Falsification

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Truth, Falsity, and Negation

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0 Summary of the lecture

This is a philosophical lecture with some logical additives. The aim is to consider the rival attractions of verification, or proof, or justification (total or partial) on the one side, and falsification or (more generally) criticism on the other. Old arguments will be deployed to reach the conclusion that all worthwhile uses of arguments are critical, rather than constructive, or exploratory, or persuasive.

The critical approach draws attention to unfamiliar epistemological problems, in particular the problem of overpopulation. Everyone, verificationist or falsificationist, is exposed to this problem, but so far it resists solution.

1 The criterion of demarcation

As all the world knows, in 1919, or 1931, or perhaps only in 1934, Karl Popper proposed falsifiability as the criterion with which to demarcate empirical science from non-scientific pursuits such as logic & mathematics, metaphysics, and pseudoscience. His proposal was a critical response to the criterion, propounded by the Vienna Circle, that scientific knowledge is what is empirically verifiable.

The distinctive doctrine of these logical empiricists was that there exist only two varieties of knowledge: analytic knowledge, which is justified by formal proof, and scientific knowledge, which is justified by empirical verification.

1 The exclusion of metaphysics

Traditional metaphysics and theology, being neither formally demonstrable nor empirically verifiable, are excluded as being devoid of empirical significance, as meaningless.

Popper argued against this doctrine (traceable to Hume's Enquiry and to Wittgenstein's Tractatus) that it places our best scientific knowledge (such as classical mechanics) on the wrong side of the divide. Scientific theories are typically universal generalizations, and therefore (as Hume pointed out) unverifiable by any finite amount of evidence. Many scientific theories (such as atomic theory) also had their origins in metaphysical speculations.

1 The asymmetry of verifiability and falsifiability

With regard to universal statements there is an asymmetry between verifiability and falsifiability. Some universal hypotheses are open in principle to empirical falsification, but they are not empirically verifiable. Existential statements, of course, may be verifiable but unfalsifiable. We shall see shortly why Popper's criterion does not exclude such statements as 'There exist atoms' from science.

The asymmetry was known, in various guises, to Aristotle (Physics), Pascal, Brochard (De l'erreur) and Bachelard, before Popper. The epistemological importance of error has often been rediscovered, for example by Bill Gates.

1 Pascal

Car quelquefois on conclut un absurde manifeste de . . . [la] négation [d'une hypothèse], et alors l'hypothèse est véritable . . . ; ou bien on conclut un absurde manifeste de son affirmation, et lors l'hypothèse est tenue pour fausse; et lorsqu'on n'a pu encore tirer d'absurde, ni de sa négation, ni de son affirmation, l'hypothèse demeure douteuse; de sorte que, pour faire qu'une hypothèse soit évidente, il ne suffit pas que tous les phénoménes s'en ensuivent, au lieu que, s'il s'ensuit quelque chose de contraire à un seul des phénomènes, cela suffit pour assurer de sa fausseté.

Blaise Pascal, Réponse au Révérend Père Noël, 29.v.1647

1 Pascal translated

For sometimes we conclude a manifest absurdity from the negation of a hypothesis, and then the hypothesis is true; or instead we conclude a manifest absurdity from its affirmation, and then the hypothesis is established as false; and when we have not been able to derive an absurdity, from either its negation or its affirmation, the hypothesis remains in doubt; so that, to establish the truth of a hypothesis, it is not enough that all the phenomena follow from it, but if there follows something contrary to one of the phenomena, that is enough to establish its falsity.

Blaise Pascal, Reply to the Revd Father Noël, 29.v.1647

1 Duhem's thesis

Following Duhem, it is often maintained that in sophisticated cases the falsification of a hypothesis is possible only when it is supplemented with (singular) auxiliary hypotheses. This cannot be denied, but it is not relevant to any logical thesis about scientific theories. It means only that empirical falsification is not always easy. It is a mistake to identify falsification with conclusive falsification.

Note that a universal generalization cannot be empirically verified, however many auxiliary hypotheses are introduced. We might assume enough to derive the generalization, but that would not be an empirical verification.

