Chapter 17, "Bootstrapping," provides an overview of the nonparametric bootstrap method as a way to obtain precision and the distribution (and thus the significance point of a test statistic), under the assumptions of independence of observation vectors and continuity of cumulative distribution function. Bootstrapping from residuals, confidence intervals for parametric functions, bootstrapping in the multiple regression model, and testing about the variance are discussed for the univariate case. Testing for the mean vector, testing for equality of two mean vectors, bootstrapping in multivariate regression, testing that the covariance is a specified matrix, and testing the equality of two covariance matrices are discussed for the multivariate case.

Chapter 18, "Imputing Missing Data," proposes single stochastic imputation for missing data and use of the "completed" dataset for inference. Cases of the multiple regression model and multivariate data are considered. For multivariate data, imputed values are obtained by first obtaining the best linear predictors of the missing observations, then adding random errors to them to obtain imputed values. Estimates of the mean vector and covariance matrix are obtained from the "completed" dataset, which has imputed values in place of missing observations. Bootstrap methods are given to obtain the estimate of the covariances of these estimators. Significance levels from the bootstrap distribution are suggested for improving inference about the mean. The author does not discuss multiple imputation, which has the advantages of single imputation, attains large-sample optimality of ML estimation, and is robust to model misspecification (Rubin 2002).

I would have liked to see (a) a more detailed discussion on transformations to achieve normality for multivariate data, and more on graphical methods for assessing multivariate normality and detecting multivariate outliers; (b) in-depth discussion on the interpretation of test results other than significance levels, including adjustment of significance levels in the case of multiple tests (Hsu 1996); and (c) comparisons on the performance of proposed tests and methodologies with other existing ones.

In conclusion, this is a great book for a first graduate course in multivariate analysis, because it covers the standard topics in "classical" normal theory approach to multivariate analysis. The "customized" SAS codes provide nice support for the implementation of the suggested methods and make this book a great reference for practitioners. This is a book with a data analytic approach and one of the best references for its level.

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Applied Functional Data Analysis, by J. O. RAMSAY and B. W. SILVERMAN, New York: Springer-Verlag, 2002, ISBN 0-387-95414-7, x + 190 pp., $39.95.

This is one of the most interesting statistics texts I have read! The authors discuss different case studies using data in the form of curves (functions) rather than numbers normally considered by statisticians. The 11 case studies give the reader a good sense of the broad power and scope of functional data analysis (FDA) without the need to be subject matter experts. This text is the second written by these authors dealing with FDA. The first book (Ramsay and Silverman 1997), reviewed by Georgiev (1998), is a comprehensive introduction to FDA, and the two books complement one another. Readers with a strong background in calculus, differential equations, and multivariate analysis techniques, such as principal components analysis (PCA), will find this text informative and easy to understand.

The book contains 12 chapters, an introduction and 11 case studies. A valuable section appearing at the end of each case study chapter is "What Have We Seen?," a concise summary of what the chapter describes. For each of the case study chapters, I briefly describe the subject matter and document statistical techniques with which the reader may not be familiar. A comprehensive set of references is provided at the end of the book, so that the reader can explore in more depth aspects of FDA in which they are interested.

Should readers wish to work through the case studies themselves, a website is available that contains many of the datasets and analyses done with MATLAB or S-PLUS. Although the authors give a Springer-Verlag website address, I had to contact one of them to get more detailed instructions on how to access the website. (To access, go to *www.statistics.bristol.ac.uk/~bernard*, link to "books" under "contents," link to the Ramsay and Silverman title under "books," and then link to the desired chapter for data and analyses.) This website contains a more complete description of how the data were analyzed, descriptions of the MATLAB and S-PLUS routines used for analyses, the original datasets, and technical details not covered in the text. To use this website, the reader will need an Adobe Acrobat Reader.

In the Introduction, the authors summarize the 11 case studies, which deal with diverse topics. This very useful chapter will enable the reader to quickly identify case studies of particular interest. Another useful feature is that discussions of interest to statistical/mathematical experts are placed at the end of the chapters, so that the general reader can safely omit these sections. Although the authors do not give a detailed definition of FDA, they use the 11 case studies to exemplify its features.

