Majorization Here There And Everywhere

Concentration Inequalities and Model SelectionThe 1-2-3 of Modular FormsTechniques of Variational AnalysisConvex OptimizationAnalytic CombinatoricsTheory of StatisticsVariational AnalysisInequalitiesAnalytic Combinatorics in Several VariablesMajorization and the Lorenz Order: A Brief IntroductionQuadrature Domains and Their ApplicationsGeometric Integration TheoryAn Introduction to Random MatricesProbabilistic Properties of Deterministic SystemsRecent Advances in Reliability TheoryTopological GroupsMathematical WritingGazette - Australian Mathematical SocietyConvex Functions and Their ApplicationsMatrices, Statistics and Big DataHigh-Dimensional ProbabilityStatistical Learning with SparsityConvex Analysis and Minimization Algorithms IAdvances on Income Inequality and Concentration MeasuresMajorization and the Lorenz Order with Applications in Applied Mathematics and EconomicsPutting Auction Theory to WorkFinely Harmonic FunctionsComplex AnalysisApproximate Quantum Markov ChainsInformation Theory and Network CodingInequalities: Theory of Majorization and Its ApplicationsThe Theory of Quantum InformationProximal AlgorithmsConvex Optimization & Euclidean Distance GeometryCMS Technical Summary ReportThe Scottish BookMatrix AnalysisSoviet Mathematics - DokladyPerturbation theory for linear operatorsGeneral Inequalities 3

Concentration Inequalities and Model Selection

With this second volume, we enter the intriguing world of complex analysis. From the first theorems on, the elegance and sweep of the results is evident. The starting point is the simple idea of extending a function initially given for real values of the argument to one that is defined when the argument is complex. From there, one proceeds to the main properties of holomorphic functions, whose proofs are generally short and quite illuminating: the Cauchy theorems, residues, analytic continuation, the argument principle. With this background, the reader is ready to learn a wealth of additional material connecting the subject with other areas of mathematics: the Fourier transform treated by contour integration, the zeta function and the prime number theorem, and an introduction to elliptic functions culminating in their application to combinatorics and number theory. Thoroughly developing a subject with many ramifications, while striking a careful balance between conceptual insights and the technical underpinnings of rigorous analysis, Complex Analysis will be welcomed by students of mathematics, physics, engineering and other sciences. The Princeton Lectures in Analysis represents a sustained effort to introduce the core areas of mathematical analysis while also illustrating the organic unity between them. Numerous examples and applications throughout its four planned volumes, of which Complex Analysis is the second, highlight the far-reaching consequences of certain ideas in analysis to other fields of mathematics and a variety of sciences. Stein and Shakarchi move from an introduction addressing Fourier series and integrals to in-depth considerations of complex analysis; measure and integration theory, and Hilbert spaces; and, finally, further topics such as functional analysis, distributions and elements of probability theory.

The 1-2-3 of Modular Forms

This classic of the mathematical literature forms a comprehensive study of the inequalities used throughout mathematics. First published in 1934, it presents clearly and exhaustively both the statement and proof of all the standard inequalities of analysis. The authors were well known for their powers of exposition and were able here to make the subject accessible to a wide audience of mathematicians.

Techniques of Variational Analysis

Formal development of the mathematical theory of quantum information with clear proofs and exercises. For graduate students and researchers.

Convex Optimization

Borwein is an authority in the area of mathematical optimization, and his book makes an important contribution to variational analysis Provides a good introduction to the topic

Analytic Combinatorics

Convex optimization problems arise frequently in many different fields. This book provides a comprehensive introduction to the subject, and shows in detail how such problems can be solved numerically with great efficiency. The book begins with the basic elements of convex sets and functions, and then describes various classes of convex optimization problems. Duality and approximation techniques are then covered, as are statistical estimation techniques. Various geometrical problems are then presented, and there is detailed discussion of unconstrained and constrained minimization problems, and interior-point methods. The focus of the book is on recognizing convex optimization problems and then finding the most appropriate technique for solving them. It contains many worked examples and homework exercises and will appeal to students, researchers and practitioners in fields such as engineering, computer science, mathematics, statistics, finance and economics.

