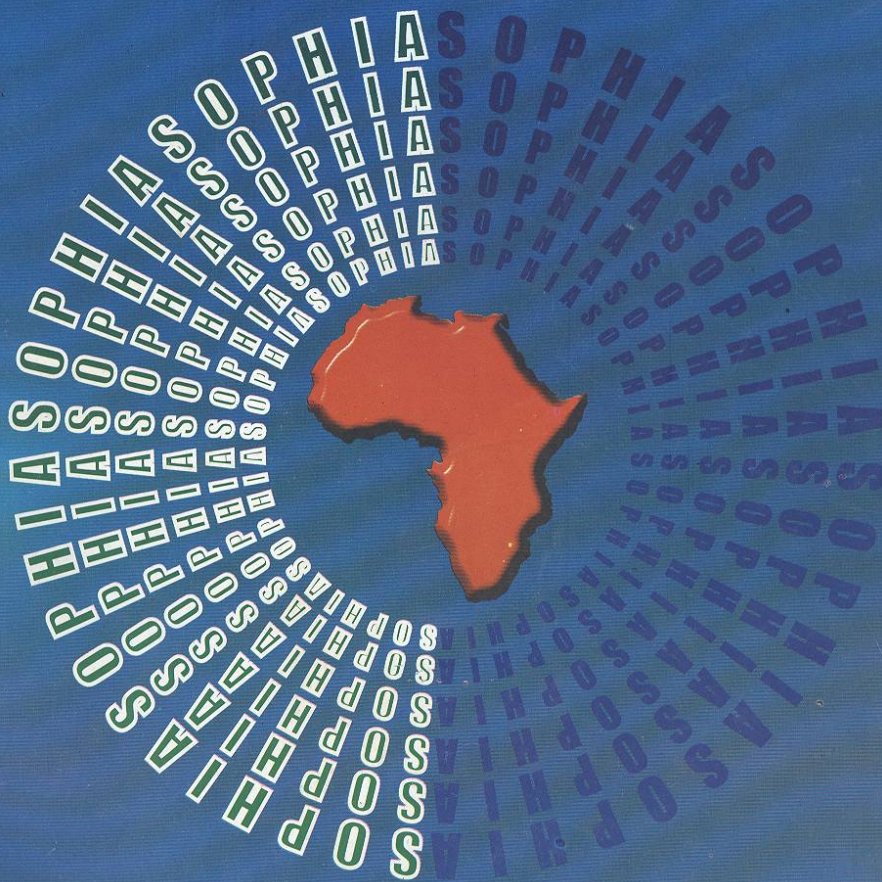


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AN EVALUATION OF "INDUCTIVISM" AS THE HALLMARK OF SCIENCE

By

I. A. P. Wogu (Ph.D Candidate)

Abstract.

Popper has argued that a scientific idea can never be proven true, because no matter how many observations seem to agree with it, it may still be wrong. On the other hand, a single contrary experiment can prove a theory forever false. No observation or experiment, however extended, can give more than a finite number of repetitions; therefore, 'the statement of a law - B depends on A - always transcends experience. Yet this kind of statement is made everywhere and all the time, and sometimes from scanty material. This in poppers opinion can only bread conjectures and refutations. Some writers on the other hand, have maintained that induction by enumeration is essential in the empirical test of the lowest-level consequences of scientific theories, since it occurs in the drawing of "conclusions" from the examination of empirical evidence. But it is also held that the empirical test is insufficient, and must be supplemented with theorification, or the expansion of isolated hypotheses into theories. To this end, the place of induction in the framing and test of scientific hypotheses is investigated in this paper. Although the existence of an inductive method is disclaimed, it is maintained that the various patterns of plausible reasoning (inductive inference included) are worth being investigated. I among other things, will argue and submit that scientific research follows neither the advice of inductivism nor the injunction of deductivism, but takes a middle course in which induction is instrumental both heuristically and methodologically, although the over-all pattern of research is hypothetico-deductive. As such, I submit that writers who claim that "induction" is the "hallmark" of science should give their claims a second thought.

