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User guide to Digital spectral analysis.--

Data Analysis Methods in Physical Oceanography is a practical reference guide to established and modern data analysis techniques in earth and ocean sciences. This second and revised edition is even more comprehensive with numerous updates, and an additional appendix on 'Convolution and Fourier transforms'. Intended for both students and established scientists, the five major chapters of the book cover data acquisition and recording, data processing and presentation, statistical methods and error handling, analysis of spatial data fields, and time series analysis methods. Chapter 5 on time series analysis is a book in itself, spanning a wide diversity of topics from stochastic processes and stationarity, coherence functions, Fourier analysis, tidal harmonic analysis, spectral and cross-spectral analysis, wavelet and other related methods for processing nonstationary data series, digital filters, and fractals. The seven appendices include unit conversions, approximation methods and nondimensional numbers used in geophysical fluid dynamics, presentations on convolution, statistical terminology, and distribution functions, and a number of important statistical tables. Twenty pages are devoted to references. Featuring:

- An in-depth presentation of modern techniques for the analysis of temporal and spatial data sets collected in oceanography, geophysics, and other disciplines in earth and ocean sciences.
- A detailed overview of oceanographic instrumentation and sensors - old and new - used to collect oceanographic data.
- 7 appendices especially

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applicable to earth and ocean sciences ranging from conversion of units, through statistical tables, to terminology and non-dimensional parameters. In praise of the first edition: "(...)This is a very practical guide to the various statistical analysis methods used for obtaining information from geophysical data, with particular reference to oceanography(...) The book provides both a text for advanced students of the geophysical sciences and a useful reference volume for researchers." Aslib Book Guide Vol 63, No. 9, 1998 "(...)This is an excellent book that I recommend highly and will definitely use for my own research and teaching." EOS Transactions, D.A. Jay, 1999 "(...)In summary, this book is the most comprehensive and practical source of information on data analysis methods available to the physical oceanographer. The reader gets the benefit of extremely broad coverage and an excellent set of examples drawn from geographical observations." Oceanography, Vol. 12, No. 3, A. Plueddemann, 1999 "(...)Data Analysis Methods in Physical Oceanography is highly recommended for a wide range of readers, from the relative novice to the experienced researcher. It would be appropriate for academic and special libraries." E-Streams, Vol. 2, No. 8, P. Mofjelf, August 1999

This work is essentially an extensive revision of my Ph.D. dissertation, [1]. It is primarily a research document on the application of probability theory to the parameter estimation problem. The people who will be interested in this material are physicists, economists, and engineers who have to deal with data on a daily basis; consequently, we have included a great deal of introductory and tutorial material. Any person with the equivalent of the mathematics background required for the graduate level study of physics should be able to follow the material contained in this book, though not without effort. From the time the dissertation was

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written until now (approximately one year) our understanding of the parameter estimation problem has changed extensively. We have tried to incorporate what we have learned into this book. I am indebted to a number of people who have aided me in preparing this document: Dr. C. Ray Smith, Steve Finney, Juana Sanchez, Matthew Self, and Dr. Pat Gibbons who acted as readers and editors. In addition, I must extend my deepest thanks to Dr. Joseph Ackerman for his support during the time this manuscript was being prepared.

Signal Processing for Neuroscientists introduces analysis techniques primarily aimed at neuroscientists and biomedical engineering students with a reasonable but modest background in mathematics, physics, and computer programming. The focus of this text is on what can be considered the 'golden trio' in the signal processing field: averaging, Fourier analysis, and filtering. Techniques such as convolution, correlation, coherence, and wavelet analysis are considered in the context of time and frequency domain analysis. The whole spectrum of signal analysis is covered, ranging from data acquisition to data processing; and from the mathematical background of the analysis to the practical application of processing algorithms. Overall, the approach to the mathematics is informal with a focus on basic understanding of the methods and their interrelationships rather than detailed proofs or derivations. One of the principle goals is to provide the reader with the background required to understand the principles of commercially available analyses software, and to allow him/her to construct his/her own analysis tools in an environment such as MATLAB®. Multiple color illustrations are integrated in the text Includes an introduction to biomedical signals, noise characteristics, and recording techniques Basics and background for more advanced topics can be found in extensive notes and appendices A Companion Website hosts the MATLAB

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scripts and several data files:

<http://www.elsevierdirect.com/companion.jsp?ISBN=9780123708670>

An efficient, digital technique for the measurement of the autocorrelation function and power spectrum of Gaussian random signals is described. As is well known, the power spectrum of a signal can be obtained by a Fourier transformation of its autocorrelation function. This report presents an indirect method of computing the autocorrelation function of a signal having Gaussian statistics which greatly reduces the amount of digital processing that is required. A review of the measurement of power spectra through the autocorrelation function method is given. The one-bit technique of computing the autocorrelation function is presented; in particular, the mean and variance of the resulting spectral estimate have been investigated. These results are then applied to the problem of the measurement of spectral lines in radio astronomy. A complete radio-astronomy system is described. (Author).

