

The Bain of Two Truths

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Abstract

A view among methodologists is that truth and convergence are related in such a way that scientific theories in their historical order of appearance contribute to the convergence to an ultimate ideal theory. It is not a fact that science develops accordingly but rather a hypothetical thought experiment to explain why science develops at all. Here, a simple formal model is presented for scrutinizing the relations between two truths and convergence.

1 Types of Convergence

Typically convergence arguments are viewed as supportive frames for some version of scientific realism. Scientific realism was originally associated with a Platonic idea. The things that are really here in the world are the unworldly forms; reality is beyond the sensory experience and that is what episteme is to grasp. Convergence, if anything, is finite convergence to the truth about the realm of forms. Contemporary scientific realism relaxes the Platonic metaphysics. Realism insists on a theory independent reality and for the reality to be independent of theory is not the same as transcending all possible experience. "Truth" is the epistemological correlate to the ontological "being". Since reality is independent of the scientific theories about it no guarantees can be provided to the effect that one will ever find the truth let alone know the truth. But there are indications that science is on the truth-track as scientific inquiry is not to be identified with any form of arbitrary inquiry. It is a self-correcting, error-eliminating and technologically sophisticated endeavour which, as time goes by, obtains better and better epistemological accuracy. The better the accuracy, the closer to the truth and the existence of the entities claimed by different sciences. For instance what has been labelled as the *convergence argument of*

experimental results points to the independent outcomes of experiments all supporting the same theoretical state of affairs. If the entities and posits postulated in the hypotheses don't refer to anything at all in the real world, but rather are made-up constructions then one should be tempted to think that the observable outcomes should rather diverge than converge. But the fact that they converge exactly witness verisimilitude or truth rather than a cosmic coincidence and insofar, according to Putnam [Putnam 78b], [Putnam 78a], renders realism the only tenable metaphysical position not making the general success of science a miracle.

The realist is willing to wait, even willing to wait all the way to limit. This may very well turn out to a substantial wait and is still consistent with the possibility of disappointment. As time does not guarantee that the theory independent reality conforms to the scientific theories about it in an isomorphic way. The general anti-realistic attitude on the other hand is that such a guarantee is to be provided because anti-realism declares bogus the realistic idea of a world whose intrinsic structural nature is strictly independent of the scientific theories about it. Peirce's version of pragmatism is an instance of anti-realism because the ideal theory converged to licenses the definition of truth which again is exhausted in limiting consensus. Limiting consensus is detectable. Another pragmatist W. James holds a similar view

The absolutists in this matter say that we not only can attain to knowing the truth, but we can also know when we have attained to knowing it; while the empiricists think that although we may attain it, we cannot infallibly know when. [James 60], pp. 95.

Both scientific realism and anti-realism may subscribe to a notion of convergence; it's just a matter of what one claims to converge to. Consider positivism. Even given its anti-realistic garments it may still be affiliated with a view of convergence since the cumulative nature of science should eventually result in the true picture of the world. But the world of what? Positivist rage over metaphysics and the verificationistic criterion of meaning would conclude that convergence to the truth only includes convergence to the *world of experience* and its possible course since that is the only world existing to science. There is Kantian support for this view because of the world in itself hypotheses are neither true nor false hence convergence to true (or false) hypotheses only applies to the world of experience. One of the most prominent contemporary neo-positivists and anti-realists Bas van Fraassen has launched a very influential argument as to why attention should be restricted to the world of experience and observables. By extending positivistic semantics he accuses realism of committing itself to something that it cannot provide namely "literally true" descriptions and theories of the world. Most theories are metaphorical accounts, but metaphorically true accounts do not sum literary truth and what is really there. Instead science should only be asked to deliver what it can deliver: empirically adequate theories [?]. The empirical adequacy only requires that there be at least one model under which all the observational sentences are true; this

suffices to "save the phenomena". Now, what Van Fraassen essentially does is to replace the cognitive goal of truth with the more lenient one of empirical adequacy and this substitution does not obscure sound scientific inquiry. It does restrict convergence to the world of experience however.

