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Book Reviews

In my review of *Ecotoxicology: A Comprehensive Treatment* by Michael C. Newman and William H. Clements in the last issue (vol. 4, no. 4), I attributed the concept of satisficing to Julian Simon. Actually, it was developed by a more illustrious economist with the same last name, Herbert Simon. Herbert Simon won the Nobel Prize for his development of decision theory for organizations, including the concepts of bounded rationality and satisficing and the application of path analysis. He also made major contributions to artificial intelligence, including codeveloping the first reasoning computer. Julian Simon is best known for arguing against the need for either conservation of resources or population control and for winning two public bets with Paul Ehrlich. My apologies to the readers for any confusion that resulted from my mental lapse. If anyone is interested in learning more about the more illustrious Dr. Simon's contributions, I recommend Hunter Crowther-Heyck's biography *Herbert A. Simon*, published in 2005 by Johns Hopkins University Press.

Also, some readers interpreted my presentation of alternatives to two ideas in the Newman and Clements text as an attack on the quality of the book itself. The presentation of contrasting views was meant to highlight the fact that the book presents potentially controversial concepts that could prompt useful debate and deeper consideration of concepts associated with ecotoxicology. As I concluded in the review, I recommend that readers buy the Newman and Clements text if they want a conceptual approach to ecotoxicology. For an academic's review of the book, see *Limnology and Oceanography Bulletin* (vol. 17, no. 2, June 2008).

SETAC Book Reviews Editor

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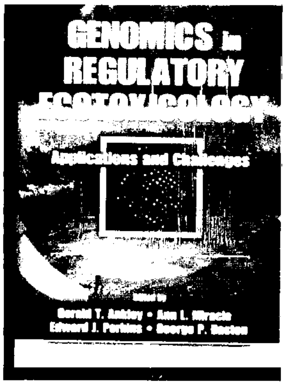
GENOMICS IN REGULATORY ECOTOXICOLOGY: APPLICATIONS AND CHALLENGES

edited by Gerald T. Ankley, Ann L. Miracle, Edward J. Perkins, and George P. Daston



Genomics is the hot new thing in ecotoxicology. Like biomarkers in the 1980s and 1990s, genomics provides an opportunity for investigators to apply novel and highly technical methods, and it promises to solve many of the problems of the old methods of organismal toxicology. However, biomarkers never became standard tools for assessing the risks of new chemicals or the risks from existing environmental contaminants. This is in part because of the inertia of assessors in regulatory agencies and the regulated community. Even more, it was because the developers of biomarkers did not understand the problems and the needs of problem solvers.

Gary Ankley and his coeditors have attempted to avoid that fate by bringing together scientists engaged in genomics research with assessment scientists from government and industry. They discussed at a Pellston workshop in 2005 and present in this book strategies for making genomics useful in a various regulatory and management contexts. The major topics were screening, tiered testing, pesticide regulation, complex mixtures, and contaminated sites. Each chapter addresses potential uses and research needs. The emphasis is on the capability of genomics to reveal mechanisms of action that can potentially allow assessors to predict effects and diagnose the causes of ongoing effects. Anyone who is working in this area and wants their work to be used and not just published should read this book.

It is important that this workshop and its proceedings be the beginning of an ongoing process of communication, planning research, and development. In particular, it would be valuable to organize and fund case studies in which genomic techniques are applied to real problems.

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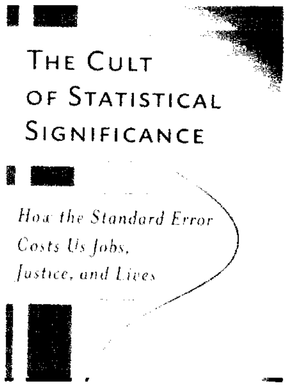
THE CULT OF STATISTICAL SIGNIFICANCE: HOW THE STANDARD ERROR COSTS US JOBS, JUSTICE, AND LIVES

by Steven T. Ziliak and Deirdre N. McCloskey



Many papers have been written and many talks presented about the technical, conceptual, and practical problems with statistical hypothesis testing. Close to home, Mike Newman recently presented an excellent review of the inferential problems in *Environmental Toxicology and Chemistry* (vol. 27, no. 5). Now, a complete book has been devoted to the issue by two economists. They attack the issue on three fronts: historical, technical, and practical.

The historical material deals primarily with two figures. The first, William Gosset (aka Student), was a brewer with Guinness and an important early contributor to statistics. He is best known for the *t* distribution for small sample statistics. More important to these authors are his attempts to get Fisher and others to pay attention to the magnitude of differences and not just to their "significance." The other is Sir Ronald Fisher himself. Fisher is portrayed as brilliant but arrogant and determined to impose his vision of statistics on the world. In particular, he opposed any consideration other than significance, as he defined it, in statistical analyses. In his influential texts, he reduced Gosset's contributions to the providing the distribution for the *t* test.