FROM THE PREFACE: Many new useful ideas are presented in this handbook, including new finite impulse response (FIR) filter design techniques, half-band and multiplierless FIR filters, interpolated FIR (IFIR) structures, and error spectrum shaping.

Digital Spectral Analysis offers a broad perspective of spectral estimation techniques and their implementation. Coverage includes spectral estimation of discrete-time or discrete-space sequences derived by sampling continuous-time or continuous-space signals. The treatment emphasizes the behavior of each spectral estimator for short data records and provides over 40 techniques described and available as implemented MATLAB functions. In addition to summarizing classical spectral estimation, this text provides theoretical background and review material in linear systems, Fourier transforms, matrix algebra, random processes, and

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statistics. Topics include Prony's method, parametric methods, the minimum variance method, eigenanalysis-based estimators, multichannel methods, and two-dimensional methods.

Suitable for advanced undergraduates and graduate students of electrical engineering — and for scientific use in the signal processing application community outside of universities — the treatment's prerequisites include some knowledge of discrete-time linear system and transform theory, introductory probability and statistics, and linear algebra. 1987 edition.

This textbook provides a careful treatment of functional analysis and some of its applications in analysis, number theory, and ergodic theory. In addition to discussing core material in functional analysis, the authors cover more recent and advanced topics, including Weyl's law for eigenfunctions of the Laplace operator, amenability and property (T), the measurable functional calculus, spectral theory for unbounded operators, and an account of Tao's approach to the prime number theorem using Banach algebras. The book further contains numerous examples and exercises, making it suitable for both lecture courses and self-study. Functional Analysis, Spectral Theory, and Applications is aimed at postgraduate and advanced undergraduate students with some background in analysis and algebra, but will also appeal to everyone with an interest in seeing how functional analysis can be applied to other parts of mathematics.

This classic describes and illustrates basic theory, with a detailed explanation of discrete wavelet transforms. Suitable for upper-level undergraduates, it is also a practical resource for professionals.

This book covers the basics of processing and spectral analysis of monovariate discrete-time signals. The approach is practical, the aim being to acquaint the reader with the indications for

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and drawbacks of the various methods and to highlight possible misuses. The book is rich in original ideas, visualized in new and illuminating ways, and is structured so that parts can be skipped without loss of continuity. Many examples are included, based on synthetic data and real measurements from the fields of physics, biology, medicine, macroeconomics etc., and a complete set of MATLAB exercises requiring no previous experience of programming is provided. Prior advanced mathematical skills are not needed in order to understand the contents: a good command of basic mathematical analysis is sufficient. Where more advanced mathematical tools are necessary, they are included in an Appendix and presented in an easy-to-follow way. With this book, digital signal processing leaves the domain of engineering to address the needs of scientists and scholars in traditionally less quantitative disciplines, now facing increasing amounts of data.

This book provides knowledge of the basic theory, spectral analysis methods, chemometrics, instrumentation, and applications of near-infrared (NIR) spectroscopy—not as a handbook but rather as a sourcebook of NIR spectroscopy. Thus, some emphasis is placed on the description of basic knowledge that is important in learning and using NIR spectroscopy. The book also deals with applications for a variety of research fields that are very useful for a wide range of readers from graduate students to scientists and engineers in both academia and industry. For readers who are novices in NIR spectroscopy, this book provides a good introduction, and for those who already are familiar with the field it affords an excellent means of strengthening their knowledge about NIR spectroscopy and keeping abreast of recent developments.

High-Resolution and Robust Signal Processing describes key methodological and theoretical

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advances achieved in this domain over the last twenty years, placing emphasis on modern developments and recent research pursuits. Applications-grounded, this sophisticated resource links theoretical background with high-resolution methods used in wireless communications, brain signal analysis, and space-time radar signal processing. Chapter extras include theorem proofs, derivations, and computational shortcuts, as well as open problems, numerical measurement, and performance examples, and simulation results Sixteen illustrious field leaders invest High-Resolution and Robust Signal Processing with: in-depth reviews of parametric high-resolution estimation and detection techniques; robust array processing solutions for adaptive beam forming and high-resolution direction finding; Parafac techniques for high-resolution array processing and specific areas of application; high-resolution nonparametric methods and implementation tactics for spectral analysis; multidimensional high-resolution data models and discussion of R-D unitary ESPRIT with colored noise; multidimensional high-resolution parameter estimation techniques applicable to channel sounding; estimation procedures for high-resolution space-time radar signal processing using 2-D or 1-D/1-D models; and models and methods for EEG/MEG space-time dipole source estimation and sensory array design.

