The Rationality of Science: Karl Popper's View

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Abstract

The second half of the twentiethcentury saw a reaction against the positivist philosophy of science. Karl Popper was the most important philosopher of science who shaped much of the current thinking on science. He showed how flawed was the positivist philosophy of science. Philosophy of Science as a frontier area of research today owes a great deal tothe Post-positivist philosopher like Karl Popper. The central concepts have become part of the day-to-day discourse about science. Particularly those social scientists who are concerned with the scientific status of social/human sciences consider their views to be seminal. Popper provides the radically different alternatives to positivism. Though it is not the only alternative to positivism rather itshaped contemporary discussions regarding science, more than other alternatives.

Keywords

Inductivism, Positivism, Verification, Falsification, Hypothetico-Deductive Method, Demarcation, Verisimilitude

Reference to this paper should be made as follows:
Received: 27.08.2021
Approved: 28.08.2021

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Article No.32
RJPSS Apr.-Sept. 2021,
Vol. XLVI No. 2,
pp. 262-270
Online available at:
https://anubooks.com/rjpss-2021-vol-xlvi-no-2/
https://doi.org/10.31995/rjpss.2021.v46i02.032

https://doi.org/10.31995/rjpss.2021.v46i02.032

In the face of difficulty and yet in orthodox preference for the complete verifiability criterion, Schlick and others have even gone to the extent of admitting that general propositions are indeed nonsense. The adoption of this as the criterion of significance would be self-stultifying. Though the general propositions cannot be conclusively verified, they can be conclusively confuted in experience by a single negative instance. For this reason, Karl Popper has proposed falsifiability rather than verifiability as the criterion of a scientific statement. According to positivists, the proposition or statement is meaningful or meaningless through the method of verification whereas, according to Popper, a proposition or statement is scientific or unscientific through the method of falsification. So the principle of falsifiability is not, indeed, as a criterion of meaning but as method of demarcating scientific statements from those of metaphysical[1]. Popper counted a statement as being falsifiable if it was logically incompatible with some class of what he called basic statements, a basic statement being one which asserted the existence of some observable state of affairs at some particular place and time.

Popper is absolutely right that, laws are not supported by their instances. Science, in Popper's view, does not proceed by induction and the verification of true theories. Rather we go on with the hypotheses we make until they are falsified, until, that is, experience shows that they are not true[2]. The problem of induction arises, in because for the law that 'All A's are B's to be true, there must not be one single A that is not a B. It follows that until we have examined every single A, we cannot be sure that the law is true. But, by the same token, we only have to find one A that is not a B in order to show that a law is false. So can never be sure that a law is true, we can, apparently, be sure that a law is false. Popper, then, does not solve the problem of induction, but he says, he dissolves it by showing there never was such a problem. According to him, the method of science is not the method of induction but the method of hypothetical deduction. Science proceeded by conjecture, that is, imaginatively inventing new theories and then make observations and do experiments that may lead, in the end, to refutation.

The Problem of Demarcation

Having worked through some preliminaries, we now turn to the most direct of our big questions, namely what makes a science a science? No sooner do we ask a big question, than we start clarifying it into smaller, more manageable ones. So first we 'will offer an explicit restatement of this question, and then further clarifications. The problem of demarcation is what we will call this challenge. It asks us to distinguish in a motivated and non-arbitrary way between genuine sciences and pseudo-sciences. Now we have to see what that statement amounts to. Every

non-science is not a pseudo-science. There are other epistemically special enterprises out there, and while it is useful to distinguish mathematics, engineering, or art from science, that is not our main problem. A pseudo-science, on the other hand, is a discipline that claims the special epistemic status that science holds. That means whatever exactly that status turns out to be, for the reasons that science gets that status, whatever exactly those reasons turn out to be. Yet a pseudo-science does not, in fact, merit such status. The claims of the pseudo-science don't deserve quite the same status that scientific claims do. Likewise, to call something scientific is not to deny that it might well be false. We know that lots of well-supported scientific statements have turned out to be wrong. So a demarcation criterion is perhaps best thought of as a qualification for a special kind of competition.