Theory of Statistics

Following the tremendous reception of our first volume on topological groups called "Topological Groups: Yesterday, Today, and Tomorrow", we now present our second volume. Like the first volume, this collection contains articles by some of the

best scholars in the world on topological groups. A feature of the first volume was surveys, and we continue that tradition in this volume with three new surveys. These surveys are of interest not only to the expert but also to those who are less experienced. Particularly exciting to active researchers, especially young researchers, is the inclusion of over three dozen open questions. This volume consists of 11 papers containing many new and interesting results and examples across the spectrum of topological group theory and related topics. Well-known researchers who contributed to this volume include Taras Banakh, Michael Megrelishvili, Sidney A. Morris, Saharon Shelah, George A. Willis, O'lga V. Sipacheva, and Stephen Wagner.

Variational Analysis

Inequalities

Analytic combinatorics aims to enable precise quantitative predictions of the properties of large combinatorial structures. The theory has emerged over recent decades as essential both for the analysis of algorithms and for the study of scientific models in many disciplines, including probability theory, statistical physics, computational biology, and information theory. With a careful combination of symbolic enumeration methods and complex analysis, drawing heavily on generating functions, results of sweeping generality emerge that can be applied in particular to fundamental structures such as permutations, sequences, strings, walks, paths, trees, graphs and maps. This account is the definitive treatment of the topic. The authors give full coverage of the underlying mathematics and a thorough treatment of both classical and modern applications of the theory. The text is complemented with exercises, examples, appendices and notes to aid understanding. The book can be used for an advanced undergraduate or a graduate course, or for self-study.

Analytic Combinatorics in Several Variables

Majorization and the Lorenz Order: A Brief Introduction

This book will help those wishing to teach a course in technical writing, or who wish to write themselves.

Quadrature Domains and Their Applications

This textbook introduces geometric measure theory through the notion of currents. Currents, continuous linear functionals

on spaces of differential forms, are a natural language in which to formulate types of extremal problems arising in geometry, and can be used to study generalized versions of the Plateau problem and related questions in geometric analysis. Motivating key ideas with examples and figures, this book is a comprehensive introduction ideal for both self-study and for use in the classroom. The exposition demands minimal background, is self-contained and accessible, and thus is ideal for both graduate students and researchers.

Geometric Integration Theory

Proximal Algorithms discusses proximal operators and proximal algorithms, and illustrates their applicability to standard and distributed convex optimization in general and many applications of recent interest in particular. Much like Newton's method is a standard tool for solving unconstrained smooth optimization problems of modest size, proximal algorithms can be viewed as an analogous tool for nonsmooth, constrained, large-scale, or distributed versions of these problems. They are very generally applicable, but are especially well-suited to problems of substantial recent interest involving large or high-dimensional datasets. Proximal methods sit at a higher level of abstraction than classical algorithms like Newton's method: the base operation is evaluating the proximal operator of a function, which itself involves solving a small convex optimization problem. These subproblems, which generalize the problem of projecting a point onto a convex set, often admit closed-form solutions or can be solved very quickly with standard or simple specialized methods. Proximal Algorithms discusses different interpretations of proximal operators and algorithms, looks at their connections to many other topics in optimization and applied mathematics, surveys some popular algorithms, and provides a large number of examples of proximal operators that commonly arise in practice.

An Introduction to Random Matrices

This book presents a substantial part of matrix analysis that is functional analytic in spirit. Topics covered include the theory of majorization, variational principles for eigenvalues, operator monotone and convex functions, and perturbation of matrix functions and matrix inequalities. The book offers several powerful methods and techniques of wide applicability, and it discusses connections with other areas of mathematics.