So it seems that depending on whether one is a realist or a anti-realist may choose to converge in two different ways. They two ways are dubbed:

- *Epistemical convergence*
- *Ontological convergence*

Primitively speaking convergence solely means for the method to stabilize to some hypothesis and not perform any subsequent mind-changes concerning the hypothesis never minding what the future brings regarding the subject matter. One may *converge epistemically* if one converges in all possible worlds in the background knowledge extending the empirical values of the world observed so far. It is called epistemic convergence because what constitutes the background knowledge in principle is free to fluctuate in accordance with one assumes to be viable alternatives to the actual world. Suppose on the other hand that the cognitive goal requires for its satisfaction the method to identify the actual world. This is a stronger notion of convergence since it forces the method to make a conjecture that encapsulates the way the world really is from here to eternity. This is essentially what *ontological convergence* amounts to; the prospect of which many epistemologists and philosophers of science have remained rather skeptical:

One often hears that successive theories grow ever closer to, or approximate more and more closely to, the truth. Apparent generalizations like that refer ... to its ontology, to the match, that is, between the entities with which the theory populates nature and what is 'really there'.

There is, I think, no theory independent way to reconstruct phrases like 'really there': the notion of a match between the ontology of a theory and its 'real' counterpart in nature now seems to me to be illusive in principle. ... if the position is relativism, I cannot see that the relativist loses anything needed to account for the nature and development of the sciences. [Kuhn 70], pp. 206.

Recall that when a scientist is working within a particular accepted constellation of ideas, methods, tools, exemplars, instrumentation and instrumental techniques but also general theoretical and *metaphysical* assumptions the scientist is said, according to Kuhn, to be working within a specific paradigm. In the period of normal science the scientists will articulate the paradigm in their ongoing attempt to account and accommodate the behavior of some relevant aspects of the real world as revealed through the results of experimentation. Parts of the articulation should go to show the adequacy of the paradigm as a representation of the world and insofar prove its relative ontological adequacy. Hence one may speak of ontological convergence to some hypothesis. But the ontological

convergence is only *relative* to a given paradigm. A new paradigm may include other incommensurable ontological assumptions so there is no unique notion of ontological convergence *trans-paradigmatically*. Hence, according to Kuhn, in comparing trans-paradigmatically one may only speak of *epistemic* convergence in some particular paradigm. This lack of a unique ontological convergence to a hypothesis across paradigms has often motivated critics of Kuhn to label his position as relativistic.

Relativism may mean many things including the subjectivist's view that whatever some method believes is true for that method and truth is exhausted in what that method chooses to believe. Subjectivism is however more an extreme type of relativism than a general characterization of the position. Relativism is not equivalent to arbitrariness. A sanitary version of relativism advocates the systematic dependency of truth or correctness on some parameter that the method is able to tune or joggle. But:

The adoption of one parameter as opposed to another is arbitrary, but the truth relative to a given parameter is not. [Kelly 96], pp. 380.

If convergence to the truth was understood subjectively then true convergence would be a fairly trivial and uninteresting matter. The method would just have to believe something and fix this belief as truth. This would go for both epistemical and ontological convergence. But even a sober relativist committed to the view that there is no such thing as ontological convergence across paradigms may still place his money on ontological convergence relative to some asserted paradigm and its metaphysical presuppositions. However standing outside some paradigm looking in, only amounts to possible epistemical convergence to some hypothesis.

Anti-realists cannot comply with the dictum of the extreme realist. When a scientist converges to some hypothesis or theory he does not assert the truth of it, only displays it and claims a variety of virtues for it which for their part may fall very short of truth. The lack of truth does not obscure the aim of science (across possible paradigms) which is to tell a reasonable or empirical adequate story about the world. Relativism does not imply subjectivism and if truth both depends upon things over which the scientist has control and upon things over which he has no control, then the scientist may not know exactly how truth depends upon what he chooses to do. It may still may be hard for the scientist to converge to a true (relative to the prevalent paradigm) hypothesis even if he is of a relativistic mind—just as hard as it may be for the (moderate) realist.

All but the extreme realist and the extreme relativist (*i. e.*, subjectivist) may legitimately operate with a notion of epistemical convergence relative to the background knowledge of empirical possibilities without in any way committing themselves to ontological convergence. Essentially whether one favors possible epistemical or ontological convergence depends upon the adopted definition of truth of a hypothesis in a world.

