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Analysis of Longitudinal Data *Oxford University Press*

This second edition has been completely revised and expanded to become the most up-to-date and thorough professional reference text in this fast-moving area of biostatistics. It contains an additional two chapters on fully parametric models for discrete repeated measures data and statistical models for

time-dependent predictors.

Analysis of Longitudinal Data *OUP Oxford*

The first edition of *Analysis of Longitudinal Data* has become a classic. Describing the statistical models and methods for the analysis of longitudinal data, it covers both the underlying statistical theory of each method, and its application to a range of examples from the agricultural and biomedical sciences. The main topics discussed are design issues, exploratory methods of analysis, linear models for continuous data, general linear models for discrete data, and models and methods for handling data and missing values. Under each heading, worked examples are presented in parallel with the

methodological development, and sufficient detail is given to enable the reader to reproduce the author's results using the data-sets as an appendix. This second edition, published for the first time in paperback, provides a thorough and expanded revision of this important text. It includes two new chapters; the first discusses fully parametric models for discrete repeated measures data, and the second explores statistical models for time-dependent predictors.

Analysis of Longitudinal Data *Oxford University Press*

This important text has been completely revised and expanded to become the most up-to-date and thorough professional reference text in this fast-moving area of biostatistics (medical

statistics). This new edition contains an additional two chapters. The first of these discusses fully parametric models for discrete repeated measures data. The second explores statistical models for time-dependent predictors where there may be feedback between the predictor and response variables.

Analysis of Longitudinal Data *Oxford University Press, USA*

Describes statistical models and methods for the analysis of longitudinal data.

Longitudinal Data Analysis *CRC Press*

Although many books currently available describe statistical models and methods for analyzing longitudinal data, they do not highlight connections between

various research threads in the statistical literature. Responding to this void, Longitudinal Data Analysis provides a clear, comprehensive, and unified overview of state-of-the-art theory and applications. It also focuses on the assorted challenges that arise in analyzing longitudinal data. After discussing historical aspects, leading researchers explore four broad themes: parametric modeling, nonparametric and semiparametric methods, joint models, and incomplete data. Each of these sections begins with an introductory chapter that provides useful background material and a broad outline to set the stage for subsequent chapters. Rather than focus on a narrowly defined topic, chapters integrate important research discussions from the statistical literature.

They seamlessly blend theory with applications and include examples and case studies from various disciplines. Destined to become a landmark publication in the field, this carefully edited collection emphasizes statistical models and methods likely to endure in the future. Whether involved in the development of statistical methodology or the analysis of longitudinal data, readers will gain new perspectives on the field.

Analysis of Longitudinal Data

Multivariate Statistical Modelling Based on Generalized Linear Models

Springer Science & Business Media

Concerned with the use of generalised linear models for univariate and

multivariate regression analysis, this is a detailed introductory survey of the subject, based on the analysis of real data drawn from a variety of subjects such as the biological sciences, economics, and the social sciences. Where possible, technical details and proofs are deferred to an appendix in order to provide an accessible account for non-experts. Topics covered include: models for multi-categorical responses, model checking, time series and longitudinal data, random effects models, and state-space models. Throughout, the authors have taken great pains to discuss the underlying theoretical ideas in ways that relate well to the data at hand. As a result, numerous researchers whose work relies on the use of these models will find this

an invaluable account.

Longitudinal Data Analysis *John Wiley & Sons*

Longitudinal data analysis for biomedical and behavioral sciences This innovative book sets forth and describes methods for the analysis of longitudinal data, emphasizing applications to problems in the biomedical and behavioral sciences. Reflecting the growing importance and use of longitudinal data across many areas of research, the text is designed to help users of statistics better analyze and understand this type of data. Much of the material from the book grew out of a course taught by Dr. Hedeker on longitudinal data analysis. The material is, therefore, thoroughly classroom tested and includes a number of features