Probabilistic Properties of Deterministic Systems

Discover New Methods for Dealing with High-Dimensional Data A sparse statistical model has only a small number of nonzero parameters or weights; therefore, it is much easier to estimate and interpret than a dense model. Statistical Learning with Sparsity: The Lasso and Generalizations presents methods that exploit sparsity to help recover the underlying

signal in a set of data. Top experts in this rapidly evolving field, the authors describe the lasso for linear regression and a simple coordinate descent algorithm for its computation. They discuss the application of l1 penalties to generalized linear models and support vector machines, cover generalized penalties such as the elastic net and group lasso, and review numerical methods for optimization. They also present statistical inference methods for fitted (lasso) models, including the bootstrap, Bayesian methods, and recently developed approaches. In addition, the book examines matrix decomposition, sparse multivariate analysis, graphical models, and compressed sensing. It concludes with a survey of theoretical results for the lasso. In this age of big data, the number of features measured on a person or object can be large and might be larger than the number of observations. This book shows how the sparsity assumption allows us to tackle these problems and extract useful and reproducible patterns from big datasets. Data analysts, computer scientists, and theorists will appreciate this thorough and up-to-date treatment of sparse statistical modeling.

Recent Advances in Reliability Theory

Topological Groups

The second edition of this book updates and expands upon a historically important collection of mathematical problems first published in the United States by Birkhäuser in 1981. These problems serve as a record of the informal discussions held by a group of mathematicians at the Scottish Café in Lwów, Poland, between the two world wars. Many of them were leaders in the development of such areas as functional and real analysis, group theory, measure and set theory, probability, and topology. Finding solutions to the problems they proposed has been ongoing since World War II, with prizes offered in many cases to those who are successful. In the 35 years since the first edition published, several more problems have been fully or partially solved, but even today many still remain unsolved and several prizes remain unclaimed. In view of this, the editor has gathered new and updated commentaries on the original 193 problems. Some problems are solved for the first time in this edition. Included again in full are transcripts of lectures given by Stanislaw Ulam, Mark Kac, Antoni Zygmund, Paul Erdös, and Andrzej Granas that provide amazing insights into the mathematical environment of Lwów before World War II and the development of The Scottish Book. Also new in this edition are a brief history of the University of Wrocław's New Scottish Book, created to revive the tradition of the original, and some selected problems from it. The Scottish Book offers a unique opportunity to communicate with the people and ideas of a time and place that had an enormous influence on the development of mathematics and try their hand on the unsolved problems. Anyone in the general mathematical community with an interest in the history of modern mathematics will find this to be an insightful and fascinating read.

Mathematical Writing

Quadrature domains were singled out about 30 years ago by D. Aharonov and H.S. Shapiro in connection with an extremal problem in function theory. Since then, a series of coincidental discoveries put this class of planar domains at the center of crossroads of several quite independent mathematical theories, e.g., potential theory, Riemann surfaces, inverse problems, holomorphic partial differential equations, fluid mechanics, operator theory. The volume is devoted to recent advances in the theory of quadrature domains, illustrating well the multi-facet aspects of their nature. The book contains a large collection of open problems pertaining to the general theme of quadrature domains.

