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Book Reviews

Books for review are to be sent to the Book Review Editor Jan Wretman, Statistical Research Unit, Statistics Sweden, S–115 81 Stockholm, Sweden.

Bateson, N., Data Construction in Social Surveys. George Allen and Unwin, London,1984, ISBN 0-04-312021 (Hardback), 0-04-312021-0 (Paperback), x + 138 pp., £ 6.95 (Paperback), £ 14.95 (Hardback).

In the preface, Bateson states that the topic of his book is "the theory, and the need for such a theory, of a part of the social survey method" (p.ix) and, later, this part is identified as data collection, or in his terminology, data *construction*. In reviewing the book, it is important to distinguish his progress in developing the theory and his argument that such a theory is needed. Bateson does quite a good job of sensitizing the reader to recognize the different perspectives of actors in the survey research process. His comments thus provide a framework for understanding this process as a social event and, by developing his theory in this way, he provides some interesting insigths. Moreover, his discussion helps to clarify notions about data quality and, ultimately, about the utility of survey research. However, the usefulness of this theory, in the sense of practical applications developed from such a theory, is not established in the book.

The first part of the book (Chapters 1 through 3) develops the basic concepts of data construction and establishes some premises for the validation of survey data. Bateson finds a balance between two extreme positions on the validity of survey data – one that naively accepts all survey data as equally valid and the other that believes survey data to be essentially invalid because the researcher must impose a subjectivity that alters social reality. He agrees with the view that data are subjective, that they are constructed, not merely collected. The researchers who pose topics for survey research, authors of survey questionnaires, interviewers who ask questions and record responses, and the coders who prepare the responses for data reduction all have a hand in shaping the data obtained from survey research efforts. Furthermore, these data are the result of an interaction with an informant (or, more conventionally, a respondent) who adds his or her own subjectivity to the data construction process.

These various perspectives are summarized in a three-part model of the data construction process: the *client,* who poses the initial topics of research and later analyzes and interprets the results; the *researcher,* who is responsible for the data construction activities; and the *social world,* usually represented by a respondent, or as Bateson prefers, an *informant.* Knowledge is produced by the interaction of the client and the social world and this interaction is shaped by the procedures instituted by the survey research professional or organization. The researcher performs a critical role in translating the client's questions to the informant and translating the informant's responses to the client.

These concepts lead Bateson to some observations on the quality of survey data and validation methods. The validity of data must consist of both *relevancy* to the needs of the client as well as *accuracy* in representing the social world. After reviewing several approaches to the issue of validation – criterion validity, face validity, construct validity, and content validity – Bateson suggests an approach that methodically evaluates each task in the data construction process against criteria for the performance of that task. In the logic of this "process validation," if the process is valid, then the data are valid. The validity of the process is determined not by comparing the results to the results of some other data construction process, but by comparing the process itself to methodological principles based on an understanding of the data construction process. These principles are not fully articulated in the book, although the second part (Chapters 4 through 8) presents steps toward their development. As in the development of any theory, the principles are ever-evolving as the body of empirical knowledge of the survey process continues to grow.

It is difficult to find fault with Bateson's suggestions. However, I believe the activity he prescribes for theory development already occurs in every reputable survey research organization. The importance of testing each step in a survey against established methodologies and the importance of questioning the methodological dicta themselves are built into standard procedures at these organizations. Bateson's arguments do demonstrate that such rigorous examination is a necessary part of methodological development; however, I believe this conclusion is understood, implicitly if not explicitly, by every experienced survey researcher.

The book's intended audience is somewhat unclear. In the preface, Bateson claims not to offer advice in the matters of detail that a novice might require. Later, however, he compares his purpose with Davis (1971). Where Davis shows how to start with a set of figures and end up with a statistical report, Bateson wants to show how to start with a given research question and end up with a set of figures. Bateson's is the more ambitious task, but Davis's is the more successful book. A novice can rely on Davis's book as an introduction to general principles of data analysis and could produce a competent piece of work after studying the book. A novice could not plan and manage a survey research effort having read Bateson's book.