As Popper sees it, the central problem in the philosophy of science is that of demarcation, i.e., of distinguishing between science and non-science. Popper maintains that what distinguishes science from the rest of our knowledge is the systematic falsifiability of scientific theories. Thus falsifiability is the line of demarcation between science and non-science. Falsifiability is the criterion of scientificity. A statement is scientific only if it is falsifiable or refutable by a conceivable event. Every genuine test of a scientific theory then is logically an attempt to refute or to falsify it. One genuine counter-instance falsifies the whole theory. In a critical sense, Popper's theory of demarcation is based upon his perception of the logical asymmetry which holds between verification and falsification; it is logically impossible to conclusively verify a universal proposition by reference to experience. But a single counter-instance conclusively falsifies the corresponding universal law. To call a theory falsifiable is not to say that it is false. Rather, it means that the theory makes some definite predictions that are capable of being tested against experience. If these predictions turn out to be wrong, then the theory has been falsified or disproved. So a falsifiable theory is one that we might discover to be false. It is not compatible with every possible course of experience. Popper thought that some supposedly scientific theories did not deserve to be called science at all; rather they were merely pseudo-science.[3]

Scientific theories are falsifiable in the sense that they transparently state under what conditions they would be rejected as false. Whenever scientific theories are advanced, it is also apparent under what conditions they turn out to be false so that we try to bring about those conditions in order to falsify our claims. In other words, a model scientific theory or statement should readily yield test implications i.e., not stating under what conditions it becomes false. It is in this connection, Popper attacks Marxism as a pseudo-scientific theory. When Marx propounded his

https://doi.org/10.31995/rjpss.2021.v46i02.032
theory of the dynamics of the capitalist society his theory was scientific because it was falsifiable since it yielded test implications such as the disappearance of middle classes, revolution in industrially advanced societies, reduction in the value of wages, etc. However the test implications were not borne out i.e., the predictions failed. Hence the theory which was scientific proved to be a false theory. Marxist theory is not only unfalsifiable and therefore non-scientific, but also pseudo-scientific. It is this pretension to be scientific while being unfalsifiable that makes the theory pseudo-scientific.

Hypothetic-Deductive Method

In accordance with what he considers to be the hallmark of scientific theories, Popper puts forward what he considers to be an adequate model of the scientific method. He characterizes his model of the scientific method as 'Hypothetico-Deductive systems'. On this view, scientific theories are the first and foremost systems of inference, within which every components proposition is located either at the 'bottom of the page' of inquiry (where the propositions resemble theorems in purely deductive systems). Or else it falls 'mid-page- 'beneath' claims of greater generality, and 'above' claims of less generality. In other words, propositions within a theory may be of the very highest level, the 'form which everything ely follows. Still, the highest-order claims are not just posited, or assumed, or presupposed simply for the purpose of deducing everything below- as in a deductive theory.[4] Rather, on the hypothetico-deductive view, even such highest order claims are themselves ultimately empirical in nature. They are a posteriori, factually true, or factually false, even though the determination of this may require subtle techniques of analysis. What are the fundamental differences between these methodological models? Firstly, the inductivist model maintains that our observations are theory-independent and therefore are indubitable. That is to say, since observations are theory-independent, they have a probability value of 1. It is also said that our theories are only winnowed from observations and therefore our scientific theories have the initial probability value1 in principle. Popper rejects the inductivist view that our observations are theory-free and hence rejects the idea that our observation statements have probability equal to 1. More importantly, he maintains that theories are not winnowed from observations or facts, but are free creations of the human mind. Our scientific ideas, in other words, are not extracted from our observations; they are pure inventions.

According to the inductivists what scientific tests do is to merely find out whether our scientific tests cannot establish the truth of scientific theories even when the tests give positive results. If a test gives a positive result, the inductivists claim that the scientific theory is established as true, whereas according to Popper

all that we claim is that our theory has not yet been falsified. In Popper's scheme, no amount of positive result of scientific testing can prove our theories. Whereas inductivists speak of confirmation of our theories in the face of positive results of the tests, Popper only speaks of corroboration. In other words, in the inductivist scheme, we can speak of scientific theories as established truths, whereas in the Popperian scheme a scientific theory however well supported by evidence remains permanently tentative. We can bring out the fundamental difference between verificationism (inductivism) and falsificationism[5] (Hypothetical-Deductivism) by drawing on the analogy between two systems of criminal law. According to the one system, the judge has to start with the assumption that the accused is innocent and consequently unless one finds evidence against him, he should be declared innocent. According to the other, the judge has to start with the assumption that the accused is a culprit and consequently, unless evidence goes in his favor, he should be declared to be a culprit. Obviously, the latter system of criminal law is harsher than the former. The inductivist scheme is analogous to the former kind of criminal law, whereas the Hypothetico-Deductive scheme is akin to the latter one.

