**Personal Details**

| Role | Name | Affiliation |
|---|---|---|
| Principal Investigator | A.Raghuramaraju | Department of Philosophy, University of Hyderabad, Hyderabad. |
| Paper Coordinator | S.K.ArunMurthi | Department of Humanities, Indian Institute of Science Education and Research, Mohali. |
| Content Writer | Kausik Bhattacharya | Department of Philosophy & Comparative Religion, Visva-Bharati, Santiniketan |
| Content Reviewer | NaliniBhushan | Department of Philosophy, Smith College, Northampton, USA. |
| Language Editor | AparajitaBasu | Consulting Editor, Philadelphia, USA |

**Description of Module**

| Subject Name | Philosophy |
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| Paper Name | Philosophy of Science |
| Module Name/Title | Popper, Falsification and its Critiques |
| Module Id | 9.11 |
| Pre-requisites | A general idea about philosophical problems, problem of induction, logical positivism, and an elementary idea about the theories of physics and chemistry |
| Objectives | To sketch the development of Popperôs falsifiability thesis, its implications, and his criticism of induction |
| Keywords | philosophy, science, empiricism, realism, logical empiricism, falsifiability, verisimilitude, laws of nature, metaphysics |

# Popper, Falsification, and its Critiques

## 1. Introductory remarks

Logical positivism is one of the intellectual sources of Karl RaimundPopperôs philosophy of science. Otto Neurath, a member of the Vienna Circle, nicknamed him óthe official oppositionô.

According to the logical positivist, a statement is factually significant or meaningful if its truth is verifiable by observation or experience. A section of the positivist philosophers holds that scientific theories and laws, being factually significant, are verifiable by experience. In other words, experience can verify the truth of a scientific statement. The view that we can verify the truth of general or universal scientific theories and laws leads us into a form of essentialismð that scientists can establish the truth of their theories beyond reasonable doubt.[1] However, it is difficult to answer how a scientific theory expressed through universal statements can be verified conclusively.

Scientific theories and laws are expressed through universal or general statements.Popper felt that contemporary empiricism could never successfully resolve the conflict between the principles of empiricism (only experience can decide about the truth or falsity of a factual statement) and Hume's realization that inductive (or generalizing) arguments are invalid.

The difficulty regarding the conclusive verification of universal statements led some philosophers of the positivist school to adopt the instrumentalist view of scientific theory, which Popper called the idealistic philosophy of science. Moritz Schlickheld that scientific laws are not genuine statements but rules for the transformation of statements, or a set of instructions, for the derivation of singular statements from other singular statements. Thus, theories are neither true nor false; they are mere instruments of predictions. Popper tried to show that instrumentalism is no more acceptable than essentialism.

As our experience cannot conclusively establish the truth of scientific theories and laws, there is a logical gap between empiricism and realism regarding them. It appears that consistent empiricism forces us to accept the idealistic philosophy of science. But Popper accepted both empiricism and realism.He involved the falsifiability thesis to bridge the logical gap between empiricism and realism.

> Theories are our own inventions, our own ideas; they are not forced upon us, but our own self-made instruments of thought; this has been clearly seen by the idealist. But some of these theories of ours can clash with reality; and when they do, we know that there is a reality; that there is something which reminds us of the fact that our ideas may by mistaken. And this is why the realist is right.[2]

According to Popper, falsifications of theories indicate the points where reality has been touched. Popper suggested that it is falsifiability, not verifiability, which is the mark of scientific propositions, and on that count he accepted both empiricism and realism.

## 2. The development of Popper's idea of falsifiability

Popperôs encounter with Marxism is another intellectual source of his philosophy of science.[3] At a very young age he was enamoured of the Marxist propaganda and regarded himself as a communist. But soon he was put off by what he felt was the dogmatic character of the creed and its intellectual arrogance, and by the time he was seventeen he had become an anti-Marxist.[4] Marxist theory claimed to be based on scientific outlook. Popper questioned whether such a theory could ever be supported by science. This prompted him to rethink about scientific method and attitude.

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[1] K. Popper, *Conjectures and Refutations* (1963: Routledge & Kegan Paul, London), p. 103.
[2] *Ibid,* p. 117.
[3] K. Popper, óAutobiography of Karl Popperô, ed. P.A. Schilpp, The*Philosophy of Karl Popper* (1974: Open Court Press, Illinois), p. 27.
[4] *Ibid*, p. 26.