Introduction

The **problem of induction** is the philosophical question of whether inductive reasoning is valid. That is, what is the justification for either:

1. Generalizing about the properties of a class of objects based on some number of observations of particular instances of that class (for example, the inference that "all swans we have seen are white, and therefore all swans are white," before the discovery of black swans); or
2. Presupposing that a sequence of events in the future will occur as it always has in the past (for example that the laws of physics will hold as they have always been observed to hold)?

The problem calls into question all empirical claims made in everyday life or through the scientific method. Although the problem dates back to the Pyrrhonism of ancient philosophy, David Hume introduced it in the mid-18th century, with the most notable response provided by Karl Popper two centuries later.

Formulation of the Problem

In inductive reasoning, one makes a series of observations and infers a new claim based on them. For instance, from a series of observations that at sea-level (approximately 14psi) samples of water freeze at 0°C (32°F), it seems valid to infer that the next sample of water will do the same, or, in general, at sea-level water freezes at 0°C. That the next sample of water freezes under those conditions merely adds to the series of observations. First, it is not certain, regardless of the number of observations, that water always freezes at 0°C at sea-level. To be certain, it must be known that the law of nature is immutable. Second, the observations themselves do not establish the validity of inductive reasoning, except inductively. In other words,

observations that inductive reasoning has worked in the past do not ensure that it will always work. This second problem is the problem of induction.

The problem of induction has been so much talked about and written about by generation after generation of philosophers in the empiricist tradition that many of them are by now understandably fed up with the subject. I therefore find it ridiculing when some group of scientist led by Magee, claim that this problematic method of reasoning should be accepted as the "Hallmark" of science. This paper therefore is a critique of the position which Magee, B alongside some other contemporary thinkers took when they held that induction is the Hallmark of science.

In order to make lighter the task of examining yet another attempt at "a solution" of the problem in focus, and considering that there is in the literature, no lack of good expositions of the problem and critical surveys of proposed solutions (e.g. Black "The Problem of Inductism" Choice and Chance "Unfinished Business") and Salmon. I will go straight to the point. I will start by giving with no justification, my own formulation of the problem; I trust its correctness and my reasons for adopting it will become clear in the exposition that will follow. The place of induction in the framing and test of scientific hypotheses shall be carefully investigated. The meaning of 'induction' will also be equated with generalization on the basis of case examination. Two kinds of induction are then distinguished. All will be with the view to showing with proofs, the place of induction in any scientific enquiry. Hopefully, the conclusion we will arrive at in the end of the paper shall be indicative of the rightful place of induction as a method in the field of science.

But before all these, the need to give a background to the evolution of the problem of induction becomes very pertinent to this paper. We shall do so by looking at the ancient origin of the problem. After this we shall look at the attempts that have been made to justify the problem. We will then spend the rest of our time on the subject of this paper.

Ancient Origins of the Problem of Induction

Pyrrhonian skeptic Sextus Empiricus first questioned induction, reasoning that a universal rule could not be established from an incomplete set of particular instances. He wrote:

"...When they propose to establish the universal from the particulars by means of induction, they will affect this by a review of either all or some of the particulars. But if they review some, the induction will be insecure, since some of the particulars omitted in the induction may contravene the universal; while if they are to review all, they will be toiling at the impossible, since the particulars are infinite and indefinite" (283).

The focus upon the gap between the premises and conclusion present in the above passage appears different from Hume's focus upon the circular reasoning of induction. However, Weintraub claims in *The Philosophical Quarterly* (460 -470) that although Sextus' approach to the problem appears different, Hume's approach was actually an application of another argument raised by Sextus(179):

Those who claim for themselves to judge the truth are bound to possess a criterion of truth. This criterion, then, either is without a judge's approval or has been approved. But if it is without approval, whence comes it that it is truth worthy? For no matter of dispute is to be trusted without judging. And, if it has been approved, that which approves it, in turn, either has been approved or has not been approved, and so on *ad infinitum*.

Although the criterion argument applies to both deduction and induction, Weintraub believes that Sextus' argument "is precisely the strategy Hume invokes against induction: it cannot be justified, because the purported justification, being inductive, is circular." She concludes that "Hume's most important legacy is the supposition that the justification of induction is not analogous to that of deduction." She ends with a discussion of Hume's implicit sanction of the validity of deduction, which Hume describes as intuitive in a manner analogous to modern foundationalism.

