz's modalities; also, in the context of appearance and development of *n*-valent logics the existence of *excluded quint principle* has also been proved (formed from the excluded tierce principle for false sentences and the excluded tierce principle for the true sentences) which in L_4 has the following form: $\lambda_1 x \cup \lambda_2 x \cup \lambda_3 x \cup \lambda_4 x = 1$ (in Grigore Moisil, *Încercări vechi şi noi de logică neclasică (Old and New Trials in the Neoclassical Logic),* Scientific Publishing House, Bucharest, 1965, p. 11, 168).

the identity principle"[5]. In this way, they realized that the logic of sentences can be used in the research of the brain (at the basis of this idea there seems to be "certain hypotheses obtained through abstraction from the neurophysiologic data"[6]) or technology ("In this way, with the help of the logic of sentences one can establish, for any series of connections in derivation, the conditions this series is permissible because we can reach a decision for all the logical-sentential expressions. The trials can be thus replaced by a logical calculation. Through it the problem of logical analysis of the relay and contacts circuits is solved"[7]). Therefore, a series of theoretical-abstract analyses can find a large practicability in a variety of scientific fields. There are known, regarding this problem the applications of the polyvalent logics in quantum mechanics. An example in this case is given by Paulette Février's applications in the case of W. Heisenberg's uncertainty relations through the construction of a trivalent logic. The relevance of the practicability of logic is visible in the case of the paraconsistent logic. The latter proved from the very beginning its usefulness in robotics, intelligent systems, medicine, air and urban traffic control etc. Another example of efficient use of the "new logic" is that where the accidents can be analyzed with the help of the formalization of temporal logic, using the logical operator "since"[8]. Moreover, from this point of view we can notice the introduction of temporal logic in the field of IT[9] too, when we try to check some programs and systems.

Still in the context of pragmatism that logic proves to have, we can mention, from this viewpoint its applications in the field of economy. Thus, through a coherent, logical attitude, the economic theory can be organized and systematized at the best level of functioning and understanding. Its applications can be found in different fields of economy. In this way, through logic we can support the idea of functionality of the economic system. As it is known, according to the principle of sufficient reasoning in order to accept or reject a sentence we must dispose of a sufficient (satisfactory) reason. Furthermore, formulating some economic theories supposes mentioning at a theoretical level some relations between different

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[5] Jean-Yves Béziau, "Teoria evaluării" (The Theory of Evaluation), in Newton da Costa, *Logici clasice şi neclasice (Classical and Neoclassical Logics)*, Technical Publishing House, Bucharest, 2004, p. 303.

[6] Georg Klaus, *Logica modernă (Modern Logic)*, Scientific and Encyclopedic Publishing House, Bucharest, 1977, p. 136.

[7] *Ibidem*, p. 148.

[8] http://profs.info.uaic.ro/~alaiba/club-i/index.php?title=Descoperirea_cauzei_erorilor_cu_logica_ temporal%C4%83 and http://www.rvs.uni-bielefeld.de/publications/Reports/FailTemLog.html, accessed in 29 August 2008.

[9] This problem was dealt by Amir Pnueli (n. 1941), An Israeli IT specialist, awarded with Turing Prize in 1996.

conceptual entities. It is visible in this situation the usefulness of a logic of relations in combination with a propositional logic where the existence of a logical implication of the kind: *"if p, then q"* is admitted. If there are two economic coordinates - the price[10] and the required quantity (demand)[11], then we can establish according to the principle of sufficient reasoning a relationship between the two coordinates that is, a specific relationship of causality. This relationship can be expressed through the formula: "If the price increases, the required quantity decreases". Furthermore, if there are the notations p= "the price increases" and q= "the required quantity decreases" then we can easily test (on the basis of the sufficient reasoning principle) the existence (or nonexistence) of the necessary condition, of the sufficient condition at the level of the two sentences, respectively. Applying the formulae from within the compound propositional logic, that is, the formula, "$(p \rightarrow q) \equiv (\sim q \rightarrow \sim p)$"[12] for the sufficient condition and the formula , "$(p \leftarrow q) \equiv (\sim p \rightarrow \sim q)$"[13] for the necessary condition   and,   after   we substitute the propositional variables with the (logical economic) in question sentences, that is using the formulae: "$(q \rightarrow p) \equiv (\sim p \rightarrow \sim q)$" [14] and, "$(q \leftarrow p) \equiv (\sim q \rightarrow \sim p)$"[15], we can easily notice that the hypothesis made from an economic standpoint can be sustainable (because of the sufficient reasons but the necessary ones are not admitted as being correct from a logical point of view). Hence, it is obvious that there is a pragmatic combination between the logic of principles, the logic of the compound sentences and the logic of relations. All these discoveries and applications have determined the researchers try classifications and divisions regarding the logic field.

