Howson 1
Popper; Bayesianism

(pp. 1–11)

Patrick Maher
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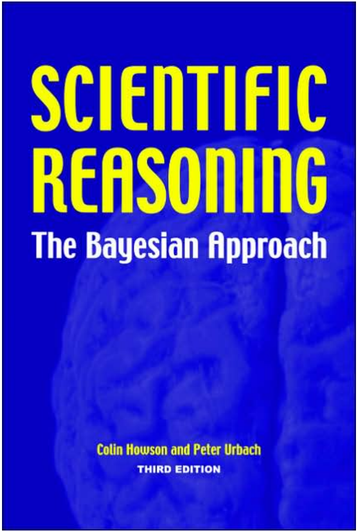
The book



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How should hypotheses be evaluated, what is the role of evidence in that process, what are the most informative experiments to perform? . . . Our approach to these questions, which we set out in this book, is the Bayesian one, based on the idea that valid inductive reasoning is reasoning according to the formal principles of probability. (p. xi)

The problem of induction (p. 1)

Scientific hypotheses have a general character relative to the empirical observations they are supposed to explain, carrying implications about phenomena and events that could not possibly figure in any actual evidence. For instance, Mendel's genetic theory concerns all inherited traits in every kind of flora and fauna, including those that are now extinct and those that are yet to evolve. There is therefore a logical gap between the information derived from empirical observation and the content of typical scientific theories. How then can such information give us reasonable confidence in those theories? This is the traditional Problem of Induction.

Popper's solution the problem of induction (pp. 2–3)

- Theories can be falsified deductively.
  - This occurs when T implies E but we observe not-E.
- Theories may be "corroborated."
  - This occurs when T implies E and we observe E (and T hasn't been falsified).
  - Corroboration doesn't prove T is true.
  - Popper said it is rational to rely on corroborated theories.

Example

Let T be "All swans are white."

- Observation of a non-white swan would falsify T.
- Observation of white swans corroborates T (provided no non-white swans have been observed).

Criticism of Popper's solution (p. 3)

When a particular theory is corroborated (in Popper's sense) by evidence, so are infinitely many other theories, all rivals to it and to each other. Only one of these can be true. But which?

Example (modified version of example on p. 3)

Suppose that all crows that have been observed so far have been black. Then these hypotheses are corroborated:

- All crows are black.
- Crows observed before 2010 are black; the others are white.
- Crows observed before 2011 are black; the others are gray.
- Etc.

The question of how to support a rational preference amongst these hypotheses then remains. And it is evident that Popper's ideas do nothing to solve the problem of induction. (p. 3)

Scientific method in practice (pp. 3–5)

- Popper only dealt with evidence that is implied by a theory or inconsistent with it. He said:
  - Evidence that is implied by a theory corroborates it.
  - Evidence that is inconsistent with a theory falsifies it.
- But most scientific evidence is not related to theories in either of these ways.
  - Evidence that confirms T is usually not implied by T.
  - Evidence that disconfirms T is usually not inconsistent with T.

There are three reasons why this is so.

Reason 1: Auxiliary hypotheses (p. 4)

Many deterministic theories that appear in science, especially the more significant ones, often have no directly testable deductive consequences, and the predictions by which they are tested and confirmed are necessarily drawn only with the assistance of auxiliary theories.

Example

Newton's law of gravitation: $F = Gm_1 m_2/d^2$. Suppose we want to test this by observations of the motion of the moon.

- What we observe is not forces but motions, so we need to use Newton's second law of motion, $F = ma$.
- We need to know the distances of the moon to other masses that may influence its motion, e.g., to the earth and the sun.
- These distances are calculated using further laws, e.g., that light travels in straight lines.

No observations are implied by Newton's law of gravitation alone.

Reason 2: Probabilistic theories (p. 5)

There are scientific theories that are probabilistic, and for that reason have no logical consequences of a verifiable character.

Example

Mendel's theory of inheritance says that if Aa is crossed with Aa then:

$$P(\mathrm{AA}) = 1/4, \quad P(\mathrm{Aa}) = 1/2, \quad P(\mathrm{aa}) = 1/4.$$

This is tested by observing frequencies.

- If the observed frequencies are close to the probabilities, that confirms the theory.
- If the frequencies are far away from the probabilities, that disconfirms the theory.

But all frequencies are consistent with the theory; none are logically implied by it.

Reason 3: Experimental error (p. 5)

Even deterministic theories may be confirmed or disconfirmed by evidence that is assigned only some probability. This may arise when a theory's quantitative consequences need to be checked with imperfect measuring instruments, subject to experimental error.

Example (p. 5)

The position of a planet at a certain time will be checked using a telescope whose readings are acknowledged in experimental work not to be completely reliable, on account of various unpredictable atmospheric conditions affecting the path of light to the telescope, as well as other uncontrollable factors, some connected with the experimenter and some with physical vagaries. For this reason, quantitative measurements are often reported in the form of a range of values, such as $a \pm b$*, where* a *is the recorded reading and* $a - b$ *and* $a + b$ *are the bounds of an interval in which it is judged that the true value very probably lies.*

Probabilistic induction (p. 6)

- *Many scientists believe that the explanations that they think up can secure for themselves an epistemic status somewhere between the two extremes of certainly right and certainly wrong.*
- *This spectrum of degrees of certainty has traditionally been characterized as a spectrum of probabilities.*

Example

Henri Poincaré, the noted mathematician and physicist, asked himself what right he had as a scientist to enunciate a theory such as Newton's laws, when it may be just chance that they are in agreement with all the available evidence. How can we know that the laws will not break down the next time they are tested? "To this objection the only answer we can give is: It is very improbable."

Logical and subjective approaches (p. 8)

Philosophers have attempted to explicate the intuitive notion of probability in two main ways:

1. *The first regards the probabilities of theories as objective, in the sense of being determined by logic alone, independent of our subjective attitudes towards them . . . This would largely solve the problem of induction and establish an objective and rational basis for science.*
2. *The other . . . treats the probability of a theory as a property of our attitude towards it; such probabilities are then interpreted, roughly speaking, as measuring degrees of belief . . . The scientific methodology based on this idea is usually referred to as the methodology of Bayesianism, because of the prominent role it reserves for a famous result of the probability calculus known as Bayes's theorem.*

Better terminology (by me)

- Bayes's theorem is due to Thomas Bayes, 1702–1761. He assumed a logical conception of probability.
- The logical approach uses Bayes's theorem in the same ways that the subjective approach does.
- Therefore, Howson and Urbach's justification for calling the subjective approach "Bayesianism" is spurious.
- The real "justification": In recent times, most Bayesians have been subjectivists.
- Better terminology:
  - Anyone who uses probabilities and Bayes's theorem to evaluate scientific theories is a Bayesian.
  - There are two kinds of Bayesian: logical and subjective.
- In this terminology:
  - Bayes was a logical Bayesian.
  - Howson and Urbach are subjective Bayesians.

Questions

1. What is the problem of induction, according to Howson and Urbach? What facts make it seem to be a problem?
2. What is Popper's solution to the problem of induction? What is Howson and Urbach's first criticism of this solution?
3. The evidence that scientists consider as confirming a theory is often not a logical consequence of the theory. Describe three common kinds of situation in which this happens.
4. What does the term "Bayesian" usually refer to, according to Howson and Urbach? What reason do they give for this? Is their reason an adequate justification for using the term this way? Why, or why not?