In the inductivist scheme of observation, tentative generalization, verification and confirmations constitute the steps of scientific procedure. In the Popperian scheme we begin with a problem, suggest a hypothesis as a tentative solution, try to falsify our solution by deducing the test implications of our solution, try to show that the implications are not borne, and consider our solution to be corroborated if repeated attempts to falsify it fails. The problem, tentative solution, falsification, and corroboration constitute the steps of scientific procedures.

Popper claims that the hypothetico-deductive model of the scientific method is superior to the inductivist model for the following reasons:

Firstly, it does justice to the critical spirit of science by maintaining that the aim of scientific testing is to falsify our theories and by maintaining that our scientific theories are, however, corroborated, permanently remain tentative. In other words, the Hypothetical-Deductivist view presents scientific theories as permanently vulnerable with the sword of possible falsification always hanging on their head. The inductivist view of the scientific method makes science a safe and defensive activity by portraying scientific testing as a search for confirming instances. It characterizes scientific theories as established truths. According to Popper, the special status according to science is due to the fact that science embodied an attitude, which is essentially open-minded and anti-dogmatic. Hypothetical-deductivism is an adequate model of scientific practice because it gives a central place to such an attitude.

https://doi.org/10.31995/rjpss.2021.v46i02.032

Secondly, Popper thinks that if science had followed the inductivist path; it would not have made the progress it has. Suppose a scientist has arrived at a generalization. If he follows the inductivist message, he will go in search of instances, which establish it as a truth. If he finds an instance that conflicts with his generalization, what he does is to qualify his generalization saying that the inductivist message, he will go in search of instances, which establish it as truth. If he finds an instance that conflicts with his generalization, what he has to be held unsupported. Such qualifications impose heavy restrictions on the scope of the generalization. This results in scientific theories becoming extremely narrow in their range of applicability. But if a scientist follows the Hypothetical-Deductivist view, he will throw away his theory once he comes across a negative instance instead of pruning it and fitting it with the known positive facts. Instead of being satisfied with a theory, tailored to suit the supporting the old theory but it is also the observations that went against the old theory and more importantly which will yield fresh test implications. The theoretical progress science has made can be explained only by the fact that science seeks to come out with bolder and bolder explanations rather than taking recourse to the defensive method of reducing the scope of the theories to make them consistent with facts[6]. Hence, Popper claims that the Hypothetico-Deductive model gives an adequate account of scientific progress. According to him, if one accepts the inductivists account of science one fails to give any explanation of scientific progress.

Thirdly, the Hypothetico-Deductive view according to Popper avoids the predicament encountered by inductivist theory in the face of Hume's challenge. As we have seen, Hume conclusively showed that the principle of induction could not be justified on logical grounds. If Hume is right then science is based upon an irrational faith. According to the Hypothetical-Deductivist view, science does not use the principle of induction at all. Hence, even though Hume is right it does matter since science follows the Hypothetical-Deductivist lines of procedure. Also, Popper seeks to establish that inductivism and Hypothetical-Deductivism are so radically different than the latter in no way face any treat akin to the one faced by the former. In this connection, he draws our attention to the logical asymmetry between verification, the central component of the inductivist scheme, and falsification, the central component of the Hypothetical-Deductivist scheme. They are logically asymmetrical in the sense that one negative instance is sufficient for conclusively falsifying a theory, whereas no amount of positive instances are sufficient to conclusively verify a theory. It may be recalled that Hume was able to come out with the problem of induction precisely because a generalization (all theories according to inductivism are generalizations) cannot be conclusively verified.

