Science and pseudoscience - Falsifiability

Nicolae Sfetcu

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Abstract

The delimitation between science and pseudoscience is part of the more general task of determining which beliefs are epistemologically justified. Standards for demarcation may vary by domain, but several basic principles are universally accepted. Karl Popper proposed falsifiability as an important criterion in distinguishing between science and pseudoscience. He argues that verification and confirmation can play no role in formulating a satisfactory criterion of demarcation. Instead, it proposes that scientific theories be distinguished from non-scientific theories by testable claims that future observations might reveal to be false.

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Science can be described as partly descriptive, partly normative. A definition of science can focus on descriptive content and specify how the term is used, or it can focus on the normative element and clarify the more fundamental meaning of the term[1]. The earliest use of this name is considered to belong to the French physiologist François Magendie, (Magendie 1843) who is considered one of the pioneers of experimental physiology. There is a divergence between the philosophers of science and some members of the scientific community about the possibility of an objective distinction between "pseudoscience" and "science."

Professor Paul DeHart Hurd believes that a great deal of scientists can distinguish between science and various pseudoscience (Hurd 1998) such as astrology, (Sfetcu 2015, 257) charlatanism, occultism (Sfetcu 2015, 229) or superstition. Pseudoscience is any subject that appears to be scientific at first glance, or whose supporters claim to be scientific, but which contravenes test conditions or deviates from other fundamental aspects of scientific methods.

Standards for demarcation may vary by domain, but several basic principles are universally accepted. All the experimental results should be reproducible, the scientific method can be applied everywhere, the prejudices can be controlled or eliminated, the experiments are correct, the studies can be objective, etc. Data to be documented for reproduction and for further studies. Statistical quantification of importance, trust, and error are also important tools for the scientific method. (Sfetcu 2015, 2)

[1] Pseudoscience is a methodology, belief, or practice considered by its supporters to be scientific, or which seems to be scientific, but does not adhere to an appropriate scientific methodology, lacking its supportive evidence or plausible character, or confirmed scientific status.

The conflict between science and pseudoscience is found, on the one hand, in the community of disciplines of knowledge that includes natural and social sciences and humanities, and on the other hand in a wide variety of movements and doctrines such as creationism (Sfetcu 2015, 112) astrology, homeopathy and holocaust denialism, in conflict with generally accepted results and methods in the knowledge community.

Not all non-sciences are pseudoscience, like metaphysics or religion. Mahner proposed the term "para-science" for non-scientific practices that are not pseudoscience. (Mahner 2007)

"Un-scientific" is a narrower concept than "non-scientific" because the first term implies a certain form of contradiction or conflict with science, and "pseudo-scientific" is more restricted than "non-scientific" because it implies an intentionality. Many authors assume that in order to be pseudoscientific, an activity or a teaching must satisfy two criteria: (Hansson 1996) (1) not being scientific and (2) its main supporters attempt to create the impression that it is scientific.

However, there are phenomena that meet both criteria, but are not pseudoscientific, such as fraud in science. Some forms of pseudoscience have as objective the struggle against a scientific theory (scientific denialism), such as the denial of the Nazi Holocaust (Gleberzon 1984) or the denial of climate change. (Williams 2005) Also, the theory of "intelligent design" (Sfetcu 2015, 103) supports a fundamentalist interpretation of genesis denying evolution.

Grove included among the pseudoscientific doctrines those who "intend to provide alternative explanations to those in science, or to pretend to explain what science cannot explain." (Grove 1985) In a wider sense, it is assumed that pseudoscience includes not only doctrines contrary to science proclaimed to be scientific but also doctrines contrary to science in court, whether or not presented in the name of science. (Hansson 1996)

Falsifiability

Karl Popper proposed falsifiability as an important criterion in distinguishing between science and pseudoscience. He argues that verification and confirmation can play no role in formulating a satisfactory criterion of demarcation. Instead, it proposes that scientific theories be distinguished from non-scientific theories by testable claims that future observations might reveal to be false. Popper draws attention to the fact that scientific theories are characterized by the existence of potential counterfeiters - statements that might be found to be false.

Popper is a realist who argues that scientific theories follow the truth; he does not believe that empirical evidence can ever give us reason to believe that a theory is true or can be true. In this sense, Popper is a fallibilist, stating that it is impossible to justify the belief that a certain scientific theory is true. Where others see the progress of science by confirming the truth of private claims, Popper describes science as progressing on an evolutionary model, the observations selecting against inappropriate theories by falsifying them. (Shea 2017) Thus, the term *falsifiability* is synonymous with *testability*.