designed to help readers better understand and apply the material. Statistical procedures featured within the text include: * Repeated measures analysis of variance * Multivariate analysis of variance for repeated measures * Random-effects regression models (RRM) * Covariance-pattern models * Generalized-estimating equations (GEE) models * Generalizations of RRM and GEE for categorical outcomes Practical in their approach, the authors emphasize the applications of the methods, using real-world examples for illustration. Some syntax examples are provided, although the authors do not generally focus on software in this book. Several datasets and computer syntax examples are posted on this title's companion Web

site. The authors intend to keep the syntax examples current as new versions of the software programs emerge. This text is designed for both undergraduate and graduate courses in longitudinal data analysis. Instructors can take advantage of overheads and additional course materials available online for adopters. Applied statisticians in biomedicine and the social sciences can also use the book as a convenient reference.

Applied Longitudinal Data Analysis for Epidemiology

A Practical Guide *Cambridge University Press*

A practical guide to the most important techniques available for longitudinal

data analysis, essential for non-statisticians and researchers.

Linear Mixed Models for Longitudinal Data *Springer Science & Business Media*

This book provides a comprehensive treatment of linear mixed models for continuous longitudinal data. Next to model formulation, this edition puts major emphasis on exploratory data analysis for all aspects of the model, such as the marginal model, subject-specific profiles, and residual covariance structure. Further, model diagnostics and missing data receive extensive treatment. Sensitivity analysis for incomplete data is given a prominent place. Most analyses were done with the MIXED procedure of the SAS software

package, but the data analyses are presented in a software-independent fashion.

Mixed Effects Models for Complex Data *CRC Press*

Although standard mixed effects models are useful in a range of studies, other approaches must often be used in correlation with them when studying complex or incomplete data. *Mixed Effects Models for Complex Data* discusses commonly used mixed effects models and presents appropriate approaches to address dropouts, missing data, measurement errors, censoring, and outliers. For each class of mixed effects model, the author reviews the corresponding class of regression model for cross-sectional data. An overview of

general models and methods, along with motivating examples. After presenting real data examples and outlining general approaches to the analysis of longitudinal/clustered data and incomplete data, the book introduces linear mixed effects (LME) models, generalized linear mixed models (GLMMs), nonlinear mixed effects (NLME) models, and semiparametric and nonparametric mixed effects models. It also includes general approaches for the analysis of complex data with missing values, measurement errors, censoring, and outliers. Self-contained coverage of specific topics. Subsequent chapters delve more deeply into missing data problems, covariate measurement errors, and censored responses in mixed effects models. Focusing on incomplete

data, the book also covers survival and frailty models, joint models of survival and longitudinal data, robust methods for mixed effects models, marginal generalized estimating equation (GEE) models for longitudinal or clustered data, and Bayesian methods for mixed effects models. Background material In the appendix, the author provides background information, such as likelihood theory, the Gibbs sampler, rejection and importance sampling methods, numerical integration methods, optimization methods, bootstrap, and matrix algebra. Failure to properly address missing data, measurement errors, and other issues in statistical analyses can lead to severely biased or misleading results. This book explores the biases that arise when

naïve methods are used and shows which approaches should be used to achieve accurate results in longitudinal data analysis.

Missing Data in Longitudinal Studies

Strategies for Bayesian Modeling and Sensitivity Analysis *CRC Press*

Drawing from the authors' own work and from the most recent developments in the field, *Missing Data in Longitudinal Studies: Strategies for Bayesian Modeling and Sensitivity Analysis* describes a comprehensive Bayesian approach for drawing inference from incomplete data in longitudinal studies. To illustrate these methods, the authors employ several data sets throughout that cover a range of study designs,

variable types, and missing data issues. The book first reviews modern approaches to formulate and interpret regression models for longitudinal data. It then discusses key ideas in Bayesian inference, including specifying prior distributions, computing posterior distribution, and assessing model fit. The book carefully describes the assumptions needed to make inferences about a full-data distribution from incompletely observed data. For settings with ignorable dropout, it emphasizes the importance of covariance models for inference about the mean while for nonignorable dropout, the book studies a variety of models in detail. It concludes with three case studies that highlight important features of the Bayesian approach for handling nonignorable

missingness. With suggestions for further reading at the end of most chapters as well as many applications to the health sciences, this resource offers a unified Bayesian approach to handle missing data in longitudinal studies.