David Hume on induction

David Hume described the problem in "*An Enquiry concerning Human Understanding*," based on his epistemological framework. Here, "reason" refers to deductive reasoning and "induction" refers to inductive reasoning.

First, Hume ponders the discovery of causal relations, which forms the basis for what he refers to as "matters of fact." He argues that causal relations are found not by reason, but by induction. This is because for any cause, multiple effects are conceivable, and the actual effect cannot be determined by reasoning about the cause; instead, one must observe occurrences of the causal relation to discover that it holds. For example, when one thinks of "a billiard ball moving in a straight line toward another, one can conceive that the first ball bounces back with the second ball remaining at rest, the first ball stops and the second ball moves, or the first ball jumps over the second, etc. There is no reason to conclude any of these possibilities over the others. Only through previous observation can it be predicted, inductively, what will actually happen with the balls. In general, it is not necessary that causal relation in the future resemble causal relations in the past, as it is always conceivable otherwise; for Hume, this is because the negation of the claim does not lead to a contradiction.

Next, Hume ponders the justification of induction. If all matters of fact are based on causal relations, and all causal relations are found by induction, then induction must be shown to be valid somehow. He uses the fact that induction assumes a valid connection between the proposition "I have found that such an object has always been attended with such an effect" and the proposition "I foresee that other objects which are in appearance similar will be attended with similar effects. One connects these two propositions not by reason, but by induction. This claim is supported by the same reasoning as that for causal relations above, and by the observation that even rationally inexperienced or inferior people can infer, for example, that touching fire causes pain. Hume challenges other philosophers to come up with a (deductive) reason for the connection. If he is right, then the justification of induction can be only inductive. But this begs the question; as induction is based on an assumption of the connection, it cannot itself explain the connection.

In this way, the problem of induction is not only concerned with the uncertainty of conclusions derived by induction, but doubts the very principle through which those uncertain conclusions are derived.

Furthermore, Hume averred that induction is not made by reason; Hume also observes that we nonetheless perform it and improve from it. He proposes a descriptive explanation for the nature of induction in the 5th part of the *Enquiry*, titled "Skeptical solution of these doubts." It is by custom or habit that one draws the inductive connection described above, and "without the influence of custom we would be entirely ignorant of every matter of fact beyond what is immediately present to the memory and senses." The result of custom is belief, which is instinctual and much stronger than imagination alone (5.2).

Rather than unproductive radical skepticism about everything, Hume said that he was actually advocating a practical skepticism based on common sense, wherein the inevitability of induction is accepted. Someone who insists on reason for certainty might, for instance, starve to death, as they would not infer the benefits of food based on previous observations of nutrition.

Colin Howson and the Problem of Induction

Colin Howson interpreted Hume to say that an inductive inference must be backed not only by observations, but also by an independent "inductive assumption."¹ Howson combined this idea with Frank P. Ramsey's view on probabilistic reasoning to conclude that "there is a genuine logic of induction which exhibits inductive reasoning as logically quite sound given suitable premises, but does not justify those premises."^[13] In this sense, the strength of inductive reasoning is comparable to that of deductive reasoning.

Karl Popper on the Problem of Induction

Karl Popper, a philosopher of science, sought to resolve the problem of induction in his *Logic of Scientific Discovery* in the context of the scientific method. He argued that science does not rely on induction, but exclusively on deduction, by making modus tollens the centrepiece of

his theory.(Spanos). Knowledge is gradually advanced as tests are made and failures are accounted for. (Dowd).

Wesley C. Salmon critiques Popper's falsifiability by arguing that in using corroborated theories, induction is being used. Salmon stated, "Modus tollens without corroboration is empty; modus tollens with corroboration is induction."^[19]

I will revisit some of the thoughts of these thinkers in detail as the work progresses.