This book is most useful to readers with at least some background in survey research. The discussion is thought provoking and the thoughts provoked are worthwhile; however, I do not believe that the concepts would be readily grasped by a novice. To the extent that survey research is a science, it is essentially an applied science and is therefore best understood in the context of on-the-job experiences. For experienced survey researchers, the book may serve a consciousness raising function, but other works, amply referenced by Bateson, as well as personal experiences should serve the same purpose. (Rossi et al. (1983) covers the same ground and provides very practical material that is missing from Batesons's book.) If the book is to be used as a text, it should definitely be accompanied by other works, many of which can be selected from this book's bibliography.

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Franke, J., Härdle, W., and Martin, D. (Eds.), Robust and Nonlinear Time Series Analysis. Lecture Notes in Statistics 26. Springer Verlag, Heidelberg, 1984, ISBN 3-540-96102-X, ix + 286 pp., DM 43.

The book contains 16 articles written by some of the leading experts in the field. Originally the articles were presented at a workshop organized by the Sonderforschungsbereich 123 "Stochastische Matematische Modelle," Heidelberg, 1983. As a whole, the articles convey a good picture of recent advances in robust methods in time series analysis. The technical level is varied, and the book is not to be recommended as an introductory text to time series analysis.

The editors have written the introduction. From a sketch of Gaussian and second order based inferential procedures, they present situations where conventional techniques may lack robustness. The concepts of robust inference theory are introduced, and feasible generalizations to time series analysis are discussed. A few key references are also given. Although the title of the book hints at nonlinearity, no article that emphasizes nonlinearity can be found. Most articles deal explicitly with time series models, while some are formulated in terms of the linear model.

Akaike studies the performance of Bayesian methods using examples involving seasonal adjustment. Order determination in AR and MA models with innovations generated by a stable law are considered by Bhansali. A few asymptotic results are given, and a Monte Carlo study is presented. Bustos, Fraiman, and Yohai prove asymptotic results for estimators based on the residual covariances of ARMA models. Corresponding results for a likelihood estimator using data tapers for the periodogram are given by Dahlhaus.

Deistler considers errors-in-variables in dynamic models. Identifiability conditions in terms of second and higher order moments are given. Minimax-robust filtering and finite-length robust predictors are introduced by Franke and Poor, who also give some of their properties. Graf, Hampel, and Tacier study inference about the mean in white noise sequences. Using a self similar process, they provide corrections to the conventional confidence interval. For the validity of this approach we must believe in the importance of the order among observations. Hannan studies order determination in ARMA models and parameter estimation. Robustness is not stressed.

Härdle considers the choice of bandwidth in a kernel type smoother. The properties and estimation of time series models with additive normal noise are studied by Lii and Rosenblatt. A general definition of Hampel's gross-error- sensitivity based on time series influence curves is introduced by Martin and Yohai. Explicit forms are given for some estimators for an AR(1) model. Qualitative robustness, the breakdown point, and sensitivity of robust operations are investigated by Papantoni-Kazakos.

The estimation of the error distribution in a regression model is discussed by Portnoy. The implication for time series models are not explicitly stated. Robinson considers the estimation of a conditional mean of unknown form, with a possibly infinite innovation variance. It is shown that a robust M-estimator has desirable large sample properties. Rousseeuw and Yohai suggest a new robust estimator for linear regression models. In addition to discussing asymptotic properties, they also give a worked example. Tuan studies, by Monte Carlo experiments, the properties of a simplified version of an approximate maximum likelihood estimator for ARMA models with additive noise. A bias correction for small samples is given.

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Råde, L. and Speed, T. (Eds.), Teaching of Statistics in the Computer Age. Proceedings of the Sixth Round Table Conference on the Teaching of Statistics. Studentlitteratur, Lund, ISBN 91-44-23631-X, Bratt Institut für Neues Lernen GmbH, Goch, ISBN 3-88598-048-7, and Chartwell Bratt Ltd, Bromley, 1985, ISBN 0-86238-090-1, 248 pp., SKR 246.

Today, the computer plays many roles in statistics. It is capable of handling large data sets. It provides new methods of solving old problems. It can be used as an advanced teaching tool. The impact of calculators and computers on the teaching of statistics at the school and university levels was the theme of a round table conference held in Canberra, Australia, August 20–23, 1984. This volume contains the papers presented at the conference and the recommendations made.

