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Critical Rationalism and Bayesianism

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Abstract: Most accounts of the scientific method, e.g.s the Deductive-Nomological (D-N), Inductive Statistical (I-S), and so on, attempt to avoid Hume's problem. Popper's philosophy of critical rationalism and subjectivist Bayesianism come into conflict here on a number of points. The most noteworthy is on the problem of induction. That is, if science rests on induction (as Sir Francis Bacon would have it), and induction cannot be justified according to the strict demands of classical deductive validity without invoking a circularity, how can we say that science is rational? And how should scientists proceed? Bayesians utilizes a consistent multivalued logic that adheres to the Kolmogorov axioms. And on the other side, Sir Karl Popper maintains that the real logic of science is deductive. It is a myth that induction is even used. I will evaluate both claims through a third-party lens. That is, Micheal Ruse' s epigenetic account of inferential reasoning. This is a modified version of Hume's propensity theory. Ultimately, deductivism cannot explain how proto-humans behaved in the wild. How they grew smarter, became tool-using beings, and became the dominant species on the planet.

Keywords: Induction, Bayes, Bayes' theorem, critical rationalism, Karl Popper, deductivism, problem of induction, epigenetic

I. Introduction

A debate between Francis Bacon and David Hume sets the stage for our topic. In the *A Treatise of Human Nature* (1739-40), and his shorter work, the *Enquiries Concerning Human Understanding* (1748), Hume pointed our attention to the old sceptical idea that thinking subjects cannot *know*. If we see a billiard ball hit another, we expect the second billiard ball to move. He alleged this connection between cause and effect was only a psychological necessity informed by custom or habit. We are aware of no principle in nature informing us that this must be the case. Since Bacon's *Novum Organum* (1620), allegedly the logic of science rested on this type of reasoning. It was steeped in observation and did not resemble the logic of Aristotle which was popular with the scholastic philosophers hitherto in medieval Europe Hume held that reasonings such as all A's are B's is the same type of reasoning based on the relation of cause and effect.[1] There may be an A that is not a B no matter how many times in nature I have seen the two being concomitant. It is fallible logic. Aristotle's syllogistic logic that was prevalent before Bacon, did not have this problem.

To begin, I offer three broad accounts of how to overcome the problem of induction, **(i)** Bayesian reasoning offers a probabilistic answer. Our answer to the question of whether or not the next raven I see will be black will not be in a binaristic form, but somewhere in between the values of 0 and 1. Our answer will not be deductively valid, nor does it have to be. **(ii)** Popper's answer, in contrast, is that scientific reasoning is deductive. We offer hypotheses and then subject them to crucial experiments. The logic follows *modus tollens*: p →q, ~q ∴~p. This is entirely deductive. Like Bayesians and Popperians, Michael Ruse's **(iii)** epigenetic account of induction dovetails well with Humean scepticism. He relies upon the propensity theory of inductive inference. This is the sceptical conclusion that the necessary connection between cause and effect is a psychological propensity which "speads itself on nature".[2] It is in agreement with the third position that I will evaluate they first two.

"*Induction, i.e. inference based on many observations, is a myth. It is neither a psychological fact, nor a fact of ordinary life, nor one of scientific procedure*."

—Sir Karl Popper
Conjectures and Refutations, p.53
Routledge Classics, 1963

II. Bayes' Theorem and Subjectivism

The most common form of Bayesian reasoning launched against Popperians is personalist or subjectivist Bayesianism. The subjectivist or personalist Bayesian account holds a normative constraint on degrees of belief. That is, the values computed with

[1] Hume's argument was first forwarded in Book I. Part III. §6. of *A Treatise of Human Nature* written in 1739-40.
[2] In Book I. Part III. §XIV. of the *Treatise* he advances the propensity theory. He writes: "Tis a common observation, that the mind has a great propensity to spread itself on external objects, and to conjoin with them any internal impressions, which they occasion, and which always make their appearance at the same time that these objects discovery themselves to the senses. (1896):165.

