ARISTOTELIAN PREMISES OF MODERN INDUCTION

TEODOR DIMA

For over 2 000 years each generation of philosophers has felt Aristotle to be their contemporary, which is why the references to his work, either critical or evaluative, have been continuous and contributed to the increase of its luminousness. The history of philosophy is not "a collection of accidental events … but, in the movement of the thinking spirit, there is essentially a coherent connection".[1] This Hegelian assertion is fully sustainable in connection with logic, whose history explains its present set of issues. Although logic is one of the systematic sciences, it is all same always interested in its own past. The past "illuminates and makes the present clear, and many of the achievements of the past have a certain value for the *present"*.[2] Besides, the perennial value of certain works belonging to the scientific heritage of logic is due to the fact that they were devised in a spirit of *positivity,* typical of the scientific constructions. Thus, the millennial interest in the *Organon* is due to the fact that "Aristotle analysed the forms of logical thinking like a modern scholar who would study the way in which the human organism works. He studied the *real* and *essential* way in which conceptual thinking operates".[3] For instance, the mechanism of the syllogism is analysed in itself, as a mechanism that starts in the moment the premises form the sufficient condition for necessarily obtaining the conclusion. As far as *induction* is concerned, although Socrates worked inductively when he employed, every so often, his "midwifery art" (*Maieutic*), "the art by which truth is born", Aristotle was nevertheless the first to theorise some elements of induction in Book V of the *Organon,* ***Topics.***

Induction means "to put together", and Aristotle himself formulated such an initial definition of induction. "Induction, or rather inductive syllogism, consists in the syllogistic establishment of a relation between one extreme term and one medium term with the aid of the other extreme term; for instance, if *M* is the medium term between *P* and *S,* through *S* it is proved that *P* belongs to *M*. This is the method by which induction is achieved".[4] Mircea Florian, the translator of the *Organon* into Romanian, noted that induction is also supported by the syllogistic operation; the process of inductive knowledge is the opposite of the deductive process, but both processes use syllogism with the difference … that the inductive

[1] G.W.F. Hegel, translated into Romanian, *Lectures of History of Philosophy,* Vol. I, Ed. Academiei, Bucharest, 1963, p. 29.

[2] Athanase Joja, *Studies of Logic,* vol. II, Ed. Academiei, 1966 (in Romanian), p. 126.

[3] *Ibidem.*

[4] Aristotle, *Prior Analytics,* II, 23, 68b.

syllogism establishes a relation between the major (*P*) and the medium (*M*) through the minor (*S*), while the deductive syllogism links the major (*P*) and minor (*S*) with the aid of the medium term (*M*).

In our opinion, Aristotle observed here a formal difference between deduction and induction. In the deductive inferences, the conclusion certainly derives from the premises. In the case of induction, the procedure is the derivation of a premise from the conclusion plus the other premise. We have proposed that the inferences thus constructed should be called *reductive,* and the procedure should be called *reduction,* opposed in logical terms to *deduction*.[5] The example given by Aristotle entitles us to support the implicit anticipation in *Prior Analytics*. "Let us mark "long life" *P,* "gallless life" *M,* and various animals with long life *S*: "people, horse, mule".[6]

People, horse and mule (S) *have long life* (P).
Gallless animals (M) *are people, horse and mule* (S).
∴ Gallless animals (M) *have long life* (P).

This "inductive syllogism" is in fact the *reduction* of the "syllogistic" *approach,* later called *Barbara*; it was obtained by the transposition of the conclusion in the place of the major premise, which thus became conclusion, and the simple conversion/transformation of the minor premise:

The gallless animals (M) *have long life* (P).
People, horse and mule (S) *are gullless animals* (M).
∴ People, horse and mule (S) *have long life* (P).

Generally, it may be said that reduction is a logical procedure of constituting *probable inferences with assertive premises* on the basis of deductive inferences. In the reductive inferences the conclusion does not derive from premises with logical necessity. On this account, the negation of a conclusion obtained by reduction is compatible with the conjunction of the premises. On the contrary, in the case of deduction the concomitant assertion of the premises and the negation of the conclusion brings about a contradiction; a very simple proof is *the demonstration by reduction to the absurd* of the accuracy of syllogistic approaches. We consider that, although the truth of the premises in the reductive inferences does not necessarilly imply the truth of the conclusion in logical terms, it nonetheless foregrounds the acceptance of the conclusion *in all probability*. Because the

[5] W.St. Jerons (in *Elementary Lessons in Logic,* London, 1870) and Chr. Sigwart (in *Logik,* Tubingen, 1873–1878) remarked, independently from each other, that induction is a form of *reductive inference.* We have enlarged on this idea in *Controversies on Induction,* in *Trends in Contemporary Logic,* Ed. Ştiinţifică, Bucharest, 1975 (in Romanian); *General Logic,* Ed. Didactică şi Pedagogică, Bucharest, 1991 (in Romanian), pp. 190–191.