1 Misunderstandings of the problem

My commendation of Popper's criterion of demarcation may surprise anyone acquainted with such titles as 'The Demise of the Demarcation Problem' (Laudan 1983) and 'The Degeneration of Popper's Theory of Demarcation' (Grünbaum 1989), or the writings of Kuhn and Lakatos.

But these authors, like others, mistake the crucial philosophical task that Popper intended a criterion of demarcation to perform. The aim was never to reveal 'a surer epistemic warrant or evidential ground for science than for non-science', which Laudan lays down as a minimal condition for 'a philosophically significant demarcation'.

1 Newton and Freud

On the contrary, one of Popper's main conclusions was that epistemic warrants and evidential grounds are unnecessary fantasies. Empirical evidence simply does not perform the task traditionally allotted to it. Empirical justification is something that we can and must do without.

Nor was it Popper's principal aim to show that Newtonian mechanics is scientific, or that Freudian and Adlerian psychoanalysis and Marxist 'scientific socialism' are unscientific. True, these were the examples that prompted him to philosophical action, but the outcome of his investigation was not a mere generalization of these judgements.

1 Science as an institution

Even if Grünbaum were right that Freudian psychoanalysis is falsifiable, and Lakatos were right that classical celestial mechanics is not, the criterion of demarcation would not thereby have been demonstrated to be wrong.

Still less was the criterion of demarcation intended 'to explicate the paradigmatic usages of "scientific" ' (Laudan). For this naturalistic purpose, a description of the institutional working of science, such as Kuhn's, is doubtless to be preferred. Institutions are important, but only educational administrators and lawyers, not philosophers, are interested in a theory's scientific status in this sense.

2 The 'main problem of philosophy'

The criterion of falsifiability, despite its reputation, is designed not to demarcate the scientific from the non-scientific but to demarcate the empirical from the non-empirical. Its aim is to not to describe what science does, but to propose a rationale for useful empirical research.

This objective is stated clearly in § 10 of The Logic of Scientific Discovery (1959): 'the main problem of philosophy is the critical analysis of the appeal to the authority of experience'. The German original of Logik der Forschung (1934) reads more simply: 'das Problem der Philosophie die [kritische] Untersuchung eben jener Erfahrung ist'.

2 Why undertake empirical investigations?

In other words, Popper began to move from an unquestioned empiricism to a more sceptical empiricist position. In the mid-1950s he described the problem of demarcation as having been 'an urgent practical problem: under what conditions is a critical appeal to experience possible — one that could bear some fruit?' (Realism and the Aim of Science, published in 1983). That is to say, what can we hope to gain from an empirical investigation?

To answer this question we must take note of a more basic asymmetry than that between verifiability and falsifiability: the asymmetry between acceptance and rejection.

2 Acceptance and rejection

It makes remarkably little sense to say that a hypothesis can be accepted only if it has already been rejected. It is the other way round: a hypothesis can be rejected only if it has already been accepted — that is, entertained.

In The Logic of Scientific Discovery, §1, Popper proposed 'the view that a hypothesis can only be empirically tested — and only after it has been advanced'. In the next section he went on: 'In order that a statement may be logically examined in this way, it must already have been presented to us. Someone must have formulated it, and submitted it to logical examination.'

2 Confirmation

The acceptance of a hypothesis is a precondition for its logical and empirical investigation, not the outcome of any investigation. All that an investigation can do is to reject what has previously been accepted. Hypotheses that are not rejected remain unharmed, but still accepted.

It will be objected that an accepted hypothesis may later be empirically confirmed, and thereby become more firmly accepted. This is a psychological illusion, without objective value. Empirical confirmation, like the confirmation of a hotel booking, may make the investigator feel better, but it tells him nothing that he did not already know.

2 Direct learning

It may be possible (but I doubt it) for us to learn directly from experience, without any expectation of what may occur. Such a process of learning can produce singular knowledge, at best. It is safe to say that, in the pursuit of universal knowledge, all that we shall learn from experience is that an already formulated hypothesis is false.