In a remark made by Albert Einstein regarding his theory of relativity, Popper found an attitude very different from the dogmatic attitude of Karl Marx, Sigmund Freud,Alfred Adler, and their followers.[5] Einstein said that, if the redshift of spectral lines due to gravitational potential did not exist, the general theory of relativity would be untenable. Einstein was looking for crucial experiments, which, if the outcomes were in agreementwith his predictions, would by no means establish his theory, though a disagreement, he stressed, would show his theory to be untenable.

This, Popper felt, was the true scientific attitude. It was different from the dogmatic attitude, which constantly claimed to find verifications of its favourite theories. If somebody proposed a scientific theory, he should answer, as Einstein did, the question: Under what conditions would I admit that my theory is untenable? In other words, what conceivable facts would I accept as refutations, or falsifications, of my theory? Popper insisted that only attempted refutations, which did not succeed *qua* refutation, would count as verification.

Popper criticized the tendency to immunizea theory or law without explaining the new fact that contradicted the theory or the law[6].The law ôFire produces smokeô is falsifiable and has actually been falsified.But its falsification could have been ruled out if it was held that anything that did not produce smokewas not fire.In such a case it would not be possible for us to discover that other conditions like the presence of wet fuel are also necessary for the production of smoke, and it would also not be possible for us to accommodate this new fact in further theorization.

Under the assumption that anything that does not produce smoke is not fire, the statement ôFire produces smokeô acquires the status of an analytic statement. An analytic statement lacks informative content though it is necessarily true. But it is by going beyond thistruism that, beginning with Isaac Newton, physical theory has reached a depth of insight beyond the Cartesian approach.[7]

Some philosophers maintain that the laws of nature are necessary in the same sense in which logical tautologies are necessary. Popper observed that Descartes held a view very similar to this.[8] Logical tautologies are derivable as theorems by the employment of logical rules from a few number of axioms. And in so far as the laws of nature are concerned Descartes maintained that all the laws of nature necessarily follow from one analytic principle according to which ôto be a bodyô means ôto be extendedô.From this principle it logically follows that two different bodies cannot take up same extension or space. As two different bodies cannot take up same extension, it further follows that one body can act upon the other only by pushing. This implies a view of causation involving the idea of physical push or contact which initiated Descartes and some subsequent scientists to explain all the events of the world in terms certain laws of nature derivable from the idea of physical push or contact. This scientific approach will be further discussed in Section 5.

According to Popper, science does not aim at mere truth; rather, it aims at true statements with high informative content consisting of non-tautological statements that can be deduced from them. Consider the statement ôThere will be a solar eclipseô. The statement is bound to be true and can never be proved false. Many centuries may pass without a solar eclipse, but the statement may still remain true, that, one day in the future, there will be a solar eclipse. The statement is highly probable due to its low informative content. The informative content of a statement is inversely proportional to its probability; the more information a statement contains the greater the number of ways it may turn out to be false. Despite having high probability, the statement ôThere will be a solar eclipseô is useless and uninteresting from the scientific point of view because of its low informative content. A statement like ôThere will be a solar eclipse on the 19th of January in the year 2016ô isinteresting from the scientific point of view and that of practical usefulness. Due to its relatively high informative content it is testable and can be proved false. Scientists are interested in statements of a high informative content, and therefore of low probability, which nevertheless come close to the truth.

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[5] *Ibid*, p. 29.
[6] *Ibid,* p. 33.
[7] K. Popper, *The Logic of Scientific Discovery* (1975: Hutchinson, London), p. 431.
[8] *Ibid,* p. 430.

A possible observational statement,whichmay contradict a theory, is called a potential falsifier of the theory.The empirical content of the theory consists of the class of the potential falsifiers of the theory.[9]Popperobserved that a theory tells us more about observable facts the more such facts it forbidsð that is, the more observable facts are incompatible with it. The empirical content of a tautology is nil, because, as it tells us nothing about the worldð as it is true regardless of the way things are, no observable fact is incompatible with it. But statements like óAll Indian ravens are blackô is not true regardless of the way things are. That it has empirical content is proved by the fact that an observational statement like óThere is a white Indian raven here nowô contradicts it. Again, the assertion óAll ravens are blackô is a stronger assertion, that is, its empirical content exceeds that of the assertion óAll Indian ravens are blackô. The former assertion is not only incompatible with the observational statement óThere is a white Indian raven here nowô, but also with the observational statement óThere is a white Australian raven here nowô. Whereas the latter assertion (All Indian ravens are black) is logically consistent with the observational statement óThere is a white Australian raven here nowô. Thus, the stronger the assertion is, the more the observational statements that contradict the assertion.