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Bayes theorem are not a probabilities out there in the world, they are *credences*.[3] The reiterative use of Bayes' theorem gives us an epistemic account of scientific reasoning. *An Essay Toward Solving a Problem in the Doctrine of Chances* was published posthumously by his friend Richard Price two years after the Rev. Thomas' death in 1761. The theorem is as follows:

$$P(A|B) = \frac{P(B|A)P(A)}{P(B)}$$

It is important to know how they claim the theorem is used in cases of scientific inference. The account is both normative, and in some cases descriptive. The theorem is to be used reiteratively. As more data comes in, the prior probabilities will change, ideally, to reflect a population's real state of affairs. Posterior probabilities are those calculated out given new information. This process is called "conditionalization". It is rational to reason in line with this theorem it is argued, because it is based on betting behavior.[4] For every black raven I see, the probability that the hypothesis that 90% of all ravens with converge on that figure, assuming it is an accurate reflection of reality. Probable reasoning has the advantage of giving us only a percentage of a population that A may be B.[5]

At the time of this writing, personalist Baysianism appears to be one of the best alternatives out there. Reiterative use of Bayes theorem and the concept of conditionalization lead to a consistent epistemic system for updating our beliefs based on observations. As time went on and we tried to verify or theory about ravens, we may discover that our figure of 90% is correct. Bayesian logic is multivalued and does not have the problem binary logic does. There are three major problems one comes across in the literature: the problem of prior probability, the problem of old evidence, and the problem of the single case. The first two have been dealt with extensively by Bayesian philosophers, the last is one that concerns me personally as a philosopher of science. I will not go into it here. However, in contrast, Popper's methodology is reliant on *modus tollens*, is bound to classical syllogistic deductive validity, and all of the classic binary constraints that go along with it. We must remember that a sentence of the form $(p \rightarrow q)$ must be either true or false according to deductive validity.

III. Popper's Critical Rationalism

Bayes'is inductive and invalid in contrast. Perhaps Popper can convince us either that induction is not used, or that his deductive system has the advantage. Ever since Bacon's stress on observation-statements, the quest been to find *the* account of science. Bacon reviled the stagnant syllogistic method of the scholastic philosophers.[6] The next hurdle for philosophers of science has since been Hume, who took an opposing view. Popper writes:

Hume, I felt, was perfectly right in pointing out that induction cannot be logically justified. He held that there can be no valid logical arguments allowing us to establish that I do not think that, if we accept the suggestion that "in agreement with reality" and "true" are Thus a "good" or "valid" rule of inference is useful because no counterexample can be found.[7]

Key ideas requisite for understanding Popper's system are *corroboration*, *crucial experiments*, and *conjectures*. In his 1934 *Logic of Scientific Discovery* (*L.Sc.D.*), he laid the foundation for an entirely deductive philosophy of science. This has the advantage of avoiding Humean worries outright. Scientists start with conjectures (guesses): "There is no such thing as a logical method of having new ideas, or a logical reconstruction of this process. My view may be expressed by saying that every discovery contains an irrational element, or a creative intuition."[8] There are only two steps, then: the introduction of the hypothesis, and then the attempt to falsify it with a crucial experiment. If a theory passes a crucial experiment, it is said to be corroborated. Theories with a high *degree of corroboration* are preferred to those with a high degree of probability.[9]

Criticisms of Popper's methodology abound. Colin Howson and Peter Urbach claim that Popper's ideas do nothing to solve the problem of induction.[10] They are some of the most vociferous against critical rationalism.

[3] An excellent discussion of what credences are, and how they are work can be found in Micheal Titlebaum's *The Foundemantals of Bayesian Epistemology, Vol. 1: Introducing Credences*. Oxford: Oxford University Press, (2022).
[4] The Dutch book argument in favor of subjective Bayesianism argues that if a bettor's reasoning is not in line with the axioms of probability, he is subject to a Dutch book. Meaning, he could lose money. See, e.g. Mike Titlebaum. *Bayesian Epistemology, Vol.2*. Oxford: Oxford University Press (2022).
[5] It has been pointed out that an inference to a population from a sample falls prey to a Humean objection as well.
[6] See Francis Bacon, *Novum Organum*. London & New York: Collier and Son, (1902).
[7] Karl Popper, *Conjectures and Refutations*, London: Routledge, (1963): 55.
[8] *Logic of Scientific Discovery*, p.8.
[9] Karl Popper, *The Logic of Scientific Discovery*. London & New York: Routledge Classics. (2007): 125.
[10] Howson and Urbach *Scientific Reasoning: The Bayesian Approach*. Chicago: Open Court (2002): 2.

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Popper's idea that unrefuted but corroborated hypotheses enjoy some special epistemic virtue led him to recommend that scientists should seek out and give preference to such hypotheses. There was also a descriptive aspect to the recommendation, for popper assumed mainstream science is conducted more or less as he believed it ought to be.[11]

Throughout Howson and Urbach's *Scientific Reasoning: the Bayesian Approach*, there are numerous claims that Popperian H – D is not descriptive of the actual practice of science. Another generally voiced complaint lodged by philosophers of science against Popper is that we can never conclusively falsify nor verify a theory. A theory can never be verified, only corroborated (which is also a cumbersome concept). Also, we must remember on Popper's system we can never consider a theory to be true, only verisimilar. Answers are fallible. There are many other debates between the subjectivist Bayesian and Popperian schools of thought, although what is most striking is Popper's claim that induction is not used in science. With that, we turn to our next subject.