Chapter Two describes a criminology study in which the criminal careers of more than 400 individuals were tracked over several decades of their life span. One objective of this study is to determine whether distinct categories of offenders can be identified. The authors present an approach to convert discrete data values into a functional datum, the need to estimate the mean functional datum, and ways of smoothing the resulting curve so that it represents the original sample mean but minimizes extraneous variability. Functional PCA is then applied and interpreted. As a result, three categories of offenders are identified: adult, desistance, and juvenile. Scores calculated from each principal component for each individual confirm that these three categories are uncorrelated, as they should be.

Chapter Three discusses the nondurable goods index, a monthly indicator of goods that wear out within 2 years (e.g., food, tobacco, clothing). Phase-plane plots are introduced to study the dynamics of the seasonable component of variation in the nondurable goods index. The rate of change of the process (velocity) is plotted on the horizontal axis, whereas the input/withdrawal of forces that produce this change is plotted on the vertical axis. For a typical year, three loops, associated with spring, summer, and fall, are seen. Interestingly, the fall loop seems most effected by "shocks," such as the stock market crash of 1929 and the end of the Vietnam War in 1974. The authors conclude this chapter by discussing the need to smooth data for phase-plane plots.

Chapter Four focuses on bone shapes from a paleopathology study. Data are studied using varimax-rotated functional principal components to determine if osteoarthritis impacts the shape of the knee joint (or vice versa). These components are described by cyclic curves in two dimensions. The rotated functional PCAs make it easier to interpret the bone shapes.

Chapter Five discusses the modeling of reaction time distributions of attention deficit hyperactive disorder (ADHD) children. The metric used is the time to react to a visual signal on a computer screen after a warning that this signal is about to appear. Nonparametric modeling of density functions is used, because the authors feel that parametric modeling may miss important distributional shape changes. A log transformation of the data is also studied, because the impact of ADHD is more multiplicative than additive. Densities of log-shifted reaction time residuals show that the ADHD children exhibit greater variability.

Chapter Six describes the need to measure human growth so that if something goes wrong with this process, it can be detected as soon as possible. Amplitude (vertical) and phase (horizontal) variation are used to interpret growth measures. The former relates to the size of growth measures, such as the velocity peak in the pubertal growth spurt; the latter, to the timing of these features without regard to their amplitude. This study reveals, for example, that boys and girls do not differ very much in amplitude acceleration but do differ in the amount of phase variation, with amplitude acceleration occurring earlier in girls. A differential equation that models the growth process is presented.

Chapter Seven examines amplitude and phase variation in two different sets of data: repeat printings by hand of the word "fda" and daily temperature measurements in Montreal, Quebec, for 34 years. The need to register the curves so that they vary only in terms of amplitude is discussed. Registration of the temperature curve, for example, will essentially remove impact of early or late arrival of some seasons, so that a better indication of long-term seasonal variation can emerge. Interestingly, residuals from registered Montreal temperature data are examined for any long-term linear trend that could suggest global warming. The standard error (.0016°C) of the regression coefficient (.0024°C/year) leads the authors to conclude that this trend is not significant. [As an aside, the average day that leaves change color on Mont Royal in Montreal is September 30 (day 273), not September 30 (day 303) as the authors state (p. 103).]

Chapter Eight revisits the analysis of bone shape data discussed in Chapter Four. The authors introduce parameterization by arc length, which is a more meaningful way of depicting functional observations than looking at the means alone, because mode variability that distinguishes osteoarthritic from normal bones may be quite different. Functional discriminant analysis is introduced as a way of distinguishing these two classes of bones. To remove erroneous features, a finite representation of the data by considering the first few principal components is used. The authors term this approach regularization. After regularization, functional discriminant analysis can distinguish groups better than analysis of the group mean curves alone. For example, this analysis shows that the extent of twist in the notch shape effectively differentiates osteoarthritic from normal bones.

Chapter Nine discusses functional models for test items, such as examinations or surveys. FDA is applied to log odds-ratio functions derived from test scores. Principle components analysis can then be applied to these curves. The resulting dimensionality may be quite small and readily interpretable. Chapter Ten examines the impact of electromyographic (EMG) recordings on muscle contraction in the lower human lip. A correlation plot and a feed-forward linear model support covariation of EMG activity with the timing/intensity of phonemes which are single distinctive sounds in a language. The feed forward linear model shows the relationship between lip acceleration (dependent variable) and EMG activity (independent variable), and takes into account the lag between neural activation onset and lip muscle contraction.