Popper's criterion of demarcation follows at once. For an empirical inquiry to be worth undertaking, there must be an empirically falsifiable hypothesis under investigation. The result of the inquiry is valuable only if it is negative. Positive evidence plays no role in the search for truth.

2 Downgrading sense experience

The empiricist tradition was the home to Popper's criterion of demarcation, but it was a critical non-positivistic empiricism, in which sense experience is doubly demoted.

Falsificationism regards observation neither as the origin of knowledge nor as its basis. The empirical method rests its decisions on observation reports, not because these reports are firm, which they are not, but because they are easily checked, and easily replaced if they are found to be untenable. Observation remains a primary scientific resource, but it is not a primordial source; it remains fundamental, but it has no foundational prestige.

2 Against positive arguments

The bankrupt business of empirical justification, in which experience and induction were traditional partners, is unceremoniously dissolved. Experience is re-employed in the new enterprise of empirical falsification and criticism, but induction is permanently retired on an invalidity pension.

Not all criticism need be empirical. The above considerations apply to all fields of inquiry (except perhaps pure mathematics), yielding the conclusion that the primary role of all argument is critical rather than justificatory. The result of the inquiry is valuable only if it is negative. Positive argument plays no role in the search for truth.

3 Critical rationalism

This is Karl Popper's philosophy of critical rationalism. What is characteristic of human rationality is not the demand for, of provision of, good reasons or support or justification or legitimation for a hypothesis, theory, or course of action, but the tireless search for critical arguments against a proposed hypothesis, theory, or action.

Positive arguments or good reasons are in three ways alien to rationality. They are unattainable (because all support is circular); they are uselessly uninformative; and for those who want to learn, rather than to instruct, they are unnecessary: rational discussion is possible without them.

3 Petitio principii

A traditional sceptical criticism maintains that all valid arguments are fallacious when construed as proofs: they are viciously circular, or they beg the question, or they commit the fallacy of petitio principii. The conclusion is included within the premises, and is no more proved or justified by the premises, or by the proof, than a sentence B can be justified by itself, or by the valid proof $\mathrm{B} \vdash \mathrm{B}$.

It is often thought that only deductively valid arguments are circular in this way; that because the conclusion of an invalid (perhaps inductive) argument is not included in the premises, such an argument is not question-begging.

3 The circularity of non-deductive arguments

Mill thought this, and came to his famous conclusion that deduction is only book-keeping, that all genuine reasoning is inductive inference from particulars to particulars.

The theorem of Popper & Miller (1983) can, however, be used to dissipate the illusion that inductive arguments may rush in where deductive arguments fear to tread. It shows that the premise or assumption A of an argument, valid or invalid, to the conclusion C cannot provide any support for C. That part of C that follows from A cannot be supported by A. That part of C that goes beyond the content of A receives no positive support from A.

3 The theorem of Popper & Miller

The theorem is easy to prove if we make some rather natural assumptions about measures of support. Assume that we have a measure of support $\mathfrak{s}(C, A)$ with the properties: (i) $\mathfrak{s}(C, A) > 0$ if C implies A; (ii) $\mathfrak{s}(C, A)$ and $\mathfrak{s}(\neg C, A)$ are not both positive. An example is $\mathfrak{s}(C, A) = \mathfrak{p}(C \mid A) - \mathfrak{p}(C)$, where $\mathfrak{p}$ is a probability measure.

The conclusion C of an argument from a premise A can be naturally split into two parts: $A \vee C$, which is that part of C that follows from A, and $A \rightarrow C$, which is the excess. The former is not supported by A. As for the latter, $\mathfrak{s}(A \wedge \neg C, A) > 0$ by (i), and so $\mathfrak{s}(A \rightarrow C, A) \leq 0$ by (ii).

3 Critical arguments

The discussions above, formal and informal, point in the same direction: there are no justificatory arguments of any kind. What resources are left to the rationalist? Critical rationalists answer that critical arguments also exist, and these need not be understood in a justificationist way.

