

## Testing Statistical Hypotheses Lehmann Romano

Testing Statistical Hypotheses, 4th Edition updates and expands upon the classic graduate text, now a two-volume set. The first volume covers finite-sample theory, while the second volume discusses large-sample theory. A definitive resource for graduate students and researchers alike, this work grows to include new topics of current relevance. New additions include an expanded treatment of multiple hypothesis testing, a new section on extensions of the Central Limit Theorem, coverage of high-dimensional testing, expanded discussions of permutation and randomization tests, coverage of testing moment inequalities, and many new problems throughout the text.

This relatively nontechnical book is the first account of the history of statistics from the Fisher revolution to the computer revolution. It sketches the careers, and highlights some of the work, of 65 people, most of them statisticians. What gives the book its special character is its emphasis on the author's interaction with these people and the inclusion of many personal anecdotes. Combined, these portraits provide an amazing fly-on-the-wall view of statistics during the period in question. The stress is on ideas and technical material is held to a minimum. Thus the book is accessible to anyone with at least an elementary background in statistics.

This classic work, now available from Springer, summarizes developments in the field of hypotheses testing. Optimality considerations continue to provide the organizing principle; however, they are now tempered by a much stronger emphasis on the robustness properties of the resulting procedures. This book is an essential reference for any graduate student in statistics.

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Statistics in Psychology covers all statistical methods needed in education and research in psychology. This book looks at research questions when planning data sampling, that is to design the intended study and to calculate the sample sizes in advance. In other words, no analysis applies if the minimum size is not determined in order to fulfil certain precision requirements. The book looks at the process of empirical research into the following seven stages: Formulation of the problem Stipulation of the precision requirements Selecting the statistical model for the planning and analysis The (optimal) design of the experiment or survey Performing the experiment or the survey Statistical analysis of the observed results Interpretation of the results.

This book presents up-to-date theory and methods of statistical hypothesis testing based on measure theory. The so-called statistical space is a measurable space adding a family of probability measures. Most topics in the book will be developed based on this term. The book includes some typical data sets, such as the relation between race and the death penalty verdict, the behavior of food intake of two kinds of Zucker rats, and the per capita income and expenditure in China during the 1978?2002 period. Emphasis is given to the process of finding appropriate statistical techniques and methods of evaluating these techniques.

Written by one of the main figures in twentieth century statistics, this book provides a unified treatment of first-order large-sample theory. It discusses a broad range of applications including introductions to density estimation, the bootstrap, and the asymptotics of survey methodology. The book is written at an elementary level making it accessible to most readers.

This book is a revision of Stochastic Processes in Information and Dynamical Systems written by the first author (E.W.) and published in 1971. The book was originally written, and

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revised, to provide a graduate level text in stochastic processes for students whose primary interest is its applications. It treats both the traditional topic of stationary processes in linear time-invariant systems as well as the more modern theory of stochastic systems in which dynamic structure plays a profound role. Our aim is to provide a high-level, yet readily accessible, treatment of those topics in the theory of continuous-parameter stochastic processes that are important in the analysis of information and dynamical systems. The theory of stochastic processes can easily become abstract. In dealing with it from an applied point of view, we have found it difficult to decide on the appropriate level of rigor. We intend to provide just enough mathematical machinery so that important results can be stated PREFACE vi with precision and clarity; so much of the theory of stochastic processes is inherently simple if the suitable framework is provided. The price of providing this framework seems worth paying even though the ultimate goal is in applications and not the mathematics per se.

Unlock today's statistical controversies and irreproducible results by viewing statistics as probing and controlling errors. Intended as a textbook for students taking a first graduate course in the subject, as well as for the general reference of interested research workers, this text discusses, in a readable form, developments from recently published work on certain broad topics not otherwise easily accessible, such as robust inference and the use of the bootstrap in a multivariate setting. A minimum background expected of the reader would include at least two courses in mathematical statistics, and certainly some exposure to the calculus of several

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variables together with the descriptive geometry of linear algebra.