Gazette - Australian Mathematical Society

The study of Euclidean distance matrices (EDMs) fundamentally asks what can be known geometrically given onlydistance information between points in Euclidean space. Each point may represent simply locationor, abstractly, any entity expressible as a vector in finite-dimensional Euclidean space.The answer to the question posed is that very much can be known about the points;the mathematics of this combined study of geometry and optimization is rich and deep.Throughout we cite beacons of historical accomplishment.The application of EDMs has already proven invaluable in discerning biological molecular conformation.The emerging practice of localization in wireless sensor networks, the global positioning system (GPS), and distance-based pattern recognitionwill certainly simplify and benefit from this theory.We study the pervasive convex Euclidean bodies and their various representations.In particular, we make convex polyhedra, cones, and dual cones more visceral through illustration, andwe study the geometric relation of polyhedral cones to nonorthogonal bases biorthogonal expansion.We explain conversion between halfspace- and vertex-descriptions of convex cones,we provide formulae for determining dual cones,and we show how classic alternative systems of linear inequalities or linear matrix inequalities and optimality conditions can be explained by generalized inequalities in terms of convex cones and their duals.The conic analogue to linear independence, called conic independence, is introducedas a new tool in the study of classical cone theory; the logical next step in the progression:linear, affine, conic.Any convex optimization problem has geometric interpretation.This is a powerful attraction: the ability to visualize geometry of an optimization problem.We provide tools to make visualization easier.The concept of faces, extreme points, and extreme directions of convex Euclidean bodiesis explained here, crucial to understanding convex optimization.The convex cone of positive semidefinite matrices, in particular, is studied in depth.We mathematically interpret, for example,its inverse image under affine transformation, and we explainhow higher-rank subsets of its boundary united with its interior are convex.The Chapter on "Geometry of convex functions",observes analogies between convex sets and functions:The set of all vector-valued convex functions is a closed convex cone.Included among the examples in this chapter, we show how the real affinefunction relates to convex functions as the hyperplane relates to convex sets.Here, also, pertinent results formultidimensional convex functions are presented that are largely ignored in the literature;tricks and tips for determining their convexityand discerning their geometry, particularly with regard to matrix calculus which remains largely unsystematizedwhen compared with the traditional

practice of ordinary calculus.Consequently, we collect some results of matrix differentiation in the appendices.The Euclidean distance matrix (EDM) is studied,its properties and relationship to both positive semidefinite and Gram matrices.We relate the EDM to the four classical axioms of the Euclidean metric;thereby, observing the existence of an infinity of axioms of the Euclidean metric beyondthe triangle inequality. We proceed byderiving the fifth Euclidean axiom and then explain why furthering this endeavoris inefficient because the ensuing criteria (while describing polyhedra)grow linearly in complexity and number.Some geometrical problems solvable via EDMs,EDM problems posed as convex optimization, and methods of solution arepresented;\eg, we generate a recognizable isotonic map of the United States usingonly comparative distance information (no distance information, only distance inequalities).We offer a new proof of the classic Schoenberg criterion, that determines whether a candidate matrix is an EDM. Our proofrelies on fundamental geometry; assuming, any EDM must correspond to a list of points contained in some polyhedron(possibly at its vertices) and vice versa.It is not widely known that the Schoenberg criterion implies nonnegativity of the EDM entries; proved here.We characterize the eigenvalues of an EDM matrix and then devisea polyhedral cone required for determining membership of a candidate matrix(in Cayley-Menger form) to the convex cone of Euclidean distance matrices (EDM cone); \ie,a candidate is an EDM if and only if its eigenspectrum belongs to a spectral cone for EDM^N.We will see spectral cones are not unique.In the chapter "EDM cone", we explain the geometric relationship betweenthe EDM cone, two positive semidefinite cones, and the elliptope.We illustrate geometric requirements, in particular, for projection of a candidate matrixon a positive semidefinite cone that establish its membership to the EDM cone. The faces of the EDM cone are described,but still open is the question whether all its faces are exposed as they are for the positive semidefinite cone.The classic Schoenberg criterion, relating EDM and positive semidefinite cones, isrevealed to be a discretized membership relation (a generalized inequality, a new Farkas'''''''-like lemma)between the EDM cone and its ordinary dual. A matrix criterion for membership to the dual EDM cone is derived thatis simpler than the Schoenberg criterion.We derive a new concise expression for the EDM cone and its dual involvingtwo subspaces and a positive semidefinite cone."Semidefinite programming" is reviewedwith particular attention to optimality conditionsof prototypical primal and dual conic programs,their interplay, and the perturbation method of rank reduction of optimal solutions(extant but not well-known).We show how to solve a ubiquitous platonic combinatorial optimization problem from linear algebra(the optimal Boolean solution x to Ax=b)via semidefinite program relaxation.A three-dimensional polyhedral analogue for the positive semidefinite cone of 3X3 symmetricmatrices is introduced; a tool for visualizing in 6 dimensions.In "EDM proximity"we explore methods of solution to a few fundamental and prevalentEuclidean distance matrix proximity problems; the problem of finding that Euclidean distance matrix closestto a given matrix in the Euclidean sense.We pay particular attention to the problem when compounded with rank minimization.We offer a new geometrical proof of a famous result discovered by Eckart \& Young in 1936 regarding Euclideanprojection of a point on a subset of the positive semidefinite cone comprising all positive semidefinite matriceshaving rank not exceeding a prescribed limit rho.We explain how this problem is transformed to a convex optimization for any rank rho.

