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BOOK REVIEWS

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SKRONDAL, A. and RABE-HESKETH, S. **Generalized Latent Variable Modeling. Multilevel, Longitudinal, and Structural Equation Models.** Chapman & Hall/CRC, Boca Raton, Florida, 2004. xi + 508 pp. US$80.96, ISBN 1-58488-000-7.

The application of statistics in such diverse fields of medicine as clinical trials, epidemiology, psychiatry, psychology, the social sciences, and microeconomics is fraught with problems of different outcomes, different units of analysis, and different study designs. Usually two or all of these problem fields occur simultaneously. The outcomes may be noncontinuous such as categorical, ordered categorical, dichotomous, censored, counts, pairwise comparisons, rankings, and durations. The units of analysis may occur on different levels such as school children within school classes within school districts. The study design may be experimental or survey data or survey where the same people are observed more than once (intervention and panel studies). While all of these problems have been treated separately in the statistical modeling literature by a large number of authors, only few statisticians have attempted to create a general modeling approach that allows to formulate general models that treat all of these issues jointly. Skrondal and Rabe-Hesketh have certainly formulated the most ambitious attempt until now. The basis of their approach is an intelligent combination of generalized linear models for different outcomes with multilevel models for different units in the same study, panel models for different occasions on the same unit, and latent variable models for unobserved parameters as well as unobserved variables.

Chapters 1–3 lay out the foundations by briefly explaining latent variable models, generalized linear models, multilevel regression models, factor analysis, and structural equation models. Chapter 4 contains the grand unified theory. First,

each univariate outcome is connected to a latent variable using the inverse link function of generalized linear models. The latent variables are conditioned either on covariates or on other latent variables. The error terms are thought to have a multivariate distribution such as the multinormal distribution. Second, the similarity between random parameters in multilevel models and factor scores in factor analytic models and structural equation models is employed. Third, a hierarchy of latent variable models is constructed by using a recursive strategy. All of these building blocks put together yield the most general model formulated until now.

Chapter 5 discusses issues of identification and equivalence. Chapter 6 focuses on estimation procedures. While the model formulation is very concise and very general, there is not yet an equivalent abstraction in the estimation methods. Therefore, one still has to fall back onto different estimation strategies for submodels of the general model. Chapter 7 shows the computation of the estimates of the latent variable scores, while Chapter 8 is concerned with the different ways to check model assumptions using tests, summary statistics, and statistics based on residuals. All of these are smart generalizations of already known techniques.

Chapters 9–14 contain a whole host of show cases from different fields of applications, each one showing in detail how the model is formulated and which estimation strategy is employed. The examples include dichotomous, ordered categorical, and unordered categorical responses, counts, durations, and mixed responses, most of them mixed with either multilevel designs, random intercepts, or structural equation problems.

Who will profit from reading this book? This is not a book for beginners in statistical modeling. The models are not spelt out in all detail. The description of the different building blocks is precise but rather short. On the one hand, it is a book written for people who like to construct and to read about very general theories and modeling strategies. These people will enjoy it very much and will find many useful suggestions and tricks of the trade. It is also a very useful book for statisticians who have specialized in one area, say multilevel models, and would like to learn more about another area, say factor analytic and structural equation models. It is made easy for them because the similarities are shown and the necessary abstraction is made. Because of its generality, the book will be more useful for biometricians in epidemiology or biometricians who work with survey data coming from complex designs or from longitudinal studies than for biometricians who work on expensive but small-scale clinical studies.

The book itself is very well written. The presentation is concise; many issues are well illustrated graphically. Altogether, the authors have written an excellent, imaginative, and authoritative text on the difficult topic of modeling the problems of multivariate outcomes with different scaling levels, different units of analysis, and different study designs simultaneously.

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CHATTERJEE, S. K. **Statistical Thought. A Perspective and History.** Oxford University Press, Oxford, New York, 2003. xix + 416 pp. US$120.00/€107.32, ISBN 0-19-852531-1.

The monograph comprises a thorough study on statistical reasoning and its underlying philosophies. It treats the evolution of statistical thought from the perspective of various approaches to statistical induction and discusses the development of statistical concepts and theories and their link to classical epistemology. The book is divided into two parts. The first part of the book (Chapters 1–4), named "Perspective," gives a background of the concept of induction first from a philosophical and then from a statistical viewpoint before discussing various interpretations of probability and their bearings on statistical induction. The second part of the book (Chapters 5–10), named "History," explores the evolution of statistical thought. Beginning with the prehistory of statistics and the genesis of the concept of probability to the dawn of modern statistics, the book presents the works and sets them into context of among others Gerolamo Cardano, Galileo Galilei, Blaise Pascal, Pierre de Fermat, Christiaan Hyugens, John Graunt, Gottfried Leibniz, James Bernoulli, John Arbuthnott, Abraham de Moivre, Thomas Simpson, Daniel Bernoulli, Thomas Bayes, Pierre-Simon Laplace, Carl Friedrich Gauss, Simeon Denis Poisson, Adolphe Quetelet, Charles Peirce, Francis Galton, Karl Pearson, and Ronald Aylmer Fisher. The last chapter, Chapter 10, of the book, amounting to nearly a quarter of the volume, is dedicated to the modern era of statistics with its complex multivariate approaches. The book emphasizes thematic relationships rather than chronological details to describe the evolution of ideas and concepts. Thus, the monograph gives an integral view of statistics, and can well serve as a base for courses and as a source of inspiration for the interested reader. Although the book claims not to give a history of statistics in terms of exact chronologies, it is in fact as well an entertaining narrative on the development of statistics and statistical induction. The second aim of the book was a personal one. The author, whose initial training in statistics was in the frequentist and behavioral tradition, wanted to settle his personal disconcertment raised by the proponents of the neo-Bayesian schools. Rather than deciding on "the right path in statistics," the author ends up by according legitimacy to all the paths in their right settings. The reader can follow his reflections by his undogmatic and dispassionate appraisal of the different approaches.

The intended audiences are researchers, lecturers, and students in statistics and in the history of science who have had "some exposure to statistical theory." Further, it aims at "logicians and philosophers interested in the problem of statistical induction in a wider philosophical context and the impact of developments in statistics on current thinking." Although this description slightly understates somewhat the statistical and logical background necessary to be able to fully acknowledge the book, this monograph can be warmly recommended to researchers and lecturers in the field interested in the history and the statistical and philosophical roots of statistical induction. Moreover, a broader audience, like that