Modelling Longitudinal and Spatially Correlated Data *Springer Science & Business Media*

Correlated data arise in numerous contexts across a wide spectrum of subject-matter disciplines. Modeling such data present special challenges and opportunities that have received increasing scrutiny by the statistical community in recent years. In October 1996 a group of 210 statisticians and other scientists assembled on the small island of Nantucket, U. S. A. , to present

and discuss new developments relating to Modelling Longitudinal and Spatially Correlated Data: Methods, Applications, and Future Directions. Its purpose was to provide a cross-disciplinary forum to explore the commonalities and meaningful differences in the source and treatment of such data. This volume is a compilation of some of the important invited and volunteered presentations made during that conference. The three days and evenings of oral and displayed presentations were arranged into six broad thematic areas. The session themes, the invited speakers and the topics they addressed were as follows:

- Generalized Linear Models: Peter McCullagh-"Residual Likelihood in Linear and Generalized Linear Models"
- Longitudinal Data Analysis: Nan Laird-

- "Using the General Linear Mixed Model to Analyze Unbalanced Repeated Measures and Longitudinal Data"
- Spatio-Temporal Processes: David R. Brillinger-"Statistical Analysis of the Tracks of Moving Particles"
- Spatial Data Analysis: Noel A. Cressie-"Statistical Models for Lattice Data"
- Modelling Messy Data: Raymond J. Carroll-"Some Results on Generalized Linear Mixed Models with Measurement Error in Covariates"
- Future Directions: Peter J.

Joint Modeling of Longitudinal and Time-to-Event Data *CRC Press*

Longitudinal studies often incur several problems that challenge standard statistical methods for data analysis. These problems include non-ignorable

missing data in longitudinal measurements of one or more response variables, informative observation times of longitudinal data, and survival analysis with intermittently measured time-dependent covariates that are subject to measurement error and/or substantial biological variation. Joint modeling of longitudinal and time-to-event data has emerged as a novel approach to handle these issues. Joint Modeling of Longitudinal and Time-to-Event Data provides a systematic introduction and review of state-of-the-art statistical methodology in this active research field. The methods are illustrated by real data examples from a wide range of clinical research topics. A collection of data sets and software for practical implementation of the joint

modeling methodologies are available through the book website. This book serves as a reference book for scientific investigators who need to analyze longitudinal and/or survival data, as well as researchers developing methodology in this field. It may also be used as a textbook for a graduate level course in biostatistics or statistics.

Best Practices in Quantitative Methods *SAGE*

The contributors to Best Practices in Quantitative Methods envision quantitative methods in the 21st century, identify the best practices, and, where possible, demonstrate the superiority of their recommendations empirically. Editor Jason W. Osborne designed this book with the goal of

providing readers with the most effective, evidence-based, modern quantitative methods and quantitative data analysis across the social and behavioral sciences. The text is divided into five main sections covering select best practices in Measurement, Research Design, Basics of Data Analysis, Quantitative Methods, and Advanced Quantitative Methods. Each chapter contains a current and expansive review of the literature, a case for best practices in terms of method, outcomes, inferences, etc., and broad-ranging examples along with any empirical evidence to show why certain techniques are better. Key Features: Describes important implicit knowledge to readers: The chapters in this volume explain the important details of

seemingly mundane aspects of quantitative research, making them accessible to readers and demonstrating why it is important to pay attention to these details. Compares and contrasts analytic techniques: The book examines instances where there are multiple options for doing things, and make recommendations as to what is the "best" choice—or choices, as what is best often depends on the circumstances. Offers new procedures to update and explicate traditional techniques: The featured scholars present and explain new options for data analysis, discussing the advantages and disadvantages of the new procedures in depth, describing how to perform them, and demonstrating their use. Intended Audience: Representing the vanguard of

research methods for the 21st century, this book is an invaluable resource for graduate students and researchers who want a comprehensive, authoritative resource for practical and sound advice from leading experts in quantitative methods.