The Place of Induction in Science

The main problem dealt with in this presentation is as follows: Does scientific research fit the scheme claimed by inductivist metascience as written in the works of KEYNES, J. M (1921), REICHENBACH, H. (1949), CARNAP, R. (1950), JEFFREYS (1957) (according to which scientific inference are inductive), or the pattern proposed by some proponents of deductivism; DUHEM, P. (1914), POPPER, K. R. (1959), WISDOM, J. (1952), (which acknowledges deduction alone in scientific reasoning)-or, finally, does it actually go along a third way of its own? The discussion will be confined to factual statements (usually called 'empirical sentences'), without thereby denying the great heuristic value of case examination as proposed in the mathematical invention and problem-solving technique POLYA, G. (1954)

Before approaching the problem let us clear the ground. By induction *stricto sensu* I understand it as the type of nondemonstrative reasoning consisting in the generalization of propositions, whether singular or general, on the basis of the examination of cases. This linguistic convention makes no appeal to epistemological categories such as 'new knowledge', which are often used in the characterization of inductive inference, although the enlargement of knowledge is the purpose of both inductive and deductive inference.

The proposed equation of induction and generalization on the basis of case examination leaves the following kinds of inference out of the domain of inductive inference: (1) analogy, which is a certain reasoning from particular to particular or from general to general; (2) the so-called induction by elimination, which is nothing but the refutation of hypotheses found unfit because their observable consequences (derived by deduction) do not match with the available empirical evidence; (3) scientific prediction, which is clearly deductive, since it consists in the derivation of singular or existential propositions from the conjunction of law statements and specific information; (4) interpolation, which is also deductive, since it amounts to specification; (5) reduction, or assertion of the antecedent on the ground of the verification of the consequent.

With the above definition in mind, we can now inquire into the role of induction in the formation and test of hypotheses.

1. Induction in the Framing of Hypotheses.

The premises of generalizing inductions may be singular or general. Let us distinguish the two cases by calling first degree induction, the inference leading from the examination of observed instances to general statements of the lowest level (e.g., 'All men are mortal'), and second degree induction the inference consisting in widening generalizations of any level (leading, e.g., from such statements as 'All men are mortal,' 'All lobsters are mortal,' 'All snakes are mortal,' to 'All many-celled organisms are mortal'). First degree induction starts from singular propositions, whereas second degree induction is the generalization of generalizations.

Empirical generalizations of the type of "All ravens are black" are often reached by first degree induction. Necessary, though not sufficient, conditions for performing a first degree induction are: (a) the facts referred to by the singular propositions that are to be generalized must have been observed, they must be actual phenomena, not merely possible facts; (b) the predicates contained in the generalization must be observable *stricto sensu* (whence the "observables" of atomic theory, such as the variable representing the "elementary" particle position, will not do for this purpose, since they are actually constructs).

Condition (a) excludes from the range of induction all inventions, and even countless elementary generalizations without which man would not have evolved beyond the Paleolithic period, such as "Many plants are born from seeds", a proposition which was most likely not obtained through observation of cases of seed germination. Condition (b) excludes from the domain of induction those hypotheses which have been called non-instantial by WISDOM, J (1952)^[20] or transcendent by KNEALE, W. (1952)^[20], because they contain non-observable, or

theoretical predicates such as "interaction", "Cynergy", "adaptation", or "mind". Transcendent hypotheses, that is, assumptions going beyond experience-are the most important in science: they enable us not only to colligate empirical data but also to explain them.

The hypothesis 'Copper is a good conductor' is a second degree inductive generalization. It contains the class term 'copper' and the disposition term 'conductor'. Its generalization 'All metals are good conductors' is, a fortiori, a second degree induction: it refers not only to the class of metals known at the moment it was framed, but to the conceptually open class of metals known and knowable. We do not accept the latter generalization just because of its inductive support, weighty as it is, but also-perhaps mainly-because the theoretical study of the crystal structure of metals shows us that the predicate 'metal' (or, if preferred, 'solid') is functionally-and not accidentally, in a Humean way-associated with the predicate 'conductor'. We accept the generalization with some confidence because we have succeeded in understanding it, by subsuming it under a theory.

Compare the above examples with the low-level inductive generalization 'All ravens are black'. Ornithology has not yet accounted for the constant conjunction of the two predicates occurring in this first degree inductive generalization. The day animal physiology hits upon an explanation of it, we shall presumably be told something like this: 'All birds having the biological properties X, Y, Z, . . . are black'. And then some ornithologist may inquire whether ravens do possess the properties X, Y, Z, . . ., in order to ascertain whether the old generalization fits in the new systematic body of knowledge.

In summary, enumerative induction plays a role in the framing of general hypotheses, though certainly not as big a role as the one imagined by inductivism.