**3. Induction and falsifiability**

Popper maintained that falsifiability, the mark of scientific statements, is what distinguishes science from non-science. On the other hand, employment of the inductive method as a feature of scientific enquiry does not distinguish science from non-science. Popper tried to show that neither can the principle of induction be justified nor is the inductive method actually used in scientific activity.

The principle of induction must be a synthetic universal statement. ó To justify it, we should have to employ inductive inferences, and to justify these we should have to assume an inductive principle of a higher order, and so on. Thus the attempt to base the principle of induction on experience breaks down, since it must lead to an infinite regress.ô[10] The principle of induction may be taken to be a priori valid. But Popper felt that a priori justification of a synthetic principle cannot be successful.

Popper also tried to show that nothing can be gained if the principle of induction is taken not as true but only as probable. ó For if a certain degree of probability is to be assigned to statements based on inductive inference, then this will have to be justified by invoking a new principle of induction, appropriately modified. And this new principle in its turn will have to be justified, and so on.ô[11] Thus, we cannot escape the problem of infinite regress.

If the principle of induction cannot be justified, what then is the rational ground for accepting a theory? Can a preference, with respect to truth or falsity, for some competing universal theories over others, ever be justified by empirical reasons? Popper did not reject the principle of empiricism and held that the principle of empiricism can be fully preserved, since the fate of a theory, its acceptance or rejection, is decided by observationsð by the result of tests.[12] It may happen that our test statements may refute someð but not allð of the competing theories; since we are searching for a true theory, we shall prefer the ones for which falsity has not been established.[13]

Induction, according to Popper, is a myth. It is neither a psychological fact, nor a fact of ordinary life, nor one of scientific procedures. A theory cannot be the result of pure observation. Some theory is presupposed by observation and observation is always selective. It needs a chosen object, a definite task, an interest, a point of view, a problem. When a scientist works with some theories he accepts, he works with a horizon of expectations. His uncritical observation is accompanied by a general expectation that under specific circumstances certain phenomena will occur. But if something, which conflicts with his expectation, occurs, then such an occurrence creates a problem for him. To solve the problem he develops

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[9] K. Popper, *Conjectures and Refutations* (1963: Routledge & Kegan Paul, London), p. 385.
[10] K. Popper, *The Logic of Scientific Discovery* (1975: Hutchinson, London), p. 29.
[11] *Ibid*, p. 30.
[12] K. Popper, *Conjectures and Refutations* (1963: Routledge & Kegan Paul, London), p. 54.
[13] K. Popper, *Objective Knowledge* (1974: Oxford University Press, Oxford), p. 8.

a new hypothesis and tests it severely for establishing it. Such a hypothesis may even be suggested by a single observation.That is why Einstein, in a letter addressed to Popper, explicitly expressed his agreement with Popperôs view that theory cannot be fabricated out of the results of observation; it can only be invented.[14] Repeated observations and experiments, according to Popper, function in science as tests of our conjectures or hypotheses, that is, attempted refutations. The theory that passes these tests is corroborated and accepted.

Our natural observation of the world process is followed by various expectations. Whenever we plug in a machine or plant seeds or mix certain chemicals, we expect that events will occur in accordance with the laws of nature. Consider the following example. A law of chemistry may have the form: The chemical reaction between X and Y under certain temperature and pressure produces Z. Naturally, we would expect the production of Z if the aforesaid conditions are satisfied. But in the field of observation we may experience non-production of Z in spite of satisfaction of the aforesaid conditions resulting in the defeat of our expectation. Repetition of this experience creates a problem for the scientist and to solve the problem he frames a new hypothesis.It may be the case that in the presence of an unknown negative catalyst,the reaction between X and Y does not take place and presence of the negative catalyst prevents the production of Z in certain fields of observation. And if our subsequent investigation reveals the fact that in the presence of a negative catalyst W, the reaction between X and Y does not take place, the problem is solved and the law is modified as ćthechemical reaction between X and Y under certain temperature and pressure in the absence ofW produces Zô There is always the possibility that a set of conditions, accepted as the sufficient condition for the occurrence of some event,might be proved to be insufficient in future when we consider more and more extended range of phenomena.