2 Knowledge and Truth

The above discussion on convergence and truth did not make much of an attempt to clarify what truth essentially is. And for a good reason: Truth is, and has always been, philosophically an odd beast. A great number of definitions and theories pertaining to truth have been advanced over the years and we are not about to launch yet a new definition or theory. The cognitive goal or correctness relation of science may be theoretical truth or something like it but in principle could be substituted for a host of others as Van Fraassen has done with empirical adequacy above. Thus, let's merge and distill two the most dominant views regarding correctness in the aim of distinguishing between two distinct cognitive goals reflecting insights that philosophers and epistemologists have had regardless of whether they are believers in truth as such or not

2.1 The Trouble with Truths

Paul Benacerraf provides an instructive sketch of the general problem. In discussing the concept of mathematical truth Benacerraf quoted at some length notes that even though the discussion revolves around mathematical truth, also broader epistemological issues concerning knowledge of mathematics and knowledge in general, are at stake:

It is my contention that two quite distinct kinds of concerns have separately motivated accounts of the nature of mathematical truths: (1) the concern for having a homogeneous semantical theory in semantics for the propositions of mathematics parallel the semantics for the rest of the language, and (2) the concern that the account that the mathematical truth mesh with a reasonable epistemology". [Benacerraf 96], p. 14.

Benacerraf continues to argue that attempts to clarify the former often enough involve neglecting or even violating the latter and vice versa. The two conflict:

Since I believe further that both concerns must be met by any adequate account, I find myself deeply satisfied with any package of semantics and epistemology that purports to account for truth and knowledge both within and outside of mathematics. For as I will suggest, accounts of truth that treat mathematical and non-mathematical discourse in relevant similar ways do so at the cost of leaving it unintelligible how we can have any mathematical knowledge whatsoever: whereas those which attribute to mathematical propositions the kinds of truth conditions we can clearly know to obtain, do so at the expense of failing to connect these conditions with any analysis of the sentences which shows how the assigned conditions are conditions of their truth. [Benacerraf 96], p. 14.

Now, truth and semantics should hook up with epistemology in such a way that an explanation is furnished of how knowledge of the truth is possible to obtain. On the semantical side, Benacerraf suggests a Tarskian approach:

"I take it that we have only one such account: Tarski's, and that its essential feature is to define truth in terms of reference (or satisfaction) on the basis of a particular kind of syntactico-semantic analysis of the language, and thus that any putative analysis of mathematical truth must be an analysis of a concept which is a truth concept at least in Tarski's sense". [Benacerraf 96], p. 19.

On the epistemological half it is argued that:

"To put it more strongly, the concept of mathematical truth, as explicated, must fit into an over-all account of knowledge in a way that makes intelligible how we have the mathematical knowledge that we have. An acceptable semantics for mathematics must fit an acceptable epistemology". [Benacerraf 96], p. 19.

On these two counts, Benacerraf and Van Fraassen's express congruent views from their respective positions of mathematics and philosophy of science. Van Fraassen's formal formulation of empirical adequacy relies heavily on model theoretic properties and he notes with respect to the language of science in general that:

"What we should try to do here is to characterize (fragments of) scientific language by means of the concepts of formal semantics but in such a way that the model structures derive in an obvious way from the models of scientific theories". [van Fraassen 80], p. 199.

The reason why the model structures should be derived in an obvious way from the models of scientific theories is exactly that the scientific theories should be empirically adequate, hence the models making the theories so adequate should be within reach of the *acceptable epistemology* (in reference to Benacerraf above) called (constructive) empiricism:¹

One relation a theory may have to the world is that of being true, of giving a true account of the facts. It may at first seem trivial to assert that science aims to find true theories. But coupled with the preceding view of what theories are like, the triviality disappears. Together they imply that science aims to find a true description of unobservable processes that explain the observable ones, and also of what are possible states of affairs, not just of what is actual. Empiricism has always been a main philosophical guide in the study of nature. But empiricism requires theories only to give a true account of what is observable, counting further postulated structures as a means to that end. ... So from an empiricist point of view, to serve as the aims of science, the postulates need not be true, except in what they say about what is actual and empirically attestable. [van Fraassen 80], p. 199.

¹Observe that it is not claimed that Benacerraf holds the same (constructive) empirical view on mathematics that Van Fraassen holds towards science. It is only claimed that they express the same sort of conditions to be met by any theory of truth and knowledge.

Now if we on top of these two requirements add in the Kuhnian variable to the equation which should yield knowable truth, truth must be such that it conforms to the paradigmatic structure and the relativistic dimension:

The world that the student then enters is not, however, fixed once and for all by the nature of the environment, on the one hand, and of science on the other. Rather it is determined jointly by the environment and the particular normal-scientific tradition that the student has been trained to pursue". [Kuhn 70], p. 111-112.