Chapter Eleven discusses the development of differential equations to model an individual's handwriting. Such empirically derived equations can be used to identify, for example, forgeries. By examining the residuals obtained by applying the dynamic models estimated for two individuals, the "legitimate" person and the potential forger, to both sets of handwriting samples, one can determine whether the two estimated differential equations are from the same individual. Chapter Twelve describes the development of a linear differential equation to model juggling, which generates more complex biomechanical data than does the handwriting data cited in Chapter Eleven. The juggling data are fit quite well with a second-order linear homogeneous differential equation without the need to use a "forcing" function or to model nonlinear effects.

I highly recommend this well-written and reasonably priced text for any statistician or mathematician who uses multivariate analyses and for anyone who may work with functional data. As the authors emphasize, FDA is still a new field, and they encourage readers to expand the scope of this field by thinking about their data from a functional standpoint. Potential applications of FDA to the physical, social, and economic sciences will almost certainly multiply rapidly over the next decade, and this text will provide a solid introduction to this field.

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Predictions in Time Series Using Regression Models, by Frantisek STULAJTER, New York: Springer-Verlag, 2002, ISBN 0-387-95350-7, viii +231 pp., $69.95.

This book is essentially a collection of theorems for treating time series via regression models. In particular, it describes numerous theorems concerning the estimation of parameters for such models, and predictions therefrom.

Chapter One (50 pp.), "Hilbert Spaces and Statistics," presents the usual results on projection and estimation, with sections devoted to double least squares estimators, invariant quadratic estimators, and unbiased invariant estimators. Chapter Two (22 pp.), "Random Processes and Time Series," defines the usual constructs (e.g., covariance stationary and the spectral distribution function). Chapter Three (74 pp.), "Estimation of Time Series Parameters," has sections on the estimation of mean parameters, estimation of the covariance function, and maximum likelihood estimation. Chapter Four (50 pp.), "Predictions of Time Series," has sections on predictions from both linear and nonlinear models, as well as on the effect of model choice on prediction and multivariate predictions. The book's final chapter, "Empirical Predictors" (26 pp.), presents numerical examples that illustrate some of the methods for which theory is presented in the previous chapters.

The book uses a bewildering array of acronyms (e.g., MLRM, WELSE, DOWELSE, DONRM, RLTM). A table defining them all in the front of the book would have been a big help. Also, some sort of numbering system for the equations would have made it easier on the reader. None of the equations is numbered, which makes it difficult to reference an equation on the same page, let alone on a different page. The Preface suggests that the book will be useful for four categories of readers: "students of mathematical statistics" as well as "students and researchers of economical and finanical mathematics and management." In truth, this book is so narrowly focused that it will almost certainly not be of interest to the latter three categories. Specialists in time series who have an interest in regression-based models may wish to have their institutional libraries order this book.

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Statistical Process Adjustment for Quality Control, by Enrique DEL CASTILLO, New York: Wiley, 2002, ISBN 0-471-43574-0, xviii +357 pp., $89.95.

I like this book. As the author states in the Preface, "The purpose of this book is to present process adjustment techniques based on EPC (engineering process control) methods and to discuss them from the point of view of controlling the quality of a *product*, emphasizing the relation with traditional SPC methods." Applied statisticians and process control engineers will find this text of particular interest; it should be more appealing to them than to quality engineers. But the reason that I like this book is that this subject is finally coming of age. This is one of the first books that attempts to apply the techniques of EPC and SPC in a format that allows both statisticians and control engineers to find a common, yet applied ground for adjusting processes. Another excellent book on this topic is the recent text by Box and Luceno (1997).

The book consists of nine chapters:

1. Process Monitoring Versus Process Adjustment
2. Modeling Discrete-Time Dynamical Processes
3. ARIMA Time-Series Models
4. Transfer Function Modeling
5. Optimal Feedback Controllers
6. Discrete-Time PID Controllers
7. EWMA Feedback Controllers and the Run-to-Run Control Problem
8. Recursive Estimation and Adaptive Control
9. Analysis and Adjustment of Multivariate Processes

Chapter One presents a review of SPC charts for the case where the data are independent and uncorrelated. The idea of autocorrelation is then introduced, and the effect on SPC chart performance is demonstrated. Deming's infamous funnel experiment is used to illustrate control via different strategies. This discussion leads to the introduction of EPC as a means of continual process adjustment, and concludes with a proposed EPC–SPC combined approach.