The technical arguments are the weakest part of the book because they are scattered through the book and often repeated but never fully developed. The major argument is that people need to know whether an effect is big enough to support a decision (e.g., is the increase in yield big enough to cover the cost of the fertilizer?), but hypothesis testing does not address that need. As a result, people implicitly or explicitly assume that a statistically significant difference is big enough to have real-world significance, but an insignificant difference is trivial. A second problem is that hypothesis testing deals with only random sampling error, leaving out the often larger uncertainties due to bias, confounding, misspecification, systematic measurement error, and so on. The fundamental logical problem is the fallacy of the transposed conditional. People want to know the probability that a hypothesis is true given the data, but hypothesis testing addresses the probability of the data given the null hypothesis. Fisher was aware that hypothesis testing could not support decisions because of these features of his tests, but his answer was to argue that the word "decision" should be struck from the vocabulary of statisticians.

The practical components of the book are chapters and sections dealing with the influence of hypothesis testing in specific technical fields. These include economics, drug testing, psychology, and epidemiology. Although the discussions of drug regulation are the scariest, I found the epidemiology sections most interesting. The famous epidemiologist Kenneth Rothman tried and largely failed to expunge hypothesis testing from epidemiology through his text books and journal editorships.

So, if Fisher's hypothesis tests are technically and practically problematical, why are they used so commonly? The authors suggest some reasons, but it seems to me that the most important one is that it allows people to avoid thinking about real significance. In most cases, scientists and statisticians are not particularly qualified to resolve issues of real significance. The designated decision makers often do not want to deal with significance either, so they are happy to let the statistics provide a pseudoanswer. My evidence to support this explanation is an analogous case. Both LC50 and LD50 values are used as benchmarks for acute toxicity even though they are clearly not minimal effects. Like significant effects from hypothesis tests, they are justified by statistics rather than real-world significance. That is, they are the minimum variance estimates from exposure–response models. Hence, it appears that environmental toxicologists, at least, are enamored not so much with hypothesis testing as with letting statistics decide which results to report.

The solution, it seems to me, is to leave policy judgments like significance to policy makers. Often this can be done generically, as in the U.S. Environmental Protection Agency's cancer risk range of 10^{-6} to 10^{-4}. When decisions must be case specific, the responsible decision maker must assume his or her responsibility. That leaves scientists and statisticians to simply provide estimates with appropriate expressions of uncertainty. That still leaves problems to be resolved, such as what sort of bounds are appropriate and how uncertainties other than sampling error should be incorporated However, they are solvable once we give up the habit of letting statistics make decisions for us.

2008. 320 pp. Softcover. ISBN 0-472-05007-9. $25. U. Michigan Press, Ann Arbor, MI.

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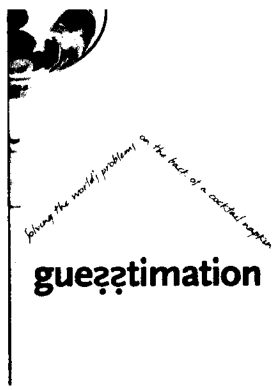
GUESTIMATION: SOLVING THE WORLD'S PROBLEMS ON THE BACK OF A COCKTAIL NAPKIN

by Lawrence Weinstein and John A. Adam



Fermi problems are quantitative problems that are intended to teach approximation and dimensional analysis. They originated with Enrico Fermi, who used them as a tool to teach introductory physics students how to address quantitative problems before they learned any physics. The classic Fermi problem is "How many piano tuners are there in Chicago?"

This is a book of Fermi problems. The authors contend that the ability to solve such problems is generally useful and that many companies present Fermi problems to interviewees for jobs or promotions to determine whether they can think quantitatively. The book begins with very brief (2 pages) advice on how to attack the problems, a few examples, and instruction in arithmetic with exponents and units conversion. Appendices contain some handy numbers, such as the population of the United States and the density of lead. The rest of the book consists of problems and explanations of how to derive the answers. Some of them are trivial (What is the mass of a mole of cats?), but others are highly topical (How much farmland would be required to power all cars in the United States with ethanol from corn?).

This book is an entertaining diversion. Keep it on the corner of your desk and, when you get bogged down with some problem, pick it up and go through one of these problems. It will give you a sense that everything has a solution. As the authors point out, factor-of-10 precision is sufficient to make most decisions that depend on quantitative information. Even