2. Induction in the Test of Hypotheses.

Scientific hypotheses are empirically tested by seeking both positive instances (inductivist injunction) and unfavorable ones (deductivist rule). But only first degree inductive generalizations have instances; hence, they are the sole ones that can be directly checked against empirical evidences. The latter do not contain theoretical predicates, such as 'acceleration', 'pollination', or 'population pressure'. Hence, case examination by itself is powerless both for the framing and the test of transcendent hypotheses.

However, we do perform inductive inferences when stating plausible "conclusions" (i.e., guesses) from the examination of observed consequences of our theories. Granted, we cannot examine instances of transcendent hypotheses such as 'The intensity of electric current is proportional to the potential difference', because they are non-instantial. But hypotheses of this kind, which are the most numerous in the advanced chapters of science, do have observable consequents when conjoined with lower-level hypotheses containing both unobservable and observable predicates-e.g., 'Electric current deflects the magnetic needle'. And, if we wish to validate transcendent hypotheses, we must examine instances of such end-points of the piece of theory to which they belong.

To sum up, in the factual sciences, the following rule of method seems to be accepted, at least tacitly: 'All hypotheses, even the highest level ones, must entail-through inferential chains as long and twisted as is necessary instancial hypotheses, so that they can be inductively confirmed'. This rule allocates induction in scientific method, the overall pattern of which is admittedly hypothetico-deductive.

Inductivism rejects the deductivist thesis that what is put to the test is always some (often remote) observable consequence of theories, and that we never test isolated hypotheses but always some *pot-pours* of fragments of various theories, eventually including those involved in the building and reading of instruments, and in the performing of calculations. Inductivism maintains that this description of scientific procedure might square only with very high level hypotheses, such as the postulates of the theories of relativity. However, the analysis of elementary scientific hypotheses, even of existential ones-like 'The Earth is surrounded by an atmosphere'-confirms the deductivist description, with the sole but important exception of the line of contact between the lowest level theorems and the empirical evidence.

Consider, for instance, the process that led to the establishment of the existence of the atmosphere. An analysis of this process as recorded in BUNGE, M. (1958) ^[30] shows that Torricelli's basic hypotheses ("We live at the bottom of a sea of elemental air", and "Air is a fluid

obeying the laws of hydrostatics") were framed by analogy, not by induction, and that the remaining process of reasoning was almost entirely deductive. Induction did not occur either in the formulation or in the elaboration of the hypotheses, nor did it intervene in the design of the imaginative experiments that put them to the test. Nobody felt the need of repeating the experiments designed by Torricelli and Pascal, nor of increasing their poor precision. Rather on the contrary, Torricelli's hypotheses were employed to explain further known facts and were instrumental in suggesting a number of new spectacular experiments, such as Guericke's and Boyle's. Induction did appear in the process, but only in the final estimation of the whole set of hypotheses and experimental results-namely, when it was concluded that the former had been confirmed by a great number and, particularly, by a great variety of experiments-whereas the rival peripatetic hypothesis of the abhorrence of void had been conclusively refuted. To sum up, enumerative induction plays a role in the test of scientific hypotheses, but only in their empirical corroboration, which is not the sole test to which they are subjected.

3. Inductivist Methodology and the Problem of Induction

According to inductivism, empirical knowledge (a) is obtained by inductive inference alone, (b) is tested only by enumerative induction, (c) is the more acceptable the more probable, and consequently (d) its logic-the logic of induction-belongs to the calculus of probability. Deductivists in the likes of POPPER, K. R. (1959)¹ and WISDOM, J. O (1952) have shown that these claims are untenable, particularly in connection with theoretical laws, which are neither obtained nor directly tested by induction, and which have exactly zero probability in any universe that is infinite in some respect; they and other authors KNEALE, W (1952), have also conclusively shown that the theory of probability does not solve the riddles of induction.

All this, however, does not prove the vanity of the cluster of problems of induction, conceived as the set of questions connected with both the inductive inference and the inductive confirmation of hypotheses; hence, those arguments do not establish the impossibility of every logic of induction. It is indeed, a fact that induction is employed in the formulation of some hypotheses (certainly not the most impressive and deep ones) and in the validation of all theories. (Suffice to recall statistical inference-the jump from a random sample to its corresponding population-and the estimation of levels of significance as contained in FISCHER, R. A. (1951) And, if a subject exists, scientific philosophy suggests that the corresponding scientific (or metascientific) approach should be attempted.