In conclusion, the trouble with truth is then twofold:

1. *The truth should be knowable.*
2. *The truth should respect the paradigmatic structure of science.*

Below, a formal concept of truth called *epistemic truth* is presented which essentially is a mixture of Van Fraassen's empirical adequacy, Kuhnian paradigmatics and which also restricts the scope of truth and falsity to the world of experience or phenomena as Kant requires:

"Our critical deduction by no means excludes the things of that sort (noumena), but rather limits the principles of the Aesthetic² in such a way that they shall not extend to all things (as everything would then be turned into mere appearance) but that they shall hold good only of objects of possible experience. Hereby, then, beings of the understanding are admitted, but with the inculcation of this rule which admits of no exception: that we neither know, nor can know anything determinate whatever about these pure beings of the understanding, because our pure concepts of the understanding as well as our pure intuitions extend to nothing but the objects of possible experience, consequently, to mere things of sense; and as soon as we leave this sphere, these concepts retain no meaning whatsoever". [Kant 64], p. 57-58

Benacerraf speaks of what he calls the "standard view" of mathematical truth and knowledge which he finds unacceptable since:

"As I have suggested above, the principal defect of the standard view is that it appears to violate the requirement that our account of mathematical truth be susceptible to integration into our over-all account of knowledge". [Benacerraf 96], p. 22.

The standard view is an extreme realism of a Platonic nature which attributes a standard model consisting of "independent" objects to classical theories expressed in a first order language. For instance, while Peano axiomatized number theory, Frege ontologically reduced the natural numbers to sets that

²I. e. the principles of sensibility, particularly, space and time.

are all extensions or purely logical concepts. Frege's Platonistic conception of numbers as unituitable objects is of course very anti-Kantian. Kant was not of the opinion that mathematics is Platonistic. For Kant, mathematics construct its objects in the "pure intuitions" of space and time. Then the mathematical objects are the *a priori* forms of transcendently ideal empirical objects. Now the Kantian combination of epistemic empiricism with ontological idealism explains the physical applicability of mathematics and licences scientific legitimacy to mathematical procedures.

To do justice to a whole tradition we choose to introduce yet another notion of truth which blends Platonic forms with Kantian noumenon.

3 Types of Truth

The formal model of inquiry is rendered from [Hendricks 01], [Hendricks 03] and [Hendricks 07]. An evidence stream ε is an ω -sequence of natural numbers, *i. e.*, $\varepsilon \in \omega^\omega$. Hence, a data stream $\varepsilon = (a_0, a_1, a_3, \dots, a_n, \dots)$ consists of code numbers of evidence, *i. e.*, at each stage i in inquiry a_i is the code number of all evidence acquired at this stage. Continue to define a possible world. A possible world is a pair consisting of a data stream ε and a time n , (ε, n) , such that $\varepsilon \in \omega^\omega$ and $n \in \omega$. The set of all possible worlds $\mathcal{W} = \{(\varepsilon, n) \mid \varepsilon \in \omega^\omega, n \in \omega\}$. Let $(\varepsilon \mid n)$ denote the finite initial segment of a world (ε, n) . Furthermore $\omega^{<\omega}$ denotes the set of all finite initial segments of elements in ω . Let $[\varepsilon \mid n]$ denote the set of all infinite evidence streams that extends $(\varepsilon \mid n)$. Refer to the finite initial segment $(\varepsilon \mid n)$ as the *handle* with *fan* $[\varepsilon \mid n]$. The world-fan is defined as $\widetilde{[\varepsilon \mid n]} = [\varepsilon \mid n] \times \omega$. The background knowledge of accessible possible worlds is defined as the set of all worlds that extends $(\varepsilon \mid n)$, *i. e.* background knowledge $[\varepsilon \mid n]_{\mathcal{K}} = \{\widetilde{[\varepsilon \mid n]} \mid \mathcal{K}\}, \mathcal{K} \subseteq \mathcal{W}$. Note that as time goes by, the background knowledge concentrates ever tighter around the actual world course.

$$[\varepsilon \mid n+k]_{\mathcal{K}} \subset \dots \subset [\varepsilon \mid n+3]_{\mathcal{K}} \subset [\varepsilon \mid n+2]_{\mathcal{K}} \subset [\varepsilon \mid n+1]_{\mathcal{K}} \subset [\varepsilon \mid n]_{\mathcal{K}}.$$