The third edition of *Testing Statistical Hypotheses* updates and expands upon the classic graduate text, emphasizing optimality theory for hypothesis testing and confidence sets. The principal additions include a rigorous treatment of large sample optimality, together with the requisite tools. In addition, an introduction to the theory of resampling methods such as the bootstrap is developed. The sections on multiple testing and goodness of fit testing are expanded. The text is suitable for Ph.D. students in statistics and includes over 300 new problems out of a total of more than 760.

Praise for the Second Edition "All statistics students and teachers will find in this book a friendly and intelligent guide to . . . applied statistics in practice." —*Journal of Applied Statistics* ". . . a very engaging and valuable book for all who use statistics in any setting." —*CHOICE* ". . . a concise guide to the basics of statistics, replete with examples . . . a valuable reference for more advanced statisticians as well." —*MAA Reviews* Now in its Third Edition, the highly readable *Common Errors in Statistics (and How to Avoid Them)* continues to serve as a thorough and straightforward discussion of basic statistical methods, presentations, approaches, and modeling techniques. Further enriched with new examples and counterexamples from the latest

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research as well as added coverage of relevant topics, this new edition of the benchmark book addresses popular mistakes often made in data collection and provides an indispensable guide to accurate statistical analysis and reporting. The authors' emphasis on careful practice, combined with a focus on the development of solutions, reveals the true value of statistics when applied correctly in any area of research. The Third Edition has been considerably expanded and revised to include: A new chapter on data quality assessment A new chapter on correlated data An expanded chapter on data analysis covering categorical and ordinal data, continuous measurements, and time-to-event data, including sections on factorial and crossover designs Revamped exercises with a stronger emphasis on solutions An extended chapter on report preparation New sections on factor analysis as well as Poisson and negative binomial regression Providing valuable, up-to-date information in the same user-friendly format as its predecessor, *Common Errors in Statistics (and How to Avoid Them)*, Third Edition is an excellent book for students and professionals in industry, government, medicine, and the social sciences.

*Fundamentals of Brain Network Analysis* is a comprehensive and accessible introduction to methods for unraveling the extraordinary complexity of neuronal connectivity. From the perspective of

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graph theory and network science, this book introduces, motivates and explains techniques for modeling brain networks as graphs of nodes connected by edges, and covers a diverse array of measures for quantifying their topological and spatial organization. It builds intuition for key concepts and methods by illustrating how they can be practically applied in diverse areas of neuroscience, ranging from the analysis of synaptic networks in the nematode worm to the characterization of large-scale human brain networks constructed with magnetic resonance imaging. This text is ideally suited to neuroscientists wanting to develop expertise in the rapidly developing field of neural connectomics, and to physical and computational scientists wanting to understand how these quantitative methods can be used to understand brain organization. Extensively illustrated throughout by graphical representations of key mathematical concepts and their practical applications to analyses of nervous systems

Comprehensively covers graph theoretical analyses of structural and functional brain networks, from microscopic to macroscopic scales, using examples based on a wide variety of experimental methods in neuroscience

Designed to inform and empower scientists at all levels of experience, and from any specialist background, wanting to use modern methods of network science to understand the organization of the brain

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Building upon the previous editions, this textbook is a first course in stochastic processes taken by undergraduate and graduate students (MS and PhD students from math, statistics, economics, computer science, engineering, and finance departments) who have had a course in probability theory. It covers Markov chains in discrete and continuous time, Poisson processes, renewal processes, martingales, and option pricing. One can only learn a subject by seeing it in action, so there are a large number of examples and more than 300 carefully chosen exercises to deepen the reader's understanding. Drawing from teaching experience and student feedback, there are many new examples and problems with solutions that use TI-83 to eliminate the tedious details of solving linear equations by hand, and the collection of exercises is much improved, with many more biological examples. Originally included in previous editions, material too advanced for this first course in stochastic processes has been eliminated while treatment of other topics useful for applications has been expanded. In addition, the ordering of topics has been improved; for example, the difficult subject of martingales is delayed until its usefulness can be applied in the treatment of mathematical finance. Comprehensively teaches the basics of testing statistical assumptions in research and the importance in doing so This book facilitates