Models for Discrete Longitudinal Data *Springer Science & Business Media*

The linear mixed model has become the main parametric tool for the analysis of continuous longitudinal data, as the authors discussed in their 2000 book. Without putting too much emphasis on software, the book shows how the different approaches can be implemented within the SAS software package. The authors received the American Statistical Association's

Excellence in Continuing Education Award based on short courses on longitudinal and incomplete data at the Joint Statistical Meetings of 2002 and 2004.

Model-based Geostatistics for Global Public Health

Methods and Applications *CRC Press*
Model-based Geostatistics for Global Public Health: Methods and Applications provides an introductory account of model-based geostatistics, its implementation in open-source software and its application in public health research. In the public health problems that are the focus of this book, the authors describe and explain the pattern of spatial variation in a health outcome

or exposure measurement of interest. Model-based geostatistics uses explicit probability models and established principles of statistical inference to address questions of this kind. Features: Presents state-of-the-art methods in model-based geostatistics. Discusses the application these methods some of the most challenging global public health problems including disease mapping, exposure mapping and environmental epidemiology. Describes exploratory methods for analysing geostatistical data, including: diagnostic checking of residuals standard linear and generalized linear models; variogram analysis; Gaussian process models and geostatistical design issues. Includes a range of more complex geostatistical problems where research is ongoing. All

of the results in the book are reproducible using publicly available R code and data-sets, as well as a dedicated R package. This book has been written to be accessible not only to statisticians but also to students and researchers in the public health sciences. The Authors Peter Diggle is Distinguished University Professor of Statistics in the Faculty of Health and Medicine, Lancaster University. He also holds honorary positions at the Johns Hopkins University School of Public Health, Columbia University International Research Institute for Climate and Society, and Yale University School of Public Health. His research involves the development of statistical methods for analyzing spatial and longitudinal data and their applications in the biomedical

and health sciences. Dr Emanuele Giorgi is a Lecturer in Biostatistics and member of the CHICAS research group at Lancaster University, where he formerly obtained a PhD in Statistics and Epidemiology in 2015. His research interests involve the development of novel geostatistical methods for disease mapping, with a special focus on malaria and other tropical diseases. In 2018, Dr Giorgi was awarded the Royal Statistical Society Research Prize "for outstanding published contribution at the interface of statistics and epidemiology." He is also the lead developer of PrevMap, an R package where all the methodology found in this book has been implemented.

Longitudinal and Panel Data

Analysis and Applications in the Social Sciences *Cambridge University Press*

An introduction to foundations and applications for quantitatively oriented graduate social-science students and individual researchers.

Applied Longitudinal Data Analysis

Modeling Change and Event Occurrence *Oxford University Press*

By charting changes over time and investigating whether and when events occur, researchers reveal the temporal rhythms of our lives.

Time Series

A Biostatistical Introduction *Oxford*

University Press, USA

Time-series analysis is one of several branches of statistics whose practical importance has increased with the availability of powerful computing tools. Methodology originally developed for specialized applications, for example in business forecasting or geophysical signal processing, is now widely available in general statistical packages. These computing developments have helped to bring the subject closer to the mainstream of applied statistics. This book is an introductory account of time-series analysis, written from the perspective of an applied statistician with a particular interest in biological applications. Throughout, analyses of data-sets drawn from the biological and medical sciences are integrated with the

methodological development. The book is unique in its emphasis on biological and medical applications of time-series analysis. Nevertheless, its methodological content is more widely applicable. It should be useful to both students and practitioners of applied statistics whatever their field of application, and to biologists whose work involves the analysis of time-series data. Book jacket.

Model Selection and Multimodel Inference

A Practical Information-Theoretic Approach *Springer Science & Business Media*

A unique and comprehensive text on the philosophy of model-based data analysis

and strategy for the analysis of empirical data. The book introduces information theoretic approaches and focuses critical attention on a priori modeling and the selection of a good approximating model that best represents the inference supported by the data. It contains several new approaches to estimating model selection uncertainty and incorporating selection uncertainty into estimates of precision. An array of examples is given to illustrate various technical issues. The text has been written for biologists and statisticians using models for making inferences from empirical data.