This is by all means an interesting characteristic because it points to how background knowledge may be understood from a broader epistemological and scientific point of view. The handle is the raw evidence that the world presents to science which scientists then identify as X-ray radiation, Zeeman effects, electromagnetic phenomena, etc. These phenomena simply exist but the interpretation of them may fluctuate as Kuhn pointed out. The phenomena exist independently of whether they are actually identified or not—they don't step into existence just because they are discovered, even though they step into epistemic existence for the scientist. In consequence, to denounce the handle is to denounce the world. Kuhnian paradigmatics are not to be identified with irrationalism such that some new paradigm simply denounces the existence of certain phenomena but just points to the fact that these phenomena may be interpreted in different ways. The fan represents the ways in which the phenomena may be interpreted according to the paradigm. Now any later paradigm must take the indisputable

existence of these phenomena into account. Science evolves because it as times goes discovers explanations to a great variety of indisputable phenomena. From this point of view it makes sense to say that one background knowledge is included in another later background knowledge exactly because the background knowledge respects the phenomena that the world has shown science up until "now", yet the interpretation of the phenomena is allowed to diverge.

The method that the scientist applies conjectures hypotheses in response to the evidence seen so far. In accordance with standard practice identify hypotheses with sets of possible worlds, *i. e.* the set of all empirical hypotheses $\mathcal{H} = P(\omega^\omega \times \omega)$ such that an empirical hypothesis h is a member of \mathcal{H} . Finally a scientific discovery method is a function from finite evidence sequences to hypotheses: $\delta : \omega^{<\omega} \longrightarrow \mathcal{H}$.

3.1 Epistemic Truth

Recall that the background knowledge consists of the empirical possible values the world may take from a given time onward. When truth has to be knowable based on Tarski-like semantics Hence one way to understand truth is that that truth is a relation between obtaining between some held hypothesis and the set of possible empirical world courses relative to the background knowledge. A concept of truth for *phenomena* called *epistemic truth*.

Definition 1 *Epistemic truth*

$$\begin{aligned} & \text{Hypothesis } h \text{ is true}^E \text{ in world } (\varepsilon, n) \\ & (\text{i.e., } (\varepsilon, n) \text{ validates } h) \Leftrightarrow [\varepsilon \mid n]_{\mathcal{K}} \cap h \neq \emptyset. \end{aligned}$$

The epistemic notion maintains that h is true in (ε, n) just in case there is a non-empty intersection between the background knowledge $[\varepsilon \mid n]_{\mathcal{K}}$ and the hypothesis h . In other words (ε, n) agrees with h up until and including n and from there on, the fan of (ε, n) , *i. e.*, the background knowledge $[\varepsilon \mid n]_{\mathcal{K}}$ must only have a non-empty intersection with h , though no single world is be picked out. Some may object that this notion is consistency with the evidence rather than a concept of truth. Realize though that h is considered to be epistemically true in a world (ε, n) if and only if:

- *the hypothesis (or proposition, i. e. set of possible worlds) corresponding to h is verified by evidence up to n ,*
- *possibly the hypothesis will be verified by future evidence in the sense that there exists possible worlds in the proposition corresponding to h which are consistent with existing evidence.*

Epistemic truth is hence more than consistency with the evidence but still a rather weak conception of truth as it only guarantees possible truth in the future. It is evident in the epistemic notion of truth that

$$\text{if } (\varepsilon, n) \text{ validates } h \text{ then } (\varepsilon, n - 1) \text{ validates } h.$$

But not the other way around, *i. e.* (ε, n) *validates* h does not imply $(\varepsilon, n + 1)$ *validates* h . What does hold however is the following which goes to show how a notion of possibility is inherent in the notion of epistemic truth:

if (ε, n) *validates* h then $\exists(\tau, n + 1) \in [\varepsilon \mid n]_{\mathcal{K}} : (\tau, n + 1)$ *validates* h ,

and even

if (ε, n) *validates* h then $\exists\tau \in [\varepsilon \mid n] \forall k \in \omega : (\tau, k)$ *validates* h . \blacktriangle

If anything is, this seems to be what Van Fraassen means by empirical adequacy:

To believe a theory is to believe that one of its models correctly represents the world. You can think of the models as representing the possible worlds allowed by the theory; one of these possible worlds is meant to be the real one. To believe the theory is to believe that exactly one of its models correctly represents the world (not just to some extent, but in all respects). Therefore, if we believe of a family of theories that are all empirically adequate, but each goes beyond the phenomena, then we are still free to believe that each is false, and hence their common part is false. For that common part is phrasable as: one of the models of one of the theories correctly represents the world". [van Fraassen 80], p. 47.