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researchers in checking the assumptions of statistical tests used in their research by focusing on the importance of checking assumptions in using statistical methods, showing them how to check assumptions, and explaining what to do if assumptions are not met. Testing Statistical Assumptions in Research discusses the concepts of hypothesis testing and statistical errors in detail, as well as the concepts of power, sample size, and effect size. It introduces SPSS functionality and shows how to segregate data, draw random samples, file split, and create variables automatically. It then goes on to cover different assumptions required in survey studies, and the importance of designing surveys in reporting the efficient findings. The book provides various parametric tests and the related assumptions and shows the procedures for testing these assumptions using SPSS software. To motivate readers to use assumptions, it includes many situations where violation of assumptions affects the findings. Assumptions required for different non-parametric tests such as Chi-square, Mann-Whitney, Kruskal Wallis, and Wilcoxon signed-rank test are also discussed. Finally, it looks at assumptions in non-parametric correlations, such as bi-serial correlation, tetrachoric correlation, and phi coefficient. An excellent reference for graduate students and research scholars of any discipline in testing



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assumptions of statistical tests before using them in their research study Shows readers the adverse effect of violating the assumptions on findings by means of various illustrations Describes different assumptions associated with different statistical tests commonly used by research scholars Contains examples using SPSS, which helps facilitate readers to understand the procedure involved in testing assumptions Looks at commonly used assumptions in statistical tests, such as z, t and F tests, ANOVA, correlation, and regression analysis Testing Statistical Assumptions in Research is a valuable resource for graduate students of any discipline who write thesis or dissertation for empirical studies in their course works, as well as for data analysts. The aim of this graduate textbook is to provide a comprehensive advanced course in the theory of statistics covering those topics in estimation, testing, and large sample theory which a graduate student might typically need to learn as preparation for work on a Ph.D. An important strength of this book is that it provides a mathematically rigorous and even-handed account of both Classical and Bayesian inference in order to give readers a broad perspective. For example, the "uniformly most powerful" approach to testing is contrasted with available decision-theoretic approaches. This volume contains six early mathematical works, four papers on fiducial inference, five on

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transformations, and twenty-seven on a miscellany of topics in mathematical statistics. Several previously unpublished works are included.

High-dimensional probability offers insight into the behavior of random vectors, random matrices, random subspaces, and objects used to quantify uncertainty in high dimensions.

Drawing on ideas from probability, analysis, and geometry, it lends itself to applications in mathematics, statistics, theoretical computer science, signal processing, optimization, and more. It is the first to integrate theory, key tools, and modern applications of high-dimensional probability.

Concentration inequalities form the core, and it covers both classical results such as Hoeffding's and Chernoff's inequalities and modern developments such as the matrix Bernstein's inequality. It then introduces the powerful methods based on stochastic processes, including such tools as Slepian's, Sudakov's, and Dudley's inequalities, as well as generic chaining and bounds based on VC dimension. A broad range of illustrations is embedded throughout, including classical and modern results for covariance estimation, clustering, networks, semidefinite programming, coding, dimension reduction, matrix completion, machine learning, compressed sensing, and sparse regression.

This textbook on the theory of probability starts from the premise that rather than being a purely mathematical discipline, probability theory is an intimate companion of statistics. The book starts with the basic tools, and goes on to cover a number of subjects in detail, including chapters on inequalities, characteristic functions and convergence. This is followed by explanations of the three main subjects in probability: the law of large numbers, the central limit theorem, and the law of the iterated logarithm. After a discussion of generalizations and extensions, the book

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concludes with an extensive chapter on martingales. These volumes present a selection of Erich L. Lehmann's monumental contributions to Statistics. These works are multifaceted. His early work included fundamental contributions to hypothesis testing, theory of point estimation, and more generally to decision theory. His work in Nonparametric Statistics was groundbreaking. His fundamental contributions in this area include results that came to assuage the anxiety of statisticians that were skeptical of nonparametric methodologies, and his work on concepts of dependence has created a large literature. The two volumes are divided into chapters of related works. Invited contributors have critiqued the papers in each chapter, and the reprinted group of papers follows each commentary. A complete bibliography that contains links to recorded talks by Erich Lehmann – and which are freely accessible to the public – and a list of Ph.D. students are also included. These volumes belong in every statistician's personal collection and are a required holding for any institutional library.