True, there is no inductive method, either in the context of invention or in the context of validation - at least in the sense of a set of secure rules guaranteeing the jump to true conclusions out of case examination; nor is there an intuitive method or a mystical method. Yet induction, intuition, and mystical states do exist and deserve to be studied scientifically. The analysis of scientific research shows the current employment of various patterns of plausible inference as contained in [KEYNES, J. M (1921) ¹, POLYA, G (1954) WRIGHT, G. H. VON (1957)¹, CZERWINSKI, Z. (1958) such as analogy, reduction, weakened reduction, and weakened modus tollens; it also shows the operation of inductive policies, as those connected with sampling, and which are after all designed to provide the best possible inductions. Why should we disregard these various kinds of nondemonstrative inference, especially knowing as we do that successful patterns tend to be accepted as rules admitted uncritically?

The rules of deductive inference, which we all revere, were not arbitrarily posited: they were adopted because they lead from accepted statements to accepted statements (and statements are accepted, in turn, if deemed to be true); conversely, statements that are not postulated by convention are regarded as true if they are obtained by procedures respecting accepted rules of inference. Such a mutual and progressive adjustment of statements and rules is apparently the sole ultimate justification of either GOODMAN, N. (1954) ^[39]. Analogously, the belief in the possibility of a logic of plausible reasoning rests not only on a false theory of knowledge which minimizes the role of constructs, and on an antitheoretically biased history of science, but also on the plain observation that some nondemonstrative inferences (usually the recorded ones, because men, as Bacon pointed out, mark when they hit!) are crowned with success. This is what entitles us to adopt as (fallible) rules of inference and inductive policies, those patterns that in good research lead from accepted propositions to accepted propositions.

Of course, the theory of plausible inference need not restrict itself to a description of the types of argument that are found in everyday life and in science: it may also refine them, devising ideal (least dirty) patterns of inference. BARKER, S. F (1957)^[40]. However, it is convenient to view such patterns neither as binding rules nor as inference tickets, but rather as more or less successful, hence advisable, patterns. This, at least in relation with the constructive period, in which the greatest freedom to imagine is needed, "since creative imagination alone is able to bridge the gap separating percepts from concepts" EINSTEIN, A, (1951)^[41], first degree inductions from transcendent hypotheses, and isolated generalizations from theoretical systems. Logic, whether inductive or deductive, does not concoct recipes for jumping to happy conclusions-jumps without which there is as little science as without their careful test-but it may show which are the best patterns that can be discerned in the test of hypotheses, framed in whatever way.

Conclusion

As must have been suspected by many, scientific research seems to follow a via media between the extremes of inductivism and deductivism. In this middle course induction is instrumental both heuristically and methodologically, by taking part in the framing of some hypotheses and in the validation of all kinds of hypotheses. Induction is certainly powerless without the invention of audacious transcendent hypotheses which could not possibly be suggested by the mere examination of experiential data; but the deepest hypotheses are idle speculation unless their lower-level consequents receive instancial confirmation. And induction plays scarcely a role in the design of experiments, which involves theories and creative imagination; but experiment is useless unless it is interpreted in terms of theories that are partly validated by the inductive processing of their empirically testable consequences.

To sum it all up, induction-which is but one of the kinds of plausible reasoning - contributes modestly to the framing of scientific hypotheses, but is in-dispensable for their test, or rather for the empirical stage of their test. Consequently, I am of the opinion that those scientists who make haste to toll the path that Magee B. (1973) PP. 11-12 and his contemporaries took, will indeed be joining a host of other contemporary thinkers to commit the fallacy of hasty generalization among other things. From the arguments I have presented here, I make bold to concluded that scientific research follows neither the advice of inductivism nor the injunction of deductivism, but takes a middle course in which induction is instrumental both heuristically and methodologically, although the over-all pattern of research is hypothetico-deductive. We therefore in fairness to the aims and objectives of science and all she stands for, submit that we will be doing science a grave injustice, if we accept that a method so highly probabilistic could pass as the Hallmark of a highly respected discipline as science.

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