The above account supports Popper's claim that most laws and theories are not arrived at by generalizing from experimental observations using inductive method, but by modifying already existing laws and theoriesas our knowledge grows through conjectures and refutations. All knowledge hasa conjectural or hypothetical character.Our knowledge would not have grown as it has if, in our search for confirming instances, we had not hit upon counter-instances.Thus, on many occasions, facing counter-instances might be the best thing that could have happened to us. We should not consider a theory or law as the ultimate achievement, for this may prevent further growth of knowledge.

**4. Falsifiability and verisimilitude**

A falsified law or theory may be regarded as an approximate description of the world, an approximation to the truth. Naturally, a law or theory may be a better approximation to the truth than another. For instance, the law ćthechemical reaction between X and Y under certain temperature and pressure in the absence ofW produces Zôis a better approximation to the truth than the law ćhe chemical reaction between X and Y under certain temperature and pressure produces Zô In that case we can rank laws and theories according to their closeness to the truth, their degrees of verisimilitude or truth likeness. Now, if a false theory is closer to the truth than another, that is, if verisimilitude admits of degree, then the history of enquiry may be viewed as one of steady progress towards the goal of truth.

Truth is not attainable in the empirical context in the sense that we can have the knowledge that we have grasped the truth. Truth in the empirical context is attainable only in the sense that it possible for us to attain true beliefs without the knowledge that they are true. Truth then becomes an idealization, a regulative principleð the permanent pursuit of our inquiry. Popper compared truth to a mountain peak, which is permanently, or almost permanently, wrapped in clouds. ćThe climber may not merely have difficulties in getting thereð he may not know when he gets there, because he may be unable to distinguish, in the clouds, between the main summit and some subsidiary peak. Yet this does not affect the objective existence of the summit é ô[15] Popper further pointed out that the very idea of error, or of

[14] A letter, dated 14.09.1935, from Einstein addressed to Popper, reproduced in the New Appendixes of *The Logic of Scientific Discovery* (1975: Hutchinson, London), pp. 461ï 4.

[15] K. Popper, *Conjectures and Refutations* (1963: Routledge & Kegan Paul, London), p. 226.

doubt, implies the idea of objective truth, which we may fail to reach. If the aforesaid climber tells us ôI have some doubts whether I reached the actual summitô, this implies that he does recognize the objective existence of the summit.

If truth be a regulative principleð the aim of rational inquiryð not only should it be attainable in the specific sense explained earlier, the history of rational inquiry should also be one of progress with respect to its primary aim. Unless the history of rational inquiry is the progress towards its primary aim, the ideal is useless and cannot be said to be rational. But the history of inquiry is a story of replacement of false theories one after another and our existing theories, according to fallibilism, are very likely to be false. Now, if all false theories have the same epistemic status, the history of inquiry cannot be a rational progress towards the aim. To resolve the conflict, the realist who discarded infallibilism must adopt the idea of verisimilitude or truth likenessð the idea that some false propositions better realize the goal of truthð are closer to the truthð than others. Thus, a philosopher, who is an optimistic realist as well as fallibilist, confronts a problemð the problem of truth likeness.

Perhaps Karl Popper is the first philosopher to take the idea of truth likeness seriously. His falsificationism bridges the logical gap between empiricism and realism, and his idea of verisimilitude or truth likeness explains how a succession of falsehoods can constitute genuine cognitive progress.

**5. Falsifiability and the epistemological status of the laws of nature**

As falsifiability is the mark of scientific statements, we cannot know whether a scientific law or theory describes essence or not.[16] Essentialism amounts to the view that science must seek ultimate explanation in terms of essence in order to provide a correct description of the world and an explanation of the events occurring in it. This view is implied by the doctrine that laws of nature are necessary in some sense. Popper discarded essentialism not only on the ground that we can never know whether a law or a theory describes essence or not, but also on the ground that the belief in essence does not help us in any way. Instead this belief hampers us by preventing fruitful questions from being raised. Popper tried to prove his point as follows.

