September 1997

Book Review of Deborah G. Mayo, Error and the Growth of Experimental Knowledge (University of Chicago Press 1996)

Kristin S. Shrader-Frechette

Book Review of Deborah G. Mayo, Error and the Growth of Experimental Knowledge (University of Chicago Press 1996)

Erratum

The second paragraph of this article incorrectly identifies a Neyman-Pearson statistical term as the "confidence-internal" method. The correct term is ""confidence-interval."

Book Review

Deborah G. Mayo, **Error and the Growth of Experimental Knowledge**
(University of Chicago Press 1996). Figures, index, preface, references. ISBN
0-226-51197-9 [493 pp. $74.00 Cloth; $29.95 Paper. 5801 S. Ellis Ave., Chicago, IL
60637.]

At the heart of many risk estimation controversies is the use of
subjective probabilities and expert judgments of risk. It is well known
that different experts often calculate annual risk probabilities for new
technologies or impacts, that vary by as much as six orders of
magnitude. The subjectivity in risk estimation and the disagreement
among risk assessors would not be so troublesome if they did not have
practical consequences in terms of life and death. Overconfidence biases
in risk estimates could lead to underregulation and greater threats to
life, while underconfidence biases in risk estimates could lead to
overregulation and fears of technology that are not warranted.

One reason for the controversy over risk estimates and for the
failure to correct subjective risk assessments is that mathematicians
themselves are divided on the meaning of probabilities and how to
check for probabilistic and statistical error. Presently, statistical practice
in science is at odds with the dominant philosophy of experiment. On
the one hand, the cornerstone of the current philosophy of experiment
is one or another of Bayesian methods. All presuppose that one can use
prior probability assignments to hypotheses, generally interpreted as an
agent's subjective degrees of belief. For Bayesians, a probability
represents the degree of subjective confidence (usually varying with the
evidence) in a proposition. On the other hand, statistical practice is
based on classical and Neyman-Pearson (NP) statistics (e.g., statistical
significance tests, confidence-internal methods) that eschew the use of
prior probabilities when these cannot be based on actual frequencies.

Mayo attempts to show that her reinterpretation of NP statistics is a
viable alternative to Bayesian approaches. She argues, for example, that
defects of one (behavioral) model of NP tests erroneously have been
taken as defects in NP methods themselves. When one uses her model
of NP tests, as Mayo says Egon Pearson intended, then "accept H"
does not mean "take action A rather than B" (as Newman saw it) but
rather "infer a specific error is ruled out" by the data. If one accepts

Mayo's account of NP methods and interprets Peircean induction as severe testing, then it is possible to reconcile philosophy of experiment with statistical practice in science.

Mayo's approach is premised on what she calls the "error-statistical account," learning piecemeal from mistakes and focusing on a statistical procedure's error probabilities to scrutinize objectively inferences based on test results. By her account, methodological rules for experimental learning are strategies that enable learning from common types of experimental mistakes. The rules systematize the day-to-day learning from mistakes. From the history of mistakes made in reaching a type of inference, one can develop a repertoire of errors and methodological rules (techniques for circumventing and uncovering errors). Some rules refer to before-trial experimental planning, others to after-trial data analysis. Although similar to Karl Popper's approach, Mayo shows that an hypothesis that he would count as "best tested" is not necessarily "well tested" for her.

Apart from its theoretical contributions to new intepretations of Kuhn and Popper, as well as solutions to important problems in philosophy of science (underdetermination, the nature of scientific progress, induction, objectivity and the role of novel evidence), Mayo's book is significantly practical. Researchers in all sciences can profit from her analyses of modelling patterns of irregularities useful for discovering errors. She discusses both philosophy of statistics and statistical methodology insightfully, making them accessible to laypeople and thought-provoking for experts — and a major contribution to science and philosophy and the foundations of risk identification and estimation.

Thanks to penetrating works like this, risk assessors, mathematicians and scientists may be more likely to learn from mistakes. They also may be less likely to exhibit the subjective and prejudicial probabilities for which risk assessment is sometimes infamous.

Kristin S. Shrader-Frechette[†]

[†]   Dr. Shrader-Frechette is Distinguished Research Professor in the Environmental Science Program and the Department of Philosophy at the University of South Florida. She holds an undergraduate degree in mathematics and physics, and a doctorate in philosophy of science from the University of Notre Dame.