Here the scientific research follows neither the way of inductivism nor the injunction of deductivism but it takes the middle course in which induction is instrumental both heuristically and methodologically, although the overall pattern of research is hypothetico-deductive.

The Growth of Scientific Knowledge

Unlike other areas of activity, science is progressive in the sense that scientific change always changes for the better, whereas other areas exhibit just change: the progress of science consists in the accumulation of observations, on the one hand, and, the cumulative growth of theories, on the other hand. The latter means that any new theory includes the old theory (plus something). Thus the growth of science essentially exhibits continuity[7]. According to Popper, unlike other areas of human activity, there is progress in science which consists in going from one theory to a better theory. Here, 'better' means 'more true'. 'More to true' means 'greater correspondence between theory and reality and 'reality means 'the world of unobservables'. In short, science is progressive in the sense our successive theories in any domain of science exhibit greater and greater verisimilitude or truth-nearness i.e. the match between our theories and reality[8]. Unlike positivists, Popper rejects the idea that the progress of science is characterized by the cumulative growth of theories. According to him, a new theory is entirely new and not an old theory plus an epsilon as Positivists thought. Thus, in Popper's scheme, the growth of science is essentially discontinuous. Of course, Popper makes some room for continuity also when he says that old theory (at least true part of it) is a limiting case of the new theory[9].

However, according to Popper, one finds in the history of science invariable transitions from theories to better theories. What does the 'better' stand for? It may be recalled that according to Popper, no scientific theory however corroborated can be said to with true. Hence, Popper drops the very concept of truth and replaces it by the concept of verisimilitude (truth-likeness or truth n,earness) in his characterization of the through science. In other words though science cannot attain truth, i.e., though our theory can na ever be said to be true, science can set for itself the goal of achieving higher and higher degree of verisimilitudethe . However successive scientific theories can progressively approximate to truth. So, in science we go from theory to better theory and the criterion for betterness is verisimilitude. But what is the criterion for verisimilitude? The totality of the test implications of a hypothesis constitutes what he calls the 'theatrical content' of the hypothesis. The totality of test implications which are borne out constitute the truth content of the hypothesis and the totality of the test implications which are not borne out is called the falsity content of the hypothesis. The criterion of the verisimilitude of a theory

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is nothing but truth content minus falsity content of a theorythe . Formally, then, Popper defines the quantitative verisimilitude which is statement 'a' posses by means of a formula:

$$Vs\ (a) = Ct\ T\ (a)\ \text{“}\ Ct\ F\ (a)$$

Where ***Vs (a)*** represents the verisimilitude of '**a'**, ***Ct T (a)*** is measure of the truth content of '**a',** and ***Ct F (a)*** is measure of falsity content.

In the actual history of science, we always find, according to Popper, theories being replaced by better theories, that is, theories with a higher degree of verisimilitude. In other words, two successive theories, at any time in the history of science, we find the successor theory possessing greater verisimilitude and is, therefore, better than its predecessor. In fact, according to him, a theory is rejected as false only if we have an alternative that is better than the one at hand in the sense that it has more test implications and a greater number of its test implications are already borne out. The growth of science is convergent in the sense that the successful part of the old theory is retained in the successor theory with the result the old theory becomes a limiting case of the new one. The growth of science thus shows continuity. In other words, it is the convergence of the old theory into the new one that provides continuity in the growth of science. It must also be noted in this connection that unlike the inductivists or positivists[10], Popper is a realist in this sense, according to him; scientific theories are about an unobservable world.

Conclusion

Here is the main reason for attacking logical positivism. It is shown also by the fact that the three main ideas under attack are exactly those which, though certainly in need of a more precise formulation, represent genuine achievements closely related to modern science. To put it briefly: First, the verifiability criterion of meaning is surely accepted through its epistemological form must be abandoned. It is neither a thesis nor a principle, nor a law, nor a prohibition, not even simply a definition but an attempt of reconstructing in logical terms the use of factual statements, both within the context of science and everyday life. There is a problem of adequacy, but not of truth. Second, the rejection of metaphysics is sometimes made in too sweeping a manner for the reason that metaphysical sentences are making too obscure and metaphysicians differ so much from one another. Certain metaphysical sentences are claimed as factual but cannot be verified by experience.

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