It is also immediate that epistemic truth is more than consistency with the evidence. Consistency with the evidence simply requires that

$$(\varepsilon \mid n) \cap h \neq \emptyset$$

while epistemic truth requires two conditions to be met:

1. h is consistent with the evidence up to n , *i. e.*, $(\varepsilon \mid n) \cap h \neq \emptyset$,
2. it is not possible to provide a counterexample to h given
 - (a) all the information acquired up until and including n and
 - (b) the background knowledge $[\varepsilon \mid n]_{\mathcal{K}}$.

Epistemic truth is also a verificationistic and conservative truth-concept while a hypothesis is considered true if it is not falsified by evidence up till now. A hypothesis is epistemically false if it is actually falsified by existing evidence, *i. e.*

$$[\varepsilon \mid n]_{\mathcal{K}} \cap h \neq \emptyset \text{ (i.e. } [\varepsilon \mid n]_{\mathcal{K}} \subseteq \bar{h}\text{)}.$$

3.2 Metaphysical Truth

A concept of truth for *nouemena* dictates that truth isn't held relative to the background knowledge of possible empirical values but rather demands identification of the only world (an sich) in which the hypothesis in question holds:

Definition 2 *Metaphysical truth*

Hypothesis h is true^M in world (ε, n) (i.e., (ε, n) validates h) $\Leftrightarrow (\varepsilon, n) \in h$.

For the metaphysical truth of a simple empirical hypothesis h it is also clear that

(ε, n) validates h iff (ε, k) validates h for all k .

4 Truthful Simultaneity

Finally, it is worthwhile to examine the interrelations between epistemic and metaphysical truth of hypotheses since these interrelations have implications with respect to both the intrinsic characterization of the notion of truth and furthermore carry implications as to the inquiry method's epistemic performance.

First of all, it is impossible to have a hypothesis which is metaphysically true but epistemically false, since

$$(\varepsilon, n) \in h \text{ and } [\varepsilon \mid n]_{\mathcal{K}} \cap h = \emptyset. \quad (0)$$

is a contradiction, which of course is as it should be.

However, the following three relations are consistent possibilities of alethic simultaneity:

$$(\varepsilon, n) \in h \text{ and } [\varepsilon \mid n]_{\mathcal{K}} \cap h \neq \emptyset. \quad (1)$$

1 is clearly a possible scenario since a hypothesis may well be metaphysically and epistemically true simultaneously.

Now consider the case where a hypothesis is simultaneously metaphysically and epistemically false, *i. e.*:

$$(\varepsilon, n) \notin h \text{ and } [\varepsilon \mid n]_{\mathcal{K}} \cap h = \emptyset. \quad (2)$$

In this case, there exists falsifying evidence at a time m earlier than n such that:

$$\exists m < n : [\varepsilon \mid m]_{\mathcal{K}} \cap h \neq \emptyset \text{ and } [\varepsilon \mid m + 1]_{\mathcal{K}} \cap h = \emptyset. \quad (2^*)$$

Finally consider the case in which a hypothesis is metaphysically false but at the same time epistemically true:

$$(\varepsilon, n) \notin h \text{ and } [\varepsilon \mid n]_{\mathcal{K}} \cap h \neq \emptyset. \quad (3)$$

In this case there exists falsifying evidence at some point in the *future*. That is,

$$\exists m \geq n : [\varepsilon \mid m]_{\mathcal{K}} \cap h \neq \emptyset \text{ and } [\varepsilon \mid m + 1]_{\mathcal{K}} \cap h = \emptyset. \quad (3^*)$$

However, it is not possible for the method to find falsifying evidence prior to $m + 1$. Furthermore, a method δ may know h at time n since it will conjecture h as true in all extensions of $(\varepsilon \mid n)$. This is essentially a *closed world assumption*: Method δ assumes h to be epistemically true unless the accumulated evidence at a given time in the world history shows otherwise. This is also in agreement with usual praxis in statistical methodology. If existing evidence does not refute your hypothesis then accept it.

You may have epistemic knowledge, but you cannot be sure that it extends to metaphysical knowledge. But then again, who can when you are just an epistemic agent equipped only with background knowledge? That's the bain of two truths.

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