A critical argument typically has the form of a reductio ad absurdum. The difference between a justificatory (petitio) argument and a critical (reductio) argument therefore appears to be that the former assumes its conclusion, while the latter assumes the negation of its conclusion. We can learn from the latter, but not from the former.

3 Objectivity

That is to say, we can make an objective epistemological advance by use of a reductio, but never by use of a petitio. That we can improve our subjective knowledge by means of valid, and hence circular, arguments, is evident. But we cannot improve our objective knowledge by derivation, since the content of the conclusion of a valid argument is objectively in the premises, though it may be well hidden.

This cannot be right. The contradiction obtained in the course of a valid reductio argument is included in its (inconsistent) premises, and the final conclusion is also included in its premises. At neither stage is anything learnt.

4 The critical approach

How an agent learns is by making a conjecture. What happens next depends on whether he adopts a justificationist attitude, and sets out to verify or confirm his conjecture, or he adopts a critical attitude, and sets out to falsity or refute the conjecture. If he is successful in the latter case, he may proceed to unlearn what he has learnt.

It is misleading — more so than I imagined — to say that we can learn by means of experience, and that the critical approach enables us to learn (in a rational manner) how wrong we are. What it does is to enable us to unlearn rationally what we have learnt, and to learn again.

4 Defeasible knowledge

The critical attitude is a dynamic one, always seeking to overturn what is known and to replace it with something different. Since the criticism supplied at each stage is at best provisional, any step may be retraced. The history of science provides many examples of ideas that, once discredited, are able to return. Justificationists often talk in this context of defeasible knowledge. What they lack is methodology that promotes and welcomes such defeats.

Circular and critical arguments are often confused, and harmless reductiones are condemned as circular. Many attacks on realism are dismissed for presupposing realism.

4 Theory-laden observations

In a 1989 paper entitled 'Can a Theory-laden Observation Test the Theory?', Allan Franklin and 13 others wrote:

> **A more difficult problem arises when the apparatus . . . depends for its proper operation on the theory of the phenomena under test. There would seem to be, at first glance, a vicious circularity if one were to use a mercury thermometer to measure the temperature of objects as part of an experiment to test whether or not objects expand as their temperature increases. . . . Such a thermometer depends on that same hypothesis for its proper operation. We believe, however, that one could use a mercury thermometer in such a test. All that would be required would be the ability to calibrate such a thermometer against another thermometer whose operation depends on a different theory . . . .**

4 Is logic beyond criticism?

The mathematician–physicist Oliver Heaviside may have been right when he said that '[l]ogic can be patient, for it is eternal'). Was he right too when he said that '[l]ogic is invincible because one must use logic to defeat logic'?

It is generally thought that there is something special about logical rules, or about those rules, such as reductio ad absurdum $\mathbb{RAA}$ and modus tollens $\mathbb{MTT}$, that are essential to the practice of critical argument. Habermas and Apel have claimed that to argue against the rules of logic is to commit a performative contradiction. Thomas Nagel and W. W. Bartley have written in a similar vein.

4 Proving invalidity

If the rule $\mathbb{R}$ of inference is supposed (or presupposed) to be valid, and a counterexample is derived with its help, then either the rule $\mathbb{R}$ itself, or one of the other rules used in the derivation, or one of its premises, cannot be valid.

Let $\mathbb{R}$ be the rule $\mathbf{A} \vdash \mathbf{C}$, and $\mathbf{B}$ be a true statement. Using $\mathbb{R}$ we may derive $\mathbf{F}(\mathbf{B})$ from $\mathbf{T}(\mathbf{B})$. What we assumed, and what we have just derived from it using $\mathbb{R}$, namely $\mathbf{F}(\mathbf{B})$, show that the instance $\mathbf{B} \vdash \mathbf{B}$ of $\mathbb{R}$ has a true premise and a false conclusion. Even more simply, we may use $\mathbb{R}$ to derive '$\mathbb{R}$ **is invalid**' from any sentence we choose. Either way, we have a proof that $\mathbb{R}$ is invalid.