[6] Aristotle, *op. cit.,* II, 23, 68b.

inductive inferences have assertive premises and probable conclusions they can be considered as reductive inferences; from this point of view, induction is opposed to deduction.

We point to the fact that there are inferences with probable conclusion that do not have a reductive form, the truth value of the conclusion depending on the quality of the information contained in the premises; if this is not sufficient, then the conclusion will result with chances of probability. Aristotle himself built *syllogisms* (*i.e.* deductive inferences) *of probability,* in which at least one of the conclusions is not assertive.[7] Nowadays, the modal logic and the probability theory are theories built deductively. In other words, a deductive inference can have a probable conclusion obtained deductively, because probability is transmitted by premises.

The induction described by Aristotle in *Prior Analytics,* commented above, entered the modern treatises of logic by the name of *complete* or *totalising, formal induction,* as it was considered to meet Aristotle's wish of granting it a generalising and demonstrative status. Yet we have observed that, obtained by means of reduction, Aristotle's construction has a probable conclusion. Still, its demonstrative character results from the fact that it can be ordered in the form of a *syllogism* with a premise that is the conjunction of some simple and singular sentences and another premise exclusive in the subject, which leads to a universal conclusion, syllogistically obtained by Figure III (*Darapta*), the rule that provides that only particular conclusions be drawn by Figure III being altered. This calls for the following conditions:

1) the multitude that forms the minor term (S) should contain a finite (and not very big) number of elements;
2) when the argument is formulated each element of the multitude should be analysed, checking if the elements are characterised by the feature rendered by the medium term (M);
3) it should be checked if the whole class made up by the enumerated and analysed elements displays that feature.

The inferential structure below thus results:

$M_1, M_2, \ldots, M_n$ are P
$M_1, M_2, \ldots, M_n$, and not only they, are S
:. All S are P.

For instance:

[7] *Ibidem,* I, 8–22, 29b–40b. A detailed approach in Romanian of the Aristotelian modal syllogism was achieved by Ion Didilescu in Ion Didilescu, Petre Botezatu, *The Science of Syllogism. Classic Theory and Modern Interpretations,* Ed. Didactică şi Pedagogică, Bucharest, 1976 (in Romanian), pp. 164–210. In the same paper Petre Botezatu referred to *the modern modal syllogistic science,* pp. 414–423.

Fluorine, chlorine, bromine and iodine occur in nature only as compounds.
Fluorine, chlorine and iodine, and not only they, are halogens.
:. All the halogens occur in nature only as compounds.

The conditions enunciated above are meant to specify Edmond Goblot's formulation: "With a view to knowing that all planets move around the Sun in the same sense and describe ellipsoidal orbits, each of them need have been observed. The same routine is necessary if we wish to find out if all metals let heat and electricity run through them".[8]

Full/complete induction is an inference that makes the transition from deduction to induction. It is used in science to determine *the intermediary laws,* characterised by medium generality, which unite several species in a genus/group, *e.g.* the halogens, the 2nd degrees curves, etc. In mathematics, full induction is used whenever the general case cannot be demonstrated at one go and has to be broken into several particular cases: the area of the triangle (three cases: the sharp-angled, rectangular and obtuse triangle), the size of the angle framed in the circle (three positions: the centre of the circle between the sides of the angle, on one of the sides, beyond the sides), etc. If the theorem holds true for each particular case, then it is true for the general case.

In ***Topics,*** Aristotle formulated a second sense of induction: "… proceeding from the particular/individual (case) to the general (case); for instance, if the best pilot is the best in his profession and the same is true about the coachman, then the best in general is the one who is skillful in his profession".[9]

This example can be expressed either by *an immediate inference by subordination,* or by the *Barbara* syllogistic approach, both operations being carried out by reduction, and therefore leading to probable conclusions; by subordination, Aristotle reasoned so:

Some people (the pilot, the coachman) who are very good in their field are also the most skilled.
:. Probably the people who are very good in their field are also the most skilled;

Syllogistically, we can reconstitute the example given by Aristotle as follows:

This pilot, this coachman … are very skilled people.
This pilot, this coachman … are very good in their field.
:. Probably all those who are very good in their field are also the most skilled.