IV. A Third Party Evaluation

We have seen how both approaches attempt to avoid the problem of induction. With Popper's Hypothetico-deductivism, hypotheses are brought forward and subjected to crucial experiments, where they are either falsified or corroborated. The system uses *modus tollens* and therefore remains entirely deductive. Bayesians argue that induction is not valid according to the strict demands of deductive validity. Instead, it is probabilistic, and the values are between 0 and 1, it is not binaristic. Probabilistic reasoning doesn't need to be valid according to the demands of strict deductive logic at all. It is a different kind of logic. To mediate between *modus tollens* and a multivalued logic as viable responses to Hume, I will use Michael Ruse's epigenetic account, which uses the propensity theory. The propensity theory presents us with yet a third viable account of how to deal with Hume's problem of induction, since it is reliant on Hume's own sceptical account.

Ruse takes an entirely different tack. He writes: "We need to look at the principles of scientific reasoning or methodology. And as I am sure you now realize, what I argue is that these principles have their being and only justification in their Darwinian value, that is in their adaptive worth to us as humans – or, at least, our proto human ancestors.[12] He argues that induction *does* exist, although it is a psychological propensity. Hume maintained this. So far, both, to an extent, Bacon and Hume are right. In his discussion of science, Ruse offers an example of why he thinks induction would be crucial to evolutionary success of our proto-human ancestors. He writes:

Consider two would-be human ancestors, one with elementary logical and mathematical skills, and the other without very much in that digestion. One can think of countless situations, many which would have happened in real life, where the proto-human would have a great selective advantage over the other. [. . .] Two tigers were seen going into the cave. Only one came out. Is the cave now safe?[13]

The question now becomes *which of the two proto-humans was your ancestor*? Of course, the answer was that the proto-human who had the predisposition to induce would have the selective advantage in the wild. Ruse goes into some detail, but the propensity to induced is called a "secondary epigenetic rule".[14] These rules are encoded and passed on in our genes. This can, in turn, explain why humans are so smart. The above line of thought would be a naturalistic argument for the psychological account of induction. If one is persuaded by this argument, our evolution as a species has had a hand in how we use reasoning processes such as deduction and induction.

V. Conclusion

The important outcome of these considerations is that Karl Popper's comment about induction in his 1963 *Conjectures and Refutations* must be false taken at face value.[15] The epigenetic account of Micheal Ruse was chosen because I liked the argument, it was a radical alternative to both ideas presented, which avoids the problem of induction. If proto-humans thought only deductively, they would have perished. If one discards Ruse's considerations, there is still the fact that Bayes' as an alternative, is a formal, consistent system used for inducement. The last and final hurdle to overcome is the contention voiced by Colin Howson, Peter Urbach, and others that it is putatively true that scientists use induction. From fields as diverse as marine biology and agricultural science, one can see it in scientific papers. Conclusions are derived from observations. Admittedly, there are other positions one

[11] Ibid., p.3.
[12] Michael Ruse. *Taking Darwin Seriously*. New York: Prometheus Books (1998): 155.
[13] Ibid., p.162.
[14] Ibid., p.145.
[15] "Induction, i.e. inference based on many observations, is a myth. It is neither a psychological fact, nor a fact of ordinary life, nor one of scientific procedure." Karl Popper, *Conjectures and Refutations,* London & New York: Routledge Classics (2002): 53.

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could hold in evaluating the two positions, and I see room for exploration. But how can we say that science is rational and how should scientists proceed? Shrugging off induction seems to be a tall order.

Subjectivist Bayesianism has a whole stock of argumentation surrounding it. Not the least of which is whether an objective version would work or not. Ruse offers an anthropologically behavioral epigenetics of inductive reasoning rather than a logical account with his primate scenarios. I have held tacitly the problem of induction originates from Sir Francis Bacon's initial attempt to codify the propensity into a form, Hume pointed this out. Ruse sidesteps Hume's argument and supports the propensity theory. There are many nuances between Popper and subjective Bayesians that cannot be capture here, such as the topic of corroboration versus probability. Ultimately, I find Popper's attempt to solve the problem by claiming a completely deductive system to be heroic to an extent. Perhaps a stronger, more revised form, critical rationalism can overcome these obstacles.

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