This book is written by seventeen experts from different parts of the world and has a varied content. Are statistical tables obsolete? Should we teach computer intensive methods? Should the student's work be done on microcomputers or at terminals? How can the pocket computer be used? These questions are all examples of topics discussed in the book, which also contains papers about teaching of statistics in New Zealand schools, the use of computer in statistics courses at the university of Melbourne, and the situation in developing countries including a report from the Philippines.

The place of computers in the learning of statistics is the topic of the contribution by B. Bastow. Discussing how computers best can be utilized to enhance the development of statistical concepts also means discussing how students learn. I think Bastow's paper is an interesting and important contribution to this discussion.

Every statistics teacher knows that it is important to give the students concrete experience of variability and stability in random experiments. Such experiments can be simulated and analyzed with a pocket computer which is the topic of L. Råde's paper. The pocket computer is a real computer but with limited capacity. Its great advantage is its availability. The pocket computer can not only be used for simulation of simple random experiments (like tossing dice) but also for work with basic probability distributions (both simulation and calculation of these distributions), statistical data analysis and simulation and analysis of more advanced random experiments.

The pocket computer can also be used instead of statistical tables. The advantage with this and how it can be done is discussed in the contribution by A. Bousbaine, P. Kent, and P. Nuesch. Contributions about the use of the pocket computer are also given by K. Aoka and C. Dupuis.

The use of microcomputers is discussed in many papers. P. Holmes points out the distinction between programs that try to teach the user some statistics and those that will do some statistics for him. Many programs are not designed for teaching and require a reasonable level of statistical understanding before they can be used properly.

D. Lunn's computer animations are efficient teaching tools. They can be used for physical exploration, modelling, mathematical exploration, simulation and illustration of basic concepts. I had the pleasure to see some of these animations live when Lunn visited Sweden in October last year, so I can guarantee that they are not only efficient but also very entertaining.

A. Engel reports about a computer science course, in which he uses statistical data as raw material for data processing. With the computer it is possible to compute the possibilities exactly without approximations or statistical tables.

In his paper, T. Speed concentrates on the theory of statistics taught in universities and what we can gain from computer intensive methods. He briefly describes some of the major methods and gives a list of references for recent publications. Cross-validation is a method of finding realistic models for real data. The data set is randomly divided into two parts: one part is used for model-fitting and the other part for model-validation. With a modern computer it is easy to examine a range of alternative models and then select the best one. The bootstrap method is a simple, computer-intensive method. With this method it is, for example, possible to calculate confidence intervals in almost any situation even when the sample distribution is unknown and approximate theory does not exist. The main idea is to simulate say 1 000 bootstrap samples taken with replacement from the original sample. The result can be used to estimate the precision of even nonormally distributed statistics. Computer-intensive methods are often much simpler than other techniques. Should we teach such methods? Speed thinks the answer is yes, but does not suggest which parts of the traditional courses should be dropped. To introduce computer-intensive methods means a radical change of present syllabuses. But of course it is important to question many traditional techniques and to have the syllabuses constantly updated with modern statistical methods.

More could be written about this book, which I have read with interest. Of course, some of the papers partly overlap each other, as is always the case with conference proceedings. My general impression is, however, that this volume should be useful for all teachers in statistics, especially the ones suffering from computerphobia (discussed in the contribution by K. Oosthuizen).

My positive impression is further strengthened by the valuable bibliography compiled by L. Råde. It contains more than one hundred recent books and articles on the theme of computers and the teaching of statistics.

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Stuart, A. (Ed.), Theory and Practice, Selected Papers by Sir Maurice Kendall. Charles Griffin and Company Ltd, High Wycombe, 1984, ISBN 0-85264-275-X, 268 pp., £18.95.

The name Maurice Kendall has hardly escaped anyone taking a serious interest in statistics.

Part of Kendall's work is well-known. While students at an introductory level come across KENDALL'S TAU on the output from an SPSS-X run, the library file of the more experienced statistician may list Kendall titles as "An Introduction to the Theory of Statistics" (with G.U. Yule), "Rank Correlation Methods," "The Advanced Theory of Statistics" (with A. Stuart – already startling by the frankness of its title), "A Dictionary of Statistical Terms" (with W.R. Buckland), "Time-Series," "Multivariate Analysis," and Kendall's essays on the history of statistics.