Expanded and updated, the Third Edition of Gopal Kanji's best-selling resource on statistical tests covers all the most commonly used tests with information on how to calculate and interpret results with simple datasets. The Third Edition now includes: - a new introduction to statistical testing with information to guide even the non-statistician through the book quickly and easily - real-world explanations of how and when to use each test with examples drawn from wide range of disciplines - a useful Classification of Tests table - all the relevant statistical tables for checking critical valu.

?This book is for students and researchers who have had a first year graduate level mathematical statistics course. It covers classical likelihood, Bayesian, and permutation inference; an introduction to basic asymptotic distribution theory; and modern topics like M-estimation, the jackknife,

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and the bootstrap. R code is woven throughout the text, and there are a large number of examples and problems. An important goal has been to make the topics accessible to a wide audience, with little overt reliance on measure theory. A typical semester course consists of Chapters 1-6 (likelihood-based estimation and testing, Bayesian inference, basic asymptotic results) plus selections from M-estimation and related testing and resampling methodology. Dennis Boos and Len Stefanski are professors in the Department of Statistics at North Carolina State. Their research has been eclectic, often with a robustness angle, although Stefanski is also known for research concentrated on measurement error, including a co-authored book on non-linear measurement error models. In recent years the authors have jointly worked on variable selection methods. ?

Classical statistical theory—hypothesis testing, estimation, and the design of experiments and sample surveys—is mainly the creation of two men: Ronald A. Fisher (1890-1962) and Jerzy Neyman (1894-1981). Their contributions sometimes complemented each other, sometimes occurred in parallel, and, particularly at later stages, often were in strong opposition. The two men would not be pleased to see their names linked in this way, since throughout most of their working lives they detested each other. Nevertheless, they worked on the same problems, and through their combined efforts created a new discipline. This new book by E.L. Lehmann, himself a student of Neyman's, explores the relationship between Neyman and Fisher, as well as their interactions with other influential statisticians, and the statistical history they helped create together. Lehmann uses direct correspondence and original papers to recreate an historical account of the creation of the Neyman-Pearson Theory as well as Fisher's dissent, and other important statistical theories.

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For advanced graduate students, this book is a one-stop shop that presents the main ideas of decision theory in an organized, balanced, and mathematically rigorous manner, while observing statistical relevance. All of the major topics are introduced at an elementary level, then developed incrementally to higher levels. The book is self-contained as it provides full proofs, worked-out examples, and problems. The authors present a rigorous account of the concepts and a broad treatment of the major results of classical finite sample size decision theory and modern asymptotic decision theory. With its broad coverage of decision theory, this book fills the gap between standard graduate texts in mathematical statistics and advanced monographs on modern asymptotic theory.

This book was written to rigorously illustrate the practical application of the projective approach to linear models. To some, this may seem contradictory. I contend that it is possible to be both rigorous and illustrative and that it is possible to use the projective approach in practical applications. Therefore, unlike many other books on linear models, the use of projections and sub spaces does not stop after the general theory. They are used wherever I could figure out how to do it. Solving normal equations and using calculus (outside of maximum likelihood theory) are anathema to me. This is because I do not believe that they contribute to the understanding of linear models. I have similar feelings about the use of side conditions. Such topics are mentioned when appropriate and thenceforward avoided like the plague. On the other side of the coin, I just as strenuously reject teaching linear models with a coordinate free approach. Although Joe Eaton assures me that the issues in complicated problems frequently become clearer when considered free of coordinate systems, my experience is that too many people never make the jump from coordinate

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free theory back to practical applications. I think that coordinate free theory is better tackled after mastering linear models from some other approach. In particular, I think it would be very easy to pick up the coordinate free approach after learning the material in this book. See Eaton (1983) for an excellent exposition of the coordinate free approach.