5 Permanent inconsistency

Bacon lamented the absence of a tabula rasa, but Baconian inductivism, and more generally every verificationist approach to scientific knowledge, tries to build up science securely from scratch. No hypothesis is accepted, in the sense of accepted as knowledge until it is verified or confirmed. For inductivists and verificationists, the corpus of what is known at any moment is therefore consistent.

But for falsificationists, who see the second stage of the acceptance process as just the exercise of a personal foible, matters are less easy. The set of hypotheses under consideration is always going to be an inconsistent set.

5 An opening for paraconsistent logic

Since we want to exploit our knowledge deductively, we cannot rest content with the idea with what we know at any moment — and therefore at every moment — is inconsistent. In such circumstances, the falsificationist imperative, that we must do all we can to falsify the hypotheses that we have surmised, is pointless. Hypotheses can indeed be falsified, but they cannot be eliminated.

In my book Out of Error (Ashgate 2006) I suggested that here was a place where paraconsistent logic might be of some service. The paraconsistent logic that I had in mind was the now quite well known system of Brouwerian logic.

5 Brouwerian logic

Brouwerian is a strict dual to intuitionistic logic, based on the connectives $\wedge$, $\vee$, $-$, and $\bot$. It contains in place of the conditional $A \to C$ the remainder $A - C$, defined as the logically strongest element B such that $A \vdash B \vee C$:

$$\Gamma, A - C \vdash B \quad \text{if \& only if} \quad \Gamma, A \vdash B \vee C.$$

There is no easy natural-language reading of the remainder operation $-$ as a connective, and the logic is tricky to work with (though it is undemanding algebraically).

I chose this logic principally in order to dualize Dummett's claim that verificationism leads to intuitionistic logic.

5 The interpretation of intuitionistic logic

Falsificationism is a realistic philosophy, whose theory of truth is transcendental. The paraconsistent logic proposed cannot therefore be a logic of truth, but it may serve, I suggest, as a logic of what we regard as falsified.

In the semantics for intuitionistic logic, due to Kanger and others, each node β of the well founded tree is home to some set of elementary propositions $\mathbf{p}$ in agreement with the rule that if $\mathbf{p} \in \alpha$ and $\alpha \leq \gamma$ then $\mathbf{p} \in \gamma$. Compound propositions are attached to nodes according to well known recursive rules, the most important of which is: $\mathbf{A} \rightarrow \mathbf{C} \in \alpha$ if & only if $\mathbf{A} \notin \gamma$ or $\mathbf{C} \in \gamma$ for all $\alpha \leq \gamma$.

5 The interpretation of Brouwerian logic

The propositions situated at a node β are understood to be those that have been proved at or before the time β.

The semantics may be dualized, with the requirement that if $\mathbf{p} \in \gamma$ and $\alpha \leq \gamma$ then $\mathbf{p} \in \alpha$. There are similar recursive rules to decide which compound propositions reside at which nodes. The rule for the remainder reads:

$\mathbf{A}-\mathbf{C} \in \alpha$ if & only if $\mathbf{A} \in \gamma$ and $\mathbf{C} \notin \gamma$ for some $\gamma \geq \alpha$.

The proposed interpretation is that the propositions at a node β have been proposed, but not yet falsified, at β.

5 Can anyone do better?

It follows that $\neg B \in \beta$ if & only if B is either falsified at β or unfalsified but falsifiable at β (these are the propositions that, according to Popper, are genuinely scientific); and that $B \wedge \neg B \in \beta$ if & only if B is both unfalsified and falsifiable at β, in other words, B is a proposition that is a candidate for the truth at β if & only if $B \wedge \neg B \in \beta$.

The main difficulty here is that to obtain the duality with proof, we had to assume that if $p \in \gamma$ and $\alpha \leq \gamma$ then $p \in \alpha$; that is, that all propositions situated somewhere in the tree are situated at its root. This requirement does not hold in any realistic portrayal of the scientific process.