Convex Functions and Their Applications

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.

Matrices, Statistics and Big Data

This book grew out of three series of lectures given at the summer school on "Modular Forms and their Applications" at the Sophus Lie Conference Center in Nordfjordeid in June 2004. The first series treats the classical one-variable theory of elliptic modular forms. The second series presents the theory of Hilbert modular forms in two variables and Hilbert modular surfaces. The third series gives an introduction to Siegel modular forms and discusses a conjecture by Harder. It also contains Harder's original manuscript with the conjecture. Each part treats a number of beautiful applications.

High-Dimensional Probability

This book presents thirty-one extensive and carefully edited chapters providing an up-to-date survey of new models and methods for reliability analysis and applications in science, engineering, and technology. The chapters contain broad coverage of the latest developments and innovative techniques in a wide range of theoretical and numerical issues in the field of statistical and probabilistic methods in reliability.

Statistical Learning with Sparsity

This book’s first edition has been widely cited by researchers in diverse fields. The following are excerpts from reviews. “Inequalities: Theory of Majorization and its Applications” merits strong praise. It is innovative, coherent, well written and, most importantly, a pleasure to read. This work is a valuable resource!” (Mathematical Reviews). “The authors present an

extremely rich collection of inequalities in a remarkably coherent and unified approach. The book is a major work on inequalities, rich in content and original in organization." (Siam Review). "The appearance of Inequalities in 1979 had a great impact on the mathematical sciences. By showing how a single concept unified a staggering amount of material from widely diverse disciplines–probability, geometry, statistics, operations research, etc.–this work was a revelation to those of us who had been trying to make sense of his own corner of this material." (Linear Algebra and its Applications). This greatly expanded new edition includes recent research on stochastic, multivariate and group majorization, Lorenz order, and applications in physics and chemistry, in economics and political science, in matrix inequalities, and in probability and statistics. The reference list has almost doubled.

Convex Analysis and Minimization Algorithms I

Advances on Income Inequality and Concentration Measures

Thorough introduction to an important area of mathematics Contains recent results Includes many exercises

Majorization and the Lorenz Order with Applications in Applied Mathematics and Economics

This book is the result of nearly fifteen years of work on developing analytic machinery to recover, as effectively as possible, asymptotics of the coefficients of a multivariate generating function. It is the first book to describe many of the results and techniques necessary to estimate coefficients of generating functions in more than one variable.

Putting Auction Theory to Work

My interest in majorization was first spurred by Ingram alkin's proclivity for finding Schur convex functions lurking in the problem section of every issue of the American Mathematical Monthly. Later my interest in income inequality led me again to try and "really" understand Hardy, Littlewood and Polya' s contributions to the majori zation literature. I have found the income distribution context to be quite convenient for discussion of inequality orderings. The pre sent set of notes is designed for a one quarter course introducing majorization and the Lorenz order. The inequality principles of Dalton, especially the transfer or Robin Hood principle, are given appropriate prominence. Initial versions of these notes were used in graduate statistics classes taught at the Colegio de Postgraduados, Chapingo, Mexico and the University of California, Riverside. I am grateful to students in these classes for their constructive critical commentaries. My wife Carole made noble efforts to harness my free form writ ing and punctuation. Occasionally I was unmoved by her requests for clarification. Time

will probably prove her right in these instances also. Peggy Franklin did an outstanding job of typing the manu script, and patiently endured requests for innumerable modifications.