The correct syllogism would be the *Darii* approach in Figure I:

[8] Edmond Goblot, *Traité de logique,* Armand Colin, Paris, 1920, p. 288.
[9] Aristotle, *Topics,* I, 12, 105a.

All those who are very good in their field are also very skilled.
Some people are very good in their field.
∴ Some people are very skilled.

In other words, Aristotle obtained the universal conclusion by replacing the major premise of the *Darii* approach with the conclusion. Hence its probable character; this Aristotelian inductive inferential structure has been called *incomplete:*

S_1, S_2 ... possess *P*
S_1, S_2 ... belong to *M*
∴ Probably *M* possesses *P.*

The premise of this inference are conjunctions of singular statements that assert about each *S* that it possesses *P,* and thus belongs to *M,* reaching universal generalisation on the research of a small number of cases. This Aristotelian boldness led Francis Bacon to a justified critique: the Aristotelian incomplete Induction produces *reckless generalisations* "… from the data of the senses and the particular facts to the most general statements".[10]

In other words, incomplete induction inflames imagination instead of working methodically, cautiously, *per gradus debitos.*

We consider that, in this instance, Aristotle had two aspects of induction in view: not only did he attribute one particular/individual characteristic to all the elements of a category, but he also correlated two characteristics that work together with several individuals. Thus the idea of the possibility of establishing connections among phenomena was expressed by the fact that these possess similar characteristics. About this kind of induction Aristotle used to say that it goes from the known to the unknown. At the beginning of the 19th century W.E. Johnson[11] picked on Aristotle's idea, considering that the incomplete induction is *problematic* and, by the fact that a characteristic is stated about the unknown members of a multitude, it helps us to conclude that that particular characteristic can be stated to be true about the unknown members of the class, too.

Along with Peirce,[12] Lalande[13] and Kneale,[14] we shall call the incomplete induction "amplifying", making it clear that its syllogistic structure breaks the general law of the correct syllogisms: *Of two particular statements no certain conclusion can result.* The resulting conclusion stands chances to increase its probability by several means. We shall refer to the *scientific induction.*

[10] Fr. Bacon, *Novum Organum,* I, 19.
[11] W.E. Johnson, *Logic,* vol. II, ch. IX, para. 1.
[12] Peirce, *Collected Papers of Charles Sanders Peirce,* Cambridge, 1931–5, *apud* von Wright, *The Logical Problem of Induction,* Oxford, 1965, p. 9.
[13] A. Lalande, *Les théories de l'induction et l'expérimentation,* Paris, 1929, p. 6.
[14] W. Kneale, *Probability and Induction,* Oxford, 1949, p. 44.

When the inductive inference its based on a necessary characteristic the major premise becomes an apodictic statement:

S_1 *necessarily possesses* P
S_1 *belongs to* M
∴ M *probably possesses* P.

The conclusion is still probable because the characteristic may necessarily belong to an object or a class of objects, and yet not belong to the including class if this class is a larger extension. For instance,

This analysed copper piece lets electricity run through it.
This piece of copper belongs to the class of metals.
∴ Probably all the metals let electricity run through them.

Thus, amplified induction does not stay for ever within the limits of the probable and, throughout the centuries, Rudolf Carnap would consider that ”the inductive probability can be interpreted as partial deductibility”.[15] Aristotle had also had the intuition of the necessity of incomplete induction. It was conceived as “a condensation of experience … elaborated and scholarly, which explicitly states …”.[16] The scientific induction is used to foretell future events. Thus, modern induction was conceived as a *strategy* of formulating the suppositions about the unknown. So the *use of induction* is *justified.* “Induction continues to face “the dilemma. On the one hand, we notice that the inductive reasoning is used by the scholar and by the average man without apparent scruples; and we have the feeling that it is valid and indispensable. On the other hand, Hume appealed to our intellectual conscience, and we find an answer to his objection. Who is right, the common sense people or the critic pholosopher? W have seen that both are partly right”.[17]

[15] R. Carnap, *Inductive Logik und Wahrncheinlichkeit,* Wien, 1958, p. 8, apud G. Vlăduțescu, *Aristotle's Experience and Induction,* Ed. Ştiințifică şi Enciclopedică, 1975 (in Romanian), p. 83.
[16] Léon Robin, *Aristotle,* p. 58, *apud* G. Vlăduțescu, *op. cit.,* p. 84.
[17] R. Carnap, *The Aim of Inductive Logic* in *Logic, Methodology and Philosophy of Science,* Standford, University Press, 1962.