Antedependence Models for Longitudinal Data *CRC Press*
The First Book Dedicated to This Class of

Longitudinal Models Although antedependence models are particularly useful for modeling longitudinal data that exhibit serial correlation, few books adequately cover these models. By gathering results scattered throughout the literature, *Antedependence Models for Longitudinal Data* offers a convenient, systematic way to learn about antedependence models. Illustrated with numerous examples, the book also covers some important statistical inference procedures associated with these models. After describing unstructured and structured antedependence models and their properties, the authors discuss informal model identification via simple summary statistics and graphical methods. They then present formal likelihood-based

procedures for normal antedependence models, including maximum likelihood and residual maximum likelihood estimation of parameters as well as likelihood ratio tests and penalized likelihood model selection criteria for the model's covariance structure and mean structure. The authors also compare the performance of antedependence models to other models commonly used for longitudinal data. With this book, readers no longer have to search across widely scattered journal articles on the subject. The book provides a thorough treatment of the properties and statistical inference procedures of various antedependence models.

Multilevel and Longitudinal Modeling Using Stata, Second

Edition Stata Press

This is a book about applied multilevel and longitudinal modeling. Other terms for multilevel models include hierarchical models, random-effects or random-coefficient models, mixed-effects models, or simply mixed models. Longitudinal data are also referred to as panel data, repeated measures, or cross-sectional time series. A popular type of multilevel model for longitudinal data is the growth-curve model. Our emphasis is on explaining the models and their assumptions, applying the methods to real data, and interpreting results.

Handbook of Statistical Analyses Using Stata CRC Press

With each new release of Stata, a comprehensive resource is needed to

highlight the improvements as well as discuss the fundamentals of the software. Fulfilling this need, *A Handbook of Statistical Analyses Using Stata*, Fourth Edition has been fully updated to provide an introduction to Stata version 9. This edition covers many

Proceedings of the Second Seattle Symposium in Biostatistics

Analysis of Correlated Data *Springer Science & Business Media*

This volume contains a selection of papers presented at the Second Seattle Symposium in Biostatistics: Analysis of Correlated Data. The symposium was held in 2000 to celebrate the 30th anniversary of the University of Washington School of Public Health and

Community Medicine. It featured keynote lectures by Norman Breslow, David Cox and Ross Prentice and 16 invited presentations by other prominent researchers. The papers contained in this volume encompass recent methodological advances in several important areas, such as longitudinal data, multivariate failure time data and genetic data, as well as innovative applications of the existing theory and methods. This volume is a valuable reference for researchers and practitioners in the field of correlated data analysis.

Joint Models for Longitudinal and Time-to-Event Data

With Applications in R *CRC Press*

In longitudinal studies it is often of interest to investigate how a marker that is repeatedly measured in time is associated with a time to an event of interest, e.g., prostate cancer studies where longitudinal PSA level measurements are collected in conjunction with the time-to-recurrence. Joint Models for Longitudinal and Time-to-Event Data: With Applications in R provides a full treatment of random effects joint models for longitudinal and time-to-event outcomes that can be utilized to analyze such data. The content is primarily explanatory, focusing on applications of joint modeling, but sufficient mathematical details are provided to facilitate understanding of the key features of these models. All illustrations put

forward can be implemented in the R programming language via the freely available package JM written by the author. All the R code used in the book is available at: <http://jmr.r-forge.r-project.org/>