Finely Harmonic Functions

This book is an evolution from my book A First Course in Information Theory published in 2002 when network coding was still at its infancy. The last few years have witnessed the rapid development of network coding into a research ?eld of its own in information science. With its root in infor- tion theory, network coding has not only brought about a paradigm shift in network communications at large, but also had signi?cant in?uence on such speci?c research ?elds as coding theory, networking, switching, wireless c- munications,distributeddatastorage,cryptography,andoptimizationtheory. While new applications of network coding keep emerging, the fundamental - sults that lay the foundation of the subject are more or less mature. One of the main goals of this book therefore is to present these results in a unifying and coherent manner. While the previous book focused only on information theory for discrete random variables, the current book contains two new chapters on information theory for continuous random variables, namely the chapter on di?erential entropy and the chapter on continuous-valued channels. With these topics included, the book becomes more comprehensive and is more suitable to be used as a textbook for a course in an electrical engineering department.

Complex Analysis

Concentration inequalities have been recognized as fundamental tools in several domains such as geometry of Banach spaces or random combinatorics. They also turn to be essential tools to develop a non asymptotic theory in statistics. This volume provides an overview of a non asymptotic theory for model selection. It also discusses some selected applications to variable selection, change points detection and statistical learning.

Approximate Quantum Markov Chains

This book was written to serve as a graduate-level textbook for special topics classes in mathematics, statistics, and economics, to introduce these topics to other researchers, and for use in short courses. It is an introduction to the theory of majorization and related notions, and contains detailed material on economic applications of majorization and the Lorenz order, investigating the theoretical aspects of these two interrelated orderings. Revising and expanding on an earlier monograph, Majorization and the Lorenz Order: A Brief Introduction, the authors provide a straightforward development and explanation of majorization concepts, addressing historical development of the topics, and providing up-to-date coverage of families of Lorenz curves. The exposition of multivariate Lorenz orderings sets it apart from existing treatments of these

topics. Mathematicians, theoretical statisticians, economists, and other social scientists who already recognize the utility of the Lorenz order in income inequality contexts and arenas will find the book useful for its sound development of relevant concepts rigorously linked to both the majorization literature and the even more extensive body of research on economic applications. Barry C. Arnold, PhD, is Distinguished Professor in the Statistics Department at the University of California, Riverside. He is a Fellow of the American Statistical Society, the American Association for the Advancement of Science, and the Institute of Mathematical Statistics, and is an elected member of the International Statistical Institute. He is the author of more than two hundred publications and eight books. José María Sarabia, PhD, is Statistics Professor in the Department of Economics at the University of Cantabria, Spain. He is author of more than one hundred publications and ten books and is an associate editor of several journals, including Journal of Banking and Finance, TEST, and Journal of Statistical Distributions and Applications.

Information Theory and Network Coding

Convex Analysis may be considered as a refinement of standard calculus, with equalities and approximations replaced by inequalities. As such, it can easily be integrated into a graduate study curriculum. Minimization algorithms, more specifically those adapted to non-differentiable functions, provide an immediate application of convex analysis to various fields related to optimization and operations research. These two topics making up the title of the book, reflect the two origins of the authors, who belong respectively to the academic world and to that of applications. Part I can be used as an introductory textbook (as a basis for courses, or for self-study); Part II continues this at a higher technical level and is addressed more to specialists, collecting results that so far have not appeared in books.

