Rights from wrongs

Stathis Psillos

Error and the Growth of Experimental Knowledge. By Deborah G. Mayo. University of Chicago Press: 1996. Pp. 493. \$74, £59.25 (hbk); \$29.95, £23.95 (pbk).

How does evidence relate to theory? Karl Popper thought that evidence can exercise only negative control: it can only falsify a hypothesis. Inductivists protested that this distorts the way in which theories are and should be evaluated, claiming that evidence can also exercise positive control: it can confirm a hypothesis in the sense that it can make the hypothesis more probable than it was taken to be before the evidence came in.

There was hope that a solution might be found when Rudolf Carnap attempted to show, based on the probability calculus, that this intuitive idea can be developed into a precise logic comparable to deductive logic. Carnap thought that, in a manner analogous to full entailment, in which whenever the premises are true, the conclusion has to be true, we might have objective degrees of entailment: a piece of evidence confirms a hypothesis by partially entailing it. But 'inductive logic', as it came to be known, was not to last. Applying the probability calculus required that some initial weight should be given to the hypotheses. Any attempt to equi-partition the weight across these hypotheses, based on an intuitively clear principle of indifference, led to paradoxes and incompatible confirmation measures.

The current orthodoxy in confirmation theory takes its cue from Carnap's failures. 'Bayesians', so called because of the central role they attribute to Bayes' theorem of probability calculus, suggest that the degree of confirmation of a hypothesis by some piece of evidence is captured by the difference between two probabilities: the posterior probability of the hypothesis given the evidence, minus its prior probability, its initial weight before the evidence came in. This neat idea offers a general model of scientific inference: on learning the evidence, use Bayes' theorem to update the initial degree of belief in the hypothesis. The posterior probability of the hypothesis thus calculated is the agent's new degree of belief in the hypothesis.

If Carnap's principle of indifference fails, where do the Bayesians' initial weights come from? The standard 'subjectivist' answer is that they express the agent's subjective degree of belief in the hypothesis. Bayesians are not concerned with how the initial probability distribution is determined, but rather with how one's degrees of belief should be redis-

tributed once the evidence is accepted.

Bayesian confirmation theory successfully tackled several problems and paradoxes that plagued its rivals, and so enjoys great respect. But many philosophers of science are naturally unhappy with its reliance on subjective degrees of belief as a means of specifying prior probabilities. Deborah Mayo offers a sustained and systematic critique of this subjectivism. But she also advances an alternative to Bayesianism that rests on the standard Neyman-Pearson statistics and uses error probabilities understood as objective frequencies. Mayo's error probabilities do not characterize the degree of confirmation of a hypothesis; they refer to the experimental process itself, and specify how reliably it can discriminate between alternative hypotheses.

Mayo is very sensitive to the severe criticism that has been directed at the underlying Neyman-Pearson statistics. To get round this, she tries to show either that the criticism has been based on a misinterpretation of the Neyman-Pearson statistics or, where the criticism finds its target (for example, the critics' point that the Neyman-Pearson statistical methods cannot show how a test can provide strong or weak evidential support to a hypothesis), that there are ways to develop the theory so that the objections are met.

Mayo's multi-targeted book weds her error-probabilities approach with the recent work in experiments and scientific model building to provide a general framework of experimental learning. Ian Hacking has shown that experiments have a life of their own, independent of high-level theorizing. What Mayo adds, in an engaging and well-argued way, is that experimental learning also has a life and a model of its own. Experimental learning is intimately connected with severely testing experimental hypotheses using reliable test procedures (those that have a high probability of detecting an error if there is one, and not registering an error if there is not). Experimental learning may be messy and piecemeal, and may require a tool-kit of techniques that ensure low error probabilities, but, as Mayo shows, it can be embedded in a rather neat statistical framework that makes a virtue out of our errors.

There might have been more about how and whether these insights apply to full-blown scientific theories. Mayo is aware of the significance of the problem, but does not discuss it in any detail. Despite this, however, there is a high probability that this important book will make an impact on the scientific community. □

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