Nonparametric Regression Methods for Longitudinal Data Analysis

Mixed-Effects Modeling Approaches

John Wiley & Sons

Incorporates mixed-effects modeling techniques for more powerful and efficient methods This book presents current and effective nonparametric regression techniques for longitudinal data analysis and systematically investigates the incorporation of mixed-effects modeling techniques into various

nonparametric regression models. The authors emphasize modeling ideas and inference methodologies, although some theoretical results for the justification of the proposed methods are presented. With its logical structure and organization, beginning with basic principles, the text develops the foundation needed to master advanced principles and applications. Following a brief overview, data examples from biomedical research studies are presented and point to the need for nonparametric regression analysis approaches. Next, the authors review mixed-effects models and nonparametric regression models, which are the two key building blocks of the proposed modeling techniques. The core section of the book consists of four chapters

dedicated to the major nonparametric regression methods: local polynomial, regression spline, smoothing spline, and penalized spline. The next two chapters extend these modeling techniques to semiparametric and time varying coefficient models for longitudinal data analysis. The final chapter examines discrete longitudinal data modeling and analysis. Each chapter concludes with a summary that highlights key points and also provides bibliographic notes that point to additional sources for further study. Examples of data analysis from biomedical research are used to illustrate the methodologies contained throughout the book. Technical proofs are presented in separate appendices. With its focus on solving problems, this is an excellent textbook for upper-level

undergraduate and graduate courses in longitudinal data analysis. It is also recommended as a reference for biostatisticians and other theoretical and applied research statisticians with an interest in longitudinal data analysis. Not only do readers gain an understanding of the principles of various nonparametric regression methods, but they also gain a practical understanding of how to use the methods to tackle real-world problems.

Methods and Applications of Longitudinal Data Analysis *Elsevier*

Methods and Applications of Longitudinal Data Analysis describes methods for the analysis of longitudinal data in the medical, biological and behavioral sciences. It introduces basic concepts

and functions including a variety of regression models, and their practical applications across many areas of research. Statistical procedures featured within the text include: descriptive methods for delineating trends over time linear mixed regression models with both fixed and random effects covariance pattern models on correlated errors generalized estimating equations nonlinear regression models for categorical repeated measurements techniques for analyzing longitudinal data with non-ignorable missing observations Emphasis is given to applications of these methods, using substantial empirical illustrations, designed to help users of statistics better analyze and understand longitudinal data. Methods and

Applications of Longitudinal Data Analysis equips both graduate students and professionals to confidently apply longitudinal data analysis to their particular discipline. It also provides a valuable reference source for applied statisticians, demographers and other quantitative methodologists. From novice to professional: this book starts with the introduction of basic models and ends with the description of some of the most advanced models in longitudinal data analysis. Enables students to select the correct statistical methods to apply to their longitudinal data and avoid the pitfalls associated with incorrect selection. Identifies the limitations of classical repeated measures models and describes newly developed techniques, along with real-

world examples.

Longitudinal Data Analysis *SAGE*

Toon Taris' survival guide takes the reader through the strengths and weaknesses of longitudinal research, making clear how to design a longitudinal study, how to collect data most effectively and how to interpret results.

Complex Surveys

A Guide to Analysis Using R *John Wiley & Sons*

A complete guide to carrying out complex survey analysis using R. As survey analysis continues to serve as a core component of sociological research, researchers are increasingly relying

upon data gathered from complex surveys to carry out traditional analyses. *Complex Surveys* is a practical guide to the analysis of this kind of data using R, the freely available and downloadable statistical programming language. As creator of the specific survey package for R, the author provides the ultimate presentation of how to successfully use the software for analyzing data from complex surveys while also utilizing the most current data from health and social sciences studies to demonstrate the application of survey research methods in these fields. The book begins with coverage of basic tools and topics within survey analysis such as simple and stratified sampling, cluster sampling, linear regression, and categorical data regression. Subsequent

chapters delve into more technical aspects of complex survey analysis, including post-stratification, two-phase sampling, missing data, and causal inference. Throughout the book, an emphasis is placed on graphics, regression modeling, and two-phase designs. In addition, the author supplies a unique discussion of epidemiological two-phase designs as well as probability-weighting for causal inference. All of the book's examples and figures are generated using R, and a related Web site provides the R code that allows readers to reproduce the presented content. Each chapter concludes with exercises that vary in level of complexity, and detailed appendices outline additional mathematical and computational

descriptions to assist readers with comparing results from various software systems. *Complex Surveys* is an excellent book for courses on sampling and complex surveys at the upper-undergraduate and graduate levels. It is also a practical reference guide for applied statisticians and practitioners in the social and health sciences who use statistics in their everyday work.