> "My proposal is based upon an asymmetry between verifiability and falsifiability; an asymmetry which results from the logical form of universal statements. For these are never derivable from singular statements but can be contradicted by singular statements. Consequently, it is possible by means of purely deductive inferences (with the help of the modus tollens of classical logic) to argue from the truth of singular statements to the falsity of universal statements. Such an argument to the falsity of universal statements is the only strictly deductive kind of inference that proceeds, as it were, in the 'inductive direction'; that is, from singular to universal statements."
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> Karl Popper, The Logic of Scientific Discovery (K. R. Popper 2002)

Popper pointed out that non-falsifiable claims are important in science. Contrary to intuition, non-falsifiable assertions can be incorporated into - and deductively generated by - falsifiable theories. Popper invented the notion of metaphysical research programs to name such non-falsifiable ideas. Unlike positivism, which considered statements to be meaningless if they

cannot be verified or falsified, Popper argued that falsifiability is only a special case of the more general notion of criticality, even though he admitted that empirical rejection is one of the most effective methods by which theories can be criticized. Criticality, unlike falsifiability and therefore rationality, can be comprehensive (without logical boundaries), although this statement is controversial, even among the supporters of Popper's philosophy and rationalism.

Initial (naive, dogmatic, or naturalist) deduction of statements is made through *modus tollens*, through an observation. The logic of *naive falsifiability* is valid but limited, due to possible "compensatory adjustments". Popper acknowledged these limitations (K. R. Popper 2002) in response to Pierre Duhem's criticism. W. V. Quine called this the argument of *confirmation holism*. To falsify logically a universal, one can find a single true falsifiable statement, but it is always possible to change the universal statement or the existential statement so that it does not falsify. Thus, naive falsification does not allow scientists to present a definitive falsification of universal statements.

Popper denied having imagined such naive theory of falsifiability. He contests that he has ever developed a naive theory of falsifiability. From the very beginning he emphasized in his work published in 1933, and especially in 1934, that you can avoid any refutation, but that it is very important to try to build your theory in such a way that it can be denied. One may try - and he has said it explicitly in *The Logic of Scientific Discovery* - to save the theory by means of assumptions or other means. (K. Popper and Lorentz 1985)

To overcome these problems, Popper imagined that science progresses by successively rejecting falsified theories by keeping those with more explanatory power, rather than by falsified statements.

The second form of falsifiability considered was the *methodological* one. The falsificationist makes the same basic assumptions as in dogmatic falsification, but they are called *tentatives*, a set of supposedly assumptions to falsify the theories. Methodological falsifiability supports risky decisions. Although the choice we make might be wrong, the methodological falsificationist sees this as a problem of the least two evils. Paul Newall states that it is hard to criticize methodological falsification for the simple reason that it is unfalsifiable. (Newall 2005)

To reduce conventionalism from methodological falsification, Popper designed a *sophisticated* version of falsifiability based on imposed conditions, that is, the new theory to have excessive empirical content, to explain everything that was explained before, and some of these new predictions to be confirmed by experiment. A theory must not be rejected as false until a better one develops. This leads us to a notion of growth or development of theories instead of dogmatic falsifiability that accepts or rejects them in single cases and no experiment can be crucial if it is not interpreted as such after the event in the light of a new theory for which it offers corroboration. Finally, the idea of proliferation of theories (pluralism) is important for sophisticated falsifiability, unlike the dogmatic version. (Newall 2005) The conflict in science is not so between theories and experiments, but always between rival theories.

> "Whilst I do not demand any final certainty from science (and consequently do not get it), the conventionalist seeks in science ‘a system of knowledge based upon ultimate grounds’, to use a phrase of Dingler." (K. R. Popper 2002)

Lakatos states that sophisticated falsification is different from the naive both in the rules of acceptance (or the "demarcation criterion") and in its rules of falsification or rejection. There is no falsification before the occurrence of a better theory. But then the negative distinctive character of naive falsification disappears; criticism becomes more difficult and also positive, constructive. (Lakatos 1970)

The problem of sophisticated falsifiability is precisely the multitude of theories considered. In the case of two incompatible theories, we have to go back to the conventional aspects of methodological falsifiability or the incontestable hypotheses of dogmatic falsifiability to make a choice. Calling on new corroborated facts involves a clear delimitation between observational and theoretical terms, with conventional decisions on what constitutes "basic" knowledge. For naive falsifiability, science develops through the successive experimental rejection of theories; steady proliferation of theories is optional but not mandatory. For sophisticated falsifiability, proliferation of theories cannot wait until accepted theories are "rejected." While naive falsifiability emphasizes the "urgency of replacing a falsified hypothesis with a better one," sophisticated falsifiability underscores the urgency of replacing any of the best assumptions. (Lakatos 1970)

Popper says that

> "The system of basic statements, as I use the term, is to include, rather, all self-consistent singular statements of a certain logical form—all conceivable singular statements of fact, as it were. Thus, the system of all basic statements will contain many statements which are mutually incompatible. "
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> "A theory is to be called 'empirical' or 'falsifiable' if it divides the class of all possible basic statements unambiguously into the following two nonempty subclasses. First, the class of all those basic statements with which it is inconsistent (or which it rules out or prohibits): we call this the class of the potential falsifiers of the theory; and secondly, the class of those basic statements which it does not contradict (or which it 'permits'). We can put this more briefly by saying: a theory is falsifiable if the class of its potential falsifiers is not empty." (K. R. Popper 2002)

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Notes:

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Email: nicolae@sfetcu.com

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