A first difference that can be made is that relating to the number of logical values: the *bivalent logic* (which operates with only two values, true and false) - *polyvalent/multivalent/plurivalent logic/* (which introduces other values too, such as: absurd, undetermined etc). It is admitted that there are two forms of polyvalent logic that is the standard logic and the non-standard one. Thus, it has been

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[10] The price represents the quantity of currency given by the buyer to the seller in exchange of a good or service. In other words, it represents the value form of measuring a good or service.
[11] The demand represents the quantity from the goods that a consumer can acquire during some time depending on the price.
[12] The propositional formula "$(p \rightarrow q) \equiv (\sim q \rightarrow \sim p)$" is read: "*if p, then q*" which is equivalent with: "*if non-q, then non-p*".
[13] The propositional formula "$(p \leftarrow q) \equiv (\sim p \rightarrow \sim q)$" is read: "*only if p, then q* is equivalent with: *if non-p, then non-q*".
[14] The propositional formula "$(q \rightarrow p) \equiv (\sim p \rightarrow \sim q)$" is read: "*if q, then p* is equivalent with: *if non-p, then non-q*".
[15] The propositional formula "$(q \leftarrow p) \equiv (\sim q \rightarrow \sim p)$" is read: "*only if q, then p* is equivalent with *if non-q, then non-p*".

admitted that the mathematical logic is formed of a standard logic and a non standard one. In its turn the non-standard has in its structure the field of the modal logics and the field of the polyvalent logics. From this perspective, the existence of some new types of logic based on axiomatic systems caused an abandonment of the idea of some unitary logic based on bivalence (the way the standard logic functions).

Another distinction is the *traditional logic* and *the non-traditional one (deviated, applicable).* Among the traditional logics we can find the logic of sentences and the logic of predicates. Within the non-traditional logic we can place the multivalent logics (fuzzy logic[16], intuitive logic), the modal logics (deontic logic, epistemological logic, temporal logic etc), the logic of preferences, the operational logic, the paraconsistent logics (or "dialectical"), the topological logic[17].

A fourth distinction is *the monotonous logic- the unmonotonous one* (or *non-monotonous logic*[18]). Monotonous logics (traditional logic, multivalent logics, modal logics) are those through which a valid reasoning is formalized. The unmonotonous logic is the one which deals with the unmonotonous reasoning that is, that reasoning which supposes the derivation of some conclusions from incomplete premises. Robert C. Moore[19] identified within the unmonotonous reasoning (1983) the implicit reasoning (through which a plausible conclusion[20] is derived from incomplete or decisive premises) and the self-epistemic reasoning (which is analyzed by the epistemic logic).

Even if these distinctions are not sometimes very well established in the specialty works, we have to remember, however, the rational character that logic sets upon the scientific knowledge in general. Still, the appearance of such distinctions generated scientific courses of action more or less independent from

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[16] Fuzzy logic (or vague logic), defined by Lotfi A. Zadeh (1965) and turned into an axiom by Bas C. Van Fraasen is the one that uses a field of logic values in the interval [0, 1], in comparison with traditional logic which uses only two numerical values (0-for false and 1-for true) – (for example: the high numbers class represents a fuzzy group because its belonging function tends towards 1 as long as the numbers increase)

[17] Topological logic represents a system built by Hempel (1936) within which certain comparable values are used such as: "truer", "less true", "as true as" etc.

[18] Non monotonous logic is the one that has the property of being monotonous according to which if a conclusion results from a group of premises then from a better reason than the first the former results from a larger group of premises.

[19] Robert C. Moore, "Semantical considerations on non-monotonic logics", *Artificial Intelligence,* Volume 25, Issue 1, Elsevier Science Publisher Ltd.Essex, Uk, (January) 1985, pp. 75-94.

[20] Such an example can be the following phrase: "In the absence of an obvious reverse we suppose that a fish can swim".

the previous ones through which the performances of the logical have become concrete in the (inter)disciplinary applications. We deal with a logical-philosophical reflection on which *a logic of scientific research* was born. From this point of view, there are structures characteristic to the logical-scientific language and specific modalities of construction of those certain structures which are tackled. Therefore, the development of a new logic (a "new logic") determined the appearance of a new model of scientific construction through which the scientific theories have experienced approaches and explanations from totally different perspectives.