Inequalities: Theory of Majorization and Its Applications

This book provides a comprehensive introduction to modern auction theory and its important new applications. It is written by a leading economic theorist whose suggestions guided the creation of the new spectrum auction designs. Aimed at graduate students and professionals in economics, the book gives the most up-to-date treatments of both traditional theories of 'optimal auctions' and newer theories of multi-unit auctions and package auctions, and shows by example how these theories are used. The analysis explores the limitations of prominent older designs, such as the Vickrey auction design, and evaluates the practical responses to those limitations. It explores the tension between the traditional theory of auctions with a fixed set of bidders, in which the seller seeks to squeeze as much revenue as possible from the fixed set, and the theory of auctions with endogenous entry, in which bidder profits must be respected to encourage participation.

The Theory of Quantum Information

Proximal Algorithms

This impressive collection from some of today’s leading distributional analysts provides an overview a wide range of economic, statistical and sociological relationships that have been opened up for scientific study by the work of two turn-of-the-20th-century economists: C. Gini and M. O. Lorenz. The authors include such figues as Barry Arnold and Frank Cowell and the resulting book deserves its place on the bookshelf of serious mathematical economists everywhere.

Convex Optimization & Euclidean Distance Geometry

This book shows how densities arise in simple deterministic systems. There has been explosive growth in interest in physical, biological and economic systems that can be profitably studied using densities. Due to the inaccessibility of the mathematical literature there has been little diffusion of the applicable mathematics into the study of these 'chaotic' systems. This book will help to bridge that gap. The authors give a unified treatment of a variety of mathematical systems generating densities, ranging from one-dimensional discrete time transformations through continuous time systems described by integro-partial differential equations. They have drawn examples from many scientific fields to illustrate the utility of the techniques presented. The book assumes a knowledge of advanced calculus and differential equations, but basic concepts from measure theory, ergodic theory, the geometry of manifolds, partial differential equations, probability theory and Markov processes, and stochastic integrals and differential equations are introduced as needed.

CMS Technical Summary Report

A rigorous introduction to the basic theory of random matrices designed for graduate students with a background in probability theory.

The Scottish Book

This book is an introduction to quantum Markov chains and explains how this concept is connected to the question of how well a lost quantum mechanical system can be recovered from a correlated subsystem. To achieve this goal, we strengthen the data-processing inequality such that it reveals a statement about the reconstruction of lost information. The main difficulty in order to understand the behavior of quantum Markov chains arises from the fact that quantum mechanical operators do not commute in general. As a result we start by explaining two techniques of how to deal with non-commuting matrices: the spectral pinching method and complex interpolation theory. Once the reader is familiar with these techniques

a novel inequality is presented that extends the celebrated Golden-Thompson inequality to arbitrarily many matrices. This inequality is the key ingredient in understanding approximate quantum Markov chains and it answers a question from matrix analysis that was open since 1973, i.e., if Lieb's triple matrix inequality can be extended to more than three matrices. Finally, we carefully discuss the properties of approximate quantum Markov chains and their implications. The book is aimed to graduate students who want to learn about approximate quantum Markov chains as well as more experienced scientists who want to enter this field. Mathematical majority is necessary, but no prior knowledge of quantum mechanics is required.

Matrix Analysis

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.

Soviet Mathematics - Doklady

Perturbation theory for linear operators

From its origins in the minimization of integral functionals, the notion of variations has evolved greatly in connection with applications in optimization, equilibrium, and control. This book develops a unified framework and provides a detailed exposition of variational geometry and subdifferential calculus in their current forms beyond classical and convex analysis. Also covered are set-convergence, set-valued mappings, epi-convergence, duality, and normal integrands.

General Inequalities 3

This volume features selected, refereed papers on various aspects of statistics, matrix theory and its applications to statistics, as well as related numerical linear algebra topics and numerical solution methods, which are relevant for problems arising in statistics and in big data. The contributions were originally presented at the 25th International Workshop on Matrices and Statistics (IWMS 2016), held in Funchal (Madeira), Portugal on June 6-9, 2016. The IWMS workshop series brings together statisticians, computer scientists, data scientists and mathematicians, helping them better

understand each other’s tools, and fostering new collaborations at the interface of matrix theory and statistics.