Applied Missing Data Analysis
Guilford Press

Walking readers step by step through complex concepts, this book translates missing data techniques into something that applied researchers and graduate students can understand and utilize in their own research. Enders explains the rationale and procedural details for

maximum likelihood estimation, Bayesian estimation, multiple imputation, and models for handling missing not at random (MNAR) data. Easy-to-follow examples and small simulated data sets illustrate the techniques and clarify the underlying principles. The companion website (www.appliedmissingdata.com) includes data files and syntax for the examples in the book as well as up-to-date information on software. The book is accessible to substantive researchers while providing a level of detail that will satisfy quantitative specialists.

Advanced Econometrics *Harvard University Press*

The main features of this text are a thorough treatment of cross-section

models--including qualitative response models, censored and truncated regression models, and Markov and duration models--and a rigorous presentation of large sample theory, classical least-squares and generalized least-squares theory, and nonlinear simultaneous equation models.

Modeling Intraindividual Variability With Repeated Measures Data

Methods and Applications *Psychology Press*

This book examines how individuals behave across time and to what degree that behavior changes, fluctuates, or remains stable. It features the most current methods on modeling repeated measures data as reported by a

distinguished group of experts in the field. The goal is to make the latest techniques used to assess intraindividual variability accessible to a wide range of researchers. Each chapter is written in a "user-friendly" style such that even the "novice" data analyst can easily apply the techniques. Each chapter features: a minimum discussion of mathematical detail; an empirical example applying the technique; and a discussion of the software related to that technique. Content highlights include analysis of mixed, multi-level, structural equation, and categorical data models. It is ideal for researchers, professionals, and students working with repeated measures data from the social and behavioral sciences, business, or biological sciences.

Linear Mixed Models for Longitudinal Data *Springer Science & Business Media*

This book provides a comprehensive treatment of linear mixed models for continuous longitudinal data. Next to model formulation, this edition puts major emphasis on exploratory data analysis for all aspects of the model, such as the marginal model, subject-specific profiles, and residual covariance structure. Further, model diagnostics and missing data receive extensive treatment. Sensitivity analysis for incomplete data is given a prominent place. Most analyses were done with the MIXED procedure of the SAS software package, but the data analyses are presented in a software-independent fashion.

Linear Mixed-Effects Models Using R

A Step-by-Step Approach *Springer Science & Business Media*

Linear mixed-effects models (LMMs) are an important class of statistical models that can be used to analyze correlated data. Such data are encountered in a variety of fields including biostatistics, public health, psychometrics, educational measurement, and sociology. This book aims to support a wide range of uses for the models by applied researchers in those and other fields by providing state-of-the-art descriptions of the implementation of LMMs in R. To help readers to get familiar with the features of the models and the details of carrying them out in R, the book includes a review of the most

important theoretical concepts of the models. The presentation connects theory, software and applications. It is built up incrementally, starting with a summary of the concepts underlying simpler classes of linear models like the classical regression model, and carrying them forward to LMMs. A similar step-by-step approach is used to describe the R tools for LMMs. All the classes of linear models presented in the book are illustrated using real-life data. The book also introduces several novel R tools for LMMs, including new class of variance-covariance structure for random-effects, methods for influence diagnostics and for power calculations. They are included into an R package that should assist the readers in applying these and other methods presented in this text.

Nonparametric Analysis of Longitudinal Data in Factorial Experiments *Wiley-Interscience*

The authoritative reference on nonparametric methods for evaluating longitudinal data in factorial designs Broadening the range of techniques that can be used to evaluate longitudinal data, *Nonparametric Analysis of Longitudinal Data in Factorial Experiments* presents nonparametric methods of evaluation that supplement the generalized linear models approach. Emphasizing the practical application of these methods in statistical procedures, this book provides a unified approach for the analysis of factorial designs involving longitudinal data that is appropriate for metric data, count data, ordered categorical data, and dichotomous data.