In these conditions, the communication as an intentional activity supposes a conventional character at the level of the interpersonal relations, meaning that the former is almost every time orientated towards the interlocutor. Thus, the argumentative discourse is built having the goal of persuading and sometimes even of manipulating. That is why the information which is transmitted and the linguistic structure of the formulations which form that certain information are very important. Consequently, an argumentative discourse aims at modifying, transforming the receiver's (receivers') certain inside moods.

Discursiveness in the process of (logical) argumentation must take into account a series of aspects connected to the used concepts, the definitions resulted with the help of these concepts, the analyzed theories (by resemblance and distinction), examples, quotations (which send to the argument of authority) etc. In fact, discursive argumentation is a specific form of substantiation. This aspect expresses the fact that the argumentative formulations many times are determined by certain interests and needs.

The argumentative performance has as a starting point a certain logical mechanism of the transmitted discourse. Still, the logical mechanism of this type of discourse depends on the discursive expressions from an argumentative process, too.

From this viewpoint, the argumentation act relates to the way in which an expression is pronounced. The moment an expression is pronounced the subjectivity (the human being) accomplishes three acts: "(1) a locutionary act (indicating a meaning and a reference), (2) an illocutionary act (transmitting a characteristic force, an act which makes the expression become formulation, promise, order etc. (3) a perlocutionary act (determining a psychological effect on the auditory: approval, satisfaction, fear etc)"[21]. Also, an important role in this

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[21] Petru Ioan, *Analiza logică a limbajului* (The Logic Analysis of Language), "Al. I. Cuza" University Press, Iaşi, 1973, p. 194.

mechanism is played by the logical operations where terms (notions) appear[22]. In this way, the argumentative performance supposes a discursive and coherent order through which some significance is given to the transmitted message. The fact that not always the logical order is synonymous with the linguistic order is interesting. This idea can be justified through the fact that the schematization of these two types of order can transmit distinct but void of meaning ideas. As long as there is still a general discursive schematization, then the transmitted message acquires significance sufficient for the receiver.

The argumentative performance represents, in fact, at an educational level a transaction, as a result of which the actors involved in this course of action have something to gain. An important aspect in this process is to know how to accept the compromise in order to turn it into an advantage. Consequently, a performance is done at different levels. The moment one tries to obtain performance the one who proposes to gain something as a result of this course of action usually sets within some limits: the maximum of performance and the minimum of performance. This can only become concrete as long as the logic not only becomes concrete, "but it is also a criterion on which we can and we must rely to support our ideas."[23]

Of course, an argumentative performance must take into consideration those aspects connected to critical thinking. In this sense, to study an argumentation by relating to its practical aspect supposes inoculating some understanding and habit to think critically[24]. Moreover, in a critical approach the problem that arises is that of discernment. Thus, the latter represents a feature of critical thinking which reminds of tolerance and self consciousness. Maybe not by chance the argumentative performance of a discourse relates to the problem of language as well.

As a result, understood as a complex system of signs, the language supposes in its structure the existence of two components: *the lexis/ the vocabulary* (which represents the total sum of signs specific to that certain language and has a dynamic character) and *the grammar* (that is the totality of rules referring to the way in which signs are used; grammar has in general a stable character). If certain

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[22] One can mention that in the specialty literature the analysis concentrates here on *a logic of terms*, there on *a logic of notions*; that is why we have preferred to specify in this context both formulations; however, in most logic works the term is understood as a word or a group of words through which a notion is expressed (the meaning itself of the term).

[23] Gheorghe Enescu, *Tratat de logică (Logic Treaty)*, LIDER Publishing House, Bucharest, 1997, p. 5.

[24] Drăgan Stoianovici and Ion Stepănescu, *Logică şi argumentare (Logic and Interpretation)*, Sigma Publishing House, Bucharest, 2001, p. 135.

criteria are followed then there are:

(1) The natural language (the language spoken by a certain nation, the behavioral language and the artificial language (the logical language, the mathematical language, the language specific to the traffic rules etc);

(2) The verbal language and the non-verbal language (the physical criterion);

(3) The first degree language/object language and the second degree language/ metalanguage (the meaning criterion);

Moreover, from a syntactical point of view, the structure of language is given by *categoremes*[25] (fundamental categories) and sin-*categoreme*s (auxiliary categories). Also, the language must reflect at the level of discursiveness a certain *sense (meaning)*, which participates in its turn in forming *the sign.* In conclusion, the study of the theory of logic supposes some relating to *a natural logic*, through which the world is getting more beautiful and wiser. Thus, the capacity to understand the objective (and physical) reality generates some argumentative architectonics meant to justify the charm of such full of mystery world. The idea of logical analysis reminds implicitly of the idea of conceptual meaning.

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[25] From the category of categoremes we can find: terms and sentences.

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