Testing Statistical Hypotheses Springer Science & Business Media

This is a graduate level textbook on measure theory and probability theory. The book can be used as a text for a two semester sequence of courses in measure theory and probability theory, with an option to include supplemental material on stochastic processes and special topics. It is intended primarily for first year Ph.D. students in mathematics and statistics although mathematically advanced students from engineering and economics would also find the book useful. Prerequisites are kept to the minimal level of an understanding of basic real analysis concepts such as limits, continuity, differentiability, Riemann integration, and convergence of sequences and series. A review of this material is included in the appendix. The book starts with an informal introduction that provides some heuristics into the abstract concepts of measure and integration theory, which are then rigorously developed. The first part of the book can be used for a standard real analysis course for both mathematics and statistics Ph.D. students as it provides full coverage of topics such as the construction of Lebesgue-Stieltjes measures on real line and Euclidean spaces, the basic convergence theorems,  $L^p$  spaces, signed measures, Radon-Nikodym theorem,

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Lebesgue's decomposition theorem and the fundamental theorem of Lebesgue integration on  $\mathbb{R}$ , product spaces and product measures, and Fubini-Tonelli theorems. It also provides an elementary introduction to Banach and Hilbert spaces, convolutions, Fourier series and Fourier and Plancherel transforms. Thus part I would be particularly useful for students in a typical Statistics Ph.D. program if a separate course on real analysis is not a standard requirement. Part II (chapters 6-13) provides full coverage of standard graduate level probability theory. It starts with Kolmogorov's probability model and Kolmogorov's existence theorem. It then treats thoroughly the laws of large numbers including renewal theory and ergodic theorems with applications and then weak convergence of probability distributions, characteristic functions, the Levy-Cramer continuity theorem and the central limit theorem as well as stable laws. It ends with conditional expectations and conditional probability, and an introduction to the theory of discrete time martingales. Part III (chapters 14-18) provides a modest coverage of discrete time Markov chains with countable and general state spaces, MCMC, continuous time discrete space jump Markov processes, Brownian motion, mixing sequences, bootstrap methods, and branching processes. It could be used for a topics/seminar course or as an introduction to stochastic processes. Krishna B. Athreya is a professor at the departments of mathematics and statistics and a Distinguished Professor in the College of Liberal Arts and Sciences at the Iowa State University. He has been a faculty member at University of Wisconsin, Madison;

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Indian Institute of Science, Bangalore; Cornell University; and has held visiting appointments in Scandinavia and Australia. He is a fellow of the Institute of Mathematical Statistics USA; a fellow of the Indian Academy of Sciences, Bangalore; an elected member of the International Statistical Institute; and serves on the editorial board of several journals in probability and statistics. Soumendra N. Lahiri is a professor at the department of statistics at the Iowa State University. He is a fellow of the Institute of Mathematical Statistics, a fellow of the American Statistical Association, and an elected member of the International Statistical Institute. Intended as the text for a sequence of advanced courses, this book covers major topics in theoretical statistics in a concise and rigorous fashion. The discussion assumes a background in advanced calculus, linear algebra, probability, and some analysis and topology. Measure theory is used, but the notation and basic results needed are presented in an initial chapter on probability, so prior knowledge of these topics is not essential. The presentation is designed to expose students to as many of the central ideas and topics in the discipline as possible, balancing various approaches to inference as well as exact, numerical, and large sample methods. Moving beyond more standard material, the book includes chapters introducing bootstrap methods, nonparametric regression, equivariant estimation, empirical Bayes, and sequential design and analysis. The book has a rich collection of exercises. Several of them illustrate how the theory developed in the book may be used in various applications. Solutions to many of the



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exercises are included in an appendix.

Comic Amy Schumer performs a stand-up set in San Francisco devoted to various aspects of her sex life and her feelings about her own body. ~ Perry Seibert, Rovi

A problem-oriented text for evaluating statistical procedures through decision and game theory. First-year graduates in statistics, computer experts and others will find this highly respected work best introduction to growing field.