Topics covered include nonparametric models, effects and hypotheses in experimental design, estimators for relative effects, experiments for one and several groups of subjects, multifactorial experiments, dependent replications, and experiments with numerous time points. The basic mathematical principles for the methods introduced here are described in theory, consistent with the book's minimal math requirements. Simple approximations for small data sets are provided, as well as ample chapter exercises to test skills, an appendix that includes original data for the examples used throughout the book, and downloadable SAS-IML macros for implementing the more extensive calculations. All applications are designed to be useful in many fields.

Generously supplemented with more than 110 graphs and tables, *Nonparametric Analysis of Longitudinal Data in Factorial Experiments* is an essential reference for statisticians and biometricians, researchers in clinical trials, psychological studies, and in the fields of forestry, agriculture, sociology, ecology, and biology, as well as graduate students in statistics and biostatistics.

Statistical Regression Modeling with R

Longitudinal and Multi-level Modeling *Springer Nature*

This book provides a concise point of reference for the most commonly used regression methods. It begins with linear and nonlinear regression for normally

distributed data, logistic regression for binomially distributed data, and Poisson regression and negative-binomial regression for count data. It then progresses to these regression models that work with longitudinal and multi-level data structures. The volume is designed to guide the transition from classical to more advanced regression modeling, as well as to contribute to the rapid development of statistics and data science. With data and computing programs available to facilitate readers' learning experience, *Statistical Regression Modeling* promotes the applications of R in linear, nonlinear, longitudinal and multi-level regression. All included datasets, as well as the associated R program in packages `nlme` and `lme4` for multi-level regression, are

detailed in Appendix A. This book will be valuable in graduate courses on applied regression, as well as for practitioners and researchers in the fields of data science, statistical analytics, public health, and related fields.

Linear Mixed Models in Practice

A SAS-Oriented Approach *Springer Science & Business Media*

A comprehensive treatment of linear mixed models, focusing on examples from designed experiments and longitudinal studies. Aimed at applied statisticians and biomedical researchers in industry, public health organisations, contract research organisations, and academia, this book is explanatory rather than mathematical rigorous.

Although most analyses were done with the MIXED procedure of the SAS software package, and many of its features are clearly elucidated, considerable effort was put into presenting the data analyses in a software-independent fashion.

Optimum Experimental Designs, with SAS *Oxford University Press on Demand*

Experiments in the field and in the laboratory cannot avoid random error and statistical methods are essential for their efficient design and analysis. Authored by leading experts in key fields, this text provides many examples of SAS code, results, plots and tables, along with a fully supported website.

A First Course in Linear Model Theory *CRC Press*

Thoroughly updated throughout, *A First Course in Linear Model Theory*, Second Edition is an intermediate-level statistics text that fills an important gap by presenting the theory of linear statistical models at a level appropriate for senior undergraduate or first-year graduate students. With an innovative approach, the authors introduce to students the mathematical and statistical concepts and tools that form a foundation for studying the theory and applications of both univariate and multivariate linear models. In addition to adding R functionality, this second edition features three new chapters and several sections on new topics that are extremely relevant to the current

research in statistical methodology. Revised or expanded topics include linear fixed, random and mixed effects models, generalized linear models, Bayesian and hierarchical linear models, model selection, multiple comparisons, and regularized and robust regression. New to the Second Edition: Coverage of inference for linear models has been expanded into two chapters. Expanded coverage of multiple comparisons, random and mixed effects models, model selection, and missing data. A new chapter on generalized linear models (Chapter 12). A new section on

multivariate linear models in Chapter 13, and expanded coverage of the Bayesian linear models and longitudinal models. A new section on regularized regression in Chapter 14. Detailed data illustrations using R. The authors' fresh approach, methodical presentation, wealth of examples, use of R, and introduction to topics beyond the classical theory set this book apart from other texts on linear models. It forms a refreshing and invaluable first step in students' study of advanced linear models, generalized linear models, nonlinear models, and dynamic models.