According to René Descartes, spatial extension is the essence of matter. From this it follows that the only way bodies can act upon each other is by pushing, since one moving body pushes another from its place because both are extended and cannot occupy the same place. Newtonôs followers considered gravity as the essence of matter, yet Newton himself, having an inclination towards Cartesian essentialism, had accepted extension as the essence of matter. He, therefore, made an attempt to find the ultimate explanation for gravity by trying to deduce the square law from the assumption of a mechanical push, which, in turn, could be explained by the essential property of all bodies, namely, extension. But Newton failed. Had he succeeded, we could have believed that he had found the ultimate explanation of gravity in terms of the idea of a mechanical push, and that belief might have prevented the fruitful question ôWhy can bodies push one another?ô from ever being raised. But by asking this, we have made progress, since we now conjecture that bodies push one another because of certain repulsive electric forces.

Popper discouraged us from accepting anything as ultimate or essential, but still insisted on us searching for the essence. Popper believed in realism and, therefore, he thought that a scientific theory must at least be an attempt to represent the essential principles of natural phenomena and changes in nature. But Popperôs doctrine is not that of explanation in terms of essenceð the ultimate explanation. His doctrine is one of explanation in terms of laws of nature of higher and higher universality. The idea behind this is that all individual things and all singular facts are subject to these laws, which explain regularities or similarities of individual things or singular facts or events. These laws are not inherent in the singular facts; rather, they are conceived as conjectural descriptions of the hidden structural or relational properties of nature. They do not describe any ultimate essence of the world. Popper called this doctrine modified essentialism.

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[16] *Ibid,* p. 105.

**6. Falsifiability and the principle of universal causation**

In Immanuel Kant's philosophy we get different senses of the term necessity. According to Kant, an analytic judgement is necessary because the denial of it is contradictory. However, when he said that a geometrical judgement is necessary, he was clearly referring to the impossibility of imagining an exception. He also spoke of a kind of necessity in his discussion on causality. What he maintainedwas not that the impossibility of imagining an exception to the principle of causality involving necessary connection, but that the principle of causality is one of the principles, which are necessary in the sense of being a necessary presupposition of empirical science.

According to Popper, the principle of universal causation, which asserts that any event whatsoever can be causally explained, is not empirically falsifiable or testable. He neither adopted nor rejected this principle but simply excluded it from the sphere of science.[17] But he acceptedthe laws of nature, though he acknowledgedthat we can never know whether a supposed law is a genuine law or whether it lookedlike a law but in fact depended upon certain spatial initial conditions prevailing in our part of the universe.[18] Nevertheless, an assumption that there exist laws of nature might be appealed to if we wished to justify our search for laws of nature[19]. But experiences may reveal that a law of nature is verydifferent from what we ever imagined.

**7. Concluding remarks**

It is now a settled position that the positivist principle of verifiability does not convincingly establish that metaphysical assertions are meaningless. Positivist philosophers have failed to establish the principle as a criterion of cognitive meaning or significance. The principle of verifiability cannot even be accepted as an adequate criterion of demarcation between science and metaphysics or non-science. Popper held thatfalsifiability is the criterion of demarcation between science and non-science. But hedid not accept his criterion as one of meaningfulness. So, many charges that have been levelled against his criterion on the supposition that it is also a criterion of meaning, are unwarranted. He asserted, ó the fact that the positivists used their criterion of verifiability and meaningfulness also as a criterion of demarcation made them deaf and blind to the fact that I used falsifiability as a criterion of demarcation, but never of meaningfulness.ô[20]

Popper held that we are all metaphysicians and science historically derives from metaphysics.[21] Hence, it is important to note that the criterion of falsifiability is not a criterion of demarcation between science and metaphysics; rather it is a criterion of demarcation between science and non-science. But Popper did not give a clear and comprehensive account of what should be counted as non-science.

Indeed science involves various metaphysical ideas and concepts, which are intelligible, though not verifiable in principle. But the question is whether the introduction of metaphysical ideas and concepts is absolutely necessary for the development of science. This is a current debate in the contemporary philosophy of science.

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[17] K. Popper, *The Logic of Scientific Discovery* (1975: Hutchinson, London), p. 61.
[18] *Ibid,* p. 433.
[19] *Ibid,* p. 437.
[20] K. Popper, óReplies to My Criticsô, ed. P.A. Schilpp, *Philosophy of Karl Popper* (1974: Open Court Press, Illinois), p. 967.
[21] *Ibid,* p. 1067.