This graduate textbook covers topics in statistical theory essential for graduate students preparing for work on a Ph.D. degree in statistics. This new edition has been revised and updated and in this fourth printing, errors have been ironed out. The first chapter provides a quick overview of concepts and results in measure-theoretic probability theory that are useful in statistics. The second chapter introduces some fundamental concepts in statistical decision theory and inference. Subsequent chapters contain detailed studies on some important topics: unbiased estimation, parametric estimation, nonparametric estimation, hypothesis testing, and confidence sets. A large number of exercises in each chapter provide not only practice problems for students, but also many additional results.

In this definitive book, D. R. Cox gives a comprehensive and balanced appraisal of statistical inference. He develops the key concepts, describing and comparing the main ideas and controversies over foundational issues that have been keenly argued for more than two-hundred years. Continuing a sixty-year career of major contributions to statistical thought, no one is better

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placed to give this much-needed account of the field. An appendix gives a more personal assessment of the merits of different ideas. The content ranges from the traditional to the contemporary. While specific applications are not treated, the book is strongly motivated by applications across the sciences and associated technologies. The mathematics is kept as elementary as feasible, though previous knowledge of statistics is assumed. The book will be valued by every user or student of statistics who is serious about understanding the uncertainty inherent in conclusions from statistical analyses.

This text is for a one semester graduate course in statistical theory and covers minimal and complete sufficient statistics, maximum likelihood estimators, method of moments, bias and mean square error, uniform minimum variance estimators and the Cramer-Rao lower bound, an introduction to large sample theory, likelihood ratio tests and uniformly most powerful tests and the Neyman Pearson Lemma. A major goal of this text is to make these topics much more accessible to students by using the theory of exponential families. Exponential families, indicator functions and the support of the distribution are used throughout the text to simplify the theory. More than 50 "brand name" distributions are used to illustrate the theory with many examples of exponential families, maximum likelihood estimators and uniformly minimum variance unbiased estimators. There are many homework problems with over 30 pages of solutions.

Concise account of main approaches; first textbook to

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synthesize modern computation with basic theory.

This second, much enlarged edition by Lehmann and Casella of Lehmann's classic text on point estimation maintains the outlook and general style of the first edition. All of the topics are updated, while an entirely new chapter on Bayesian and hierarchical Bayesian approaches is provided, and there is much new material on simultaneous estimation. Each chapter concludes with a Notes section which contains suggestions for further study. This is a companion volume to the second edition of Lehmann's "Testing Statistical Hypotheses".

Since Efron's profound paper on the bootstrap, an enormous amount of effort has been spent on the development of bootstrap, jackknife, and other resampling methods. The primary goal of these computer-intensive methods has been to provide statistical tools that work in complex situations without imposing unrealistic or unverifiable assumptions about the data generating mechanism. This book sets out to lay some of the foundations for subsampling methodology and related methods.

This detailed introduction to distribution theory uses no measure theory, making it suitable for students in statistics and econometrics as well as for researchers who use statistical methods. Good backgrounds in calculus and linear algebra are important and a course in elementary mathematical analysis is useful, but not required. An appendix gives a detailed summary of the mathematical definitions and results that are used in the book. Topics covered range from the basic distribution and density functions, expectation, conditioning, characteristic functions, cumulants, convergence in distribution and the central limit theorem to more advanced concepts such as exchangeability, models with a group structure, asymptotic approximations to integrals, orthogonal polynomials and saddlepoint approximations. The emphasis is on topics useful

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in understanding statistical methodology; thus, parametric statistical models and the distribution theory associated with the normal distribution are covered comprehensively.

Priced very competitively compared with other textbooks at this level! This gracefully organized textbook reveals the rigorous theory of probability and statistical inference in the style of a tutorial, using worked examples, exercises, numerous figures and tables, and computer simulations to develop and illustrate concepts. Beginning wi

This book establishes the theoretical foundations of a general methodology for multiple hypothesis testing and discusses its software implementation in R and SAS. These are applied to a range of problems in biomedical and genomic research, including identification of differentially expressed and co-expressed genes in high-throughput gene expression experiments; tests of association between gene expression measures and biological annotation metadata; sequence analysis; and genetic mapping of complex traits using single nucleotide polymorphisms. The procedures are based on a test statistics joint null distribution and provide Type I error control in testing problems involving general data generating distributions, null hypotheses, and test statistics.

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