Along with finite differences and finite elements, spectral methods are one of the three main methodologies for solving partial differential equations on computers. This book provides a detailed presentation of basic spectral algorithms, as well as a systematical presentation of basic convergence theory and error analysis for spectral methods. Readers of this book will be exposed to a unified framework for designing and analyzing spectral algorithms for a variety of problems, including in particular high-order differential equations and problems in unbounded

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domains. The book contains a large number of figures which are designed to illustrate various concepts stressed in the book. A set of basic matlab codes has been made available online to help the readers to develop their own spectral codes for their specific applications.

The Spectral Analysis of Time Series describes the techniques and theory of the frequency domain analysis of time series. The book discusses the physical processes and the basic features of models of time series. The central feature of all models is the existence of a spectrum by which the time series is decomposed into a linear combination of sines and cosines. The investigator can use Fourier decompositions or other kinds of spectrals in time series analysis. The text explains the Wiener theory of spectral analysis, the spectral representation for weakly stationary stochastic processes, and the real spectral representation. The book also discusses sampling, aliasing, discrete-time models, linear filters that have general properties with applications to continuous-time processes, and the applications of multivariate spectral models. The text describes finite parameter models, the distribution theory of spectral estimates with applications to statistical inference, as well as sampling properties of spectral estimates, experimental design, and spectral computations. The book is intended either as a textbook or for individual reading for one-semester or two-quarter course for students of time series analysis users. It is also suitable for mathematicians or professors of calculus, statistics, and advanced mathematics.

Spectral techniques facilitate the design and testing of today's increasingly complex digital devices. There is heightened interest in spectral techniques for the design of digital devices dictated by ever increasing demands on technology that often cannot be

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met by classical approaches. Spectral methods provide a uniform and consistent theoretic environment for recent achievements in this area, which appear divergent in many other approaches. Spectral Logic and Its Applications for the Design of Digital Devices gives readers a foundation for further exploration of abstract harmonic analysis over finite groups in the analysis, design, and testing of digital devices. After an introduction, this book provides the essential mathematical background for discussing spectral methods. It then delves into spectral logic and its applications, covering: *

- * Walsh, Haar, arithmetic transform, Reed-Muller transform for binary-valued functions and Vilenkin-Chrestenson transform, generalized Haar, and other related transforms for multiple-valued functions
- * Polynomial expressions and decision diagram representations for switching and multiple-value functions
- * Spectral analysis of Boolean functions
- * Spectral synthesis and optimization of combinational and sequential devices
- * Spectral methods in analysis and synthesis of reliable devices
- * Spectral techniques for testing computer hardware

This is the authoritative reference for computer science and engineering professionals and researchers with an interest in spectral methods of representing discrete functions and related applications in the design and testing of digital devices. It is also an excellent text for graduate students in courses covering spectral logic and its applications.

Introduction and background; Probability functions and amplitude measures; Correlation and spectral density functions; Single input/single output relationships;

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System identification and response; Propagation path identification; Single input/multiple output problems; Multiple input/output relationships; Energy source identification; Procedures for solving multiple input/output problems; Statistical errors in measurements.

Combining clear explanations of elementary principles, advanced topics and applications with step-by-step mathematical derivations, this textbook provides a comprehensive yet accessible introduction to digital signal processing. All the key topics are covered, including discrete-time Fourier transform, z-transform, discrete Fourier transform and FFT, A/D conversion, and FIR and IIR filtering algorithms, as well as more advanced topics such as multirate systems, the discrete cosine transform and spectral signal processing. Over 600 full-color illustrations, 200 fully worked examples, hundreds of end-of-chapter homework problems and detailed computational examples of DSP algorithms implemented in MATLAB® and C aid understanding, and help put knowledge into practice. A wealth of supplementary material accompanies the book online, including interactive programs for instructors, a full set of solutions and MATLAB® laboratory exercises, making this the ideal text for senior undergraduate and graduate courses on digital signal processing.

The relative motion between the transmitter and the receiver modifies the nonstationarity properties of the transmitted signal. In particular, the almost-cyclostationarity property exhibited by almost all modulated signals adopted in

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communications, radar, sonar, and telemetry can be transformed into more general kinds of nonstationarity. A proper statistical characterization of the received signal allows for the design of signal processing algorithms for detection, estimation, and classification that significantly outperform algorithms based on classical descriptions of signals. Generalizations of Cyclostationary Signal Processing addresses these issues and includes the following key features: Presents the underlying theoretical framework, accompanied by details of their practical application, for the mathematical models of generalized almost-cyclostationary processes and spectrally correlated processes; two classes of signals finding growing importance in areas such as mobile communications, radar and sonar. Explains second- and higher-order characterization of nonstationary stochastic processes in time and frequency domains. Discusses continuous- and discrete-time