An opportunity to improve your knowledge of the wide-ranging statistical thinking of Maurice Kendall is now provided by Alan Stuart's collection of some of Kendall's less accessible papers, originally published between 1938 and 1961.

As memorial selections in general, this work runs the risk of being welcomed with more due respect than genuine interest. And – it should be admitted – this was also my a priori attitude before I started to read this sample of Kendall's work. However, a posteriori, I was very much mistaken.

The volume includes 17 papers, covering both theory and application. The theoretical part focuses on three topics which specialists certainly will find valuable: the theory of symmetric functions of sample observations (six papers), ranking methods (four papers), and time-series (three papers). A layman may experience some difficulties in trying to follow all details in these theoretical papers – at least on a first reading – as the selected papers are not self-contained (representing extracts from a quite extensive discussion, how could they be ?) and the notation used by Kendall seems somewhat obsolete to a modern eye. On the other hand, the cronologically reproduced papers provide excellent reading by illuminating the development of Kendall's intellectual efforts and by highlighting important steps towards the state of the art in statistics today.

The applied part, consisting of four papers, is accessible to the non-specialist. In this section the role of statistics and statisticians is placed in the forefront, a topic which is probably even more important today than at the time when the papers were written. These highly relevant papers also illustrate some major characteristics in Kendall's writings: the excellency and quality of his style and diction.

Referring to mathematical expositions in statistical theory, Kendall states ("Inaugural Lecture: The Statistical Approach," 1950):

> "Nevertheless I feel sometimes, in wrestling with papers on statistical matters with a full emblazonment of modern mathematics, sets of points, Lebesgue integration, asymptotic summability and so forth, that work which achieves a slight gain in generality at the expence of being incomprehensible is defeating its own purpose. The mathematician, I suggest, ought to have some small responsibility of making himself understood."

Extending this statement to statistics in general, Kendall's own papers – with their emphasis on ideas rather than on techniques – provide outstanding examples of how to present statistical matters. In this way they set a standard that too few current statistical writings reach.

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Tiago de Oliveira, J. (Ed.), Statistical Extremes and Applications. D. Reidel Publishing Company, Dordrecht, 1984 (Published in cooperation with NATO Scientific Affairs Division), ISBN 90-277-1804-0, xii + 692 pp., Dfl. 235.

This volume consists of proceedings of NATO Advanced Study Institute on Statistical Extremes and Applications, in Portugal, 1983. It contains 51 papers under the following headings:
Probabilistic Aspects
Univariate Statistics
Multivariate Theory
Extremes and Stochastic Processes
Applications
Rates of Convergence

Concomitants
Computing
Seismic Risk
Contributed Papers.

According to the preface, the purpose of the book "was to obtain a complete perspective of the field with a series of promising directions of research and some recent results." The editor has managed quite well. The only major subject I miss is the extreme value theory of random fields.

The starting point of the book is the classical result by Fisher and Tippet (1928) and Gnedenko (1943), which states that a suitably normalized maximum M_n of n independent and identically distributed (i.i.d.) random variables can only have an asymptotic distribution of a very specific form.

More precisely, if

$$P[a_n(M_n-b_n)\leqslant x]\rightarrow G[a(x-b)],\ n\rightarrow\infty, \qquad (1)$$

then G is either degenerate or

$$G(y) = \exp\,[-(1+ky)^{-1/k}],\ 1+ky>0,$$

for some $a > 0$ and some real b and k.

When k=0, G is defined as the Gumbel distribution function, $G(y) = \exp(-e^{-y})$. The Weibull distributions correspond to $k < 0$ and the Frechet distributions correspond to $k > 0$.

When M_n is the maximum of i.i.d. random variables with a given distribution function F, it is interesting to know which k-value applies. Necessary and sufficient conditions for convergence towards any of the possible limits are known and reviewed in a paper by L. de Haan. It should be noted that for some distributions such as Poisson and the geometric distribution, only degenerate limits can occur in (1).

The simple form of the possible limit distributions has focused interest on the problem of estimating the scale parameter a, the location parameter b, and the shape parameter k.

In papers by Herbach, Mann, Tiago de Oliveira, and Ramachandran, various estimation procedures are discussed such as methods of moments, maximum likelihood estimation, (nearly) best linear estimate and plot methods. However, I don't find any reference to Pitman's best invariant estimate.

One motive for studying the statistical properties of the limit distributions in (1) is that these are the only possible limits of the maximum of i.i.d. sequences. But dependence between successive observations may occur in applications. Of course, the set of possible limit distributions is then much bigger and, in fact, contains all distributions. However, there are surprisingly weak mixing conditions, discovered by Leadbetter, such that if a stationary process satisfies Leadbetter's conditions the only possible limit laws of the maximum are given by (1). For normal sequences, Leadbetter's mixing conditions are close to Berman's classical covariance condition, $r(n)\log n\rightarrow 0$ as $n\rightarrow\infty$. The papers by Leadbetter and Rootzén discuss the relation between the maximum of processes and of i.i.d. sequences in terms of the "extremal index." This index equals one when the maximum of the process and that of the sequence have the same limit law, and it is less than one when clusters of high level crossings occur in the process. Y. Mittal reviews her joint work with Ylvisaker on highly dependent normal processes.

For example, when $r(n)\log n \rightarrow \gamma > 0$ as $n\rightarrow\infty$, the normalized maximum is asymptotically the sum of two independent random variables, one with a Gumbel distribution and one with a normal distribution. When $\gamma = 0$ the normal component vanishes, whereas when $\gamma = \infty$ the Gumbel component vanishes.

In an interesting paper, R. Davis studies the joint convergence of the maximum and the minimum of a stationary sequence. He shows that they are generally not independent, even if they have an asymptotic extreme value distribution.

Let us now return to the weakly dependent case of a stationary sequence $\xi_1, \xi_2,\ldots$ with the marginal distribution function F. The extreme value theory reviewed, so far, suggests the following approximations:

$$P(\max_{1\leqslant k\leqslant n} \xi_k \leqslant x) \approx F^n(x) \approx G[a_n(x-b_n)] =$$
$$= \exp\,[-(1+ka_n\,(x-b_n)^{-1/k})].$$

If the sequence is normal, we obtain k=0 and

$$P(\max_{1\leqslant k\leqslant n} \xi_k \leqslant x) \approx \Phi^n[(x-\mu)/\sigma] \approx$$
$$\approx\exp[-e^{-a_n(x-b_n)}]$$

with

$$a_n = \sigma(2\log n)^{1/2}$$

and

$$b_n = \mu + \sigma^{-1}[(2 \log n)^{1/2}$$
$$- 1/2(2 \log n)^{-1/2}(\log \log n + \log 4 \pi)].$$

In applications, one is often interested in return periods which correspond to fractiles in the distribution of the maximum. The question is then which approximation, F^n or G, is best for practical use. When using F^n, μ and σ have to be estimated from the sample in the normal case. When using G, a_n and b_n have to be estimated. One way to do the latter is to partition the sample into subsamples and to observe the maximum of each subsample. J. Galambos argues that F^n is highly sensitive to deviations from the model in the tail of the distribution. Hence, a direct application of the limit distribution gives a much more robust estimate of the fractiles. I. Weissman points out that it is often better to use the extreme order statistics than to partition the sample.

In general, a high rate of convergence justifies the use of a limit law instead of the exact distribution. However, in the extreme value theory, the rate of convergence is extremely slow. For example, Hall (1979) showed that

$$\sup_x |\Phi^n[(x-\mu)/\sigma] - G[a_n(x-b_n)]| = 0((\log n)^{-1})$$

and that this order cannot be improved. In papers by Andersen, Balkema, de Haan, Resnick, and Galambos these matters are discussed.

J. Cohen studies the effect on the maximum likelihood estimates, when deviations from the extreme value model occurs. One possible improvement is the use of the "penultimate" estimate. This means that the shape parameter k, although known in the normal case, is estimated to obtain better fit.

Another line of thought is the threshold methods for sample extremes. Here, one models the exceedences above a high level directly. Usually, the positions of the exceedences are governed by a Poisson process and the height of an exceedence follows a Pareto distribution. The Pareto distribution is the asymptotic conditional distribution of a random variable when it exceeds a high level. Pickands (1975) gave necessary and sufficient conditions for the existence of this limit distribution. The connection between this method and the extreme order statistics method is discussed in papers by Davison and Smith. It is noted that in applications, the calculated return levels are very sensitive to the model adopted.

The volume also includes papers on multivariate extremes, extremal processes and applications from fields such as hydrology, meterology, and engineering.

I think that the book is very readable and gives a good picture of what extreme value theory can and cannot do. There are many good review papers, but few new results.

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Zanakis, S.H. and Rustagi, J.S. (Eds.), Optimization in Statistics. TIMS Studies in the Management Sciences, Vol. 19. North-Holland Publishing Company, Amsterdam, New York, Oxford, 1982, ISBN 0-444-86544-6, x + 336 pp., Dfl. 160.

Optimization is needed in statistics, as well as statistics in optimization. The developments made in these two fields have been too separated and their interface has not received the attention it deserves.

This volume of papers is a first step in giving optimization in statistics the attention it deserves. It is divided into three parts according to the statistical application area : (a) regression and correlation, (b) multivariate data analysis and design of experiments, and (c) statistical estimation, reliability and quality control. Every section starts with a valuable introduction by the editors including a short summary of the papers belonging to that section, and many references.

The first part, on correlation and regression, consists of seven papers and is quite comprehensive. A couple of the papers are reviews of the state of the art and give a good number of references.

A great deal of emphasis is placed on least absolute deviations in linear regression analysis. This criterion is best when the median is superior to the mean as an estimator of location for the error distribution. And it is preferable to the criterion of least squares in the presence of outliers and when the error distribution has "heavy tails." To solve the least absolute deviation problem is to solve a linear programming (LP) problem. The use of computers together with a recently developed asymptotic theory of the regression estimators will most certainly bring this into the mainstream of regression model-fitting applications.

Several algorithms are given to solve the LP-problem, e.g., generalized network models or branch-and-bound algorithms for stepwise regression. With the LP-formulation it is easy to put constraints on the parameters. The section alson contains a paper on an absolute deviations curve-fitting algorithm for non-linear models and a couple of papers on correlation and regression for ordinal scale data. Several of the papers give references to computer programs that are available.

The section about multivariate data analysis and design of experiments (six papers) is more diverse. Some examples follow. For principal component analysis and linear discriminant analysis, constraints are put on the coefficients to make them more easily interpreted. The problem is solved by a general branch-and-bound algorithm. For clustering problems, an algorithm using Lagrangian relaxation and column generation is used. For the error localization and imputation process in large data sets, algorithms based on set covering are proposed and tested.

The third section, about parameter estimation, reliability and quality control (five papers), is as diverse as the title reads.

Two of the most common methods of estimation of parameters are maximum likelihood and least squares. The first method involves a maximization problem, and the latter a minimization problem. Thus, optimization techniques enter into both estimation procedures. In the simplest cases the solutions can be found analytically. But when the distributions are more complex some iterative mathematical programming algorithms must be used. The examples given in the book deal with Weibull distributions.

For a finite mixture of Weibull distributions (which have been found to represent a wide range of real-world situations) a stepwise first-order or second-order Newton method is used to estimate the parameters. Another paper deals with optimal outlier tests for Weibull models by which one can identify process changes or predict failure times.

Two papers handle reliability and are both theoretical. One gives a Bayesian scheme for estimating reliability growth of a system which undergoes several stages of testing. The other shows that the class of discrete decreasing failure rate average life distributions is a convex set, and the extreme points are obtained.

The paper on quality control deals with acceptance sampling. It takes conflicting goals into explicit consideration, where the conflicting goals are low cost and high outgoing quality. A couple of algorithms are suggested and evaluated.

The book is, as stated by the editors, supposed to be used as a reference or textbook in universities. The first part on regression and correlation can certainly be valuable, whereas the remaining parts are too diverse, with varying quality of papers.

The reader is assumed to be familiar with the elements of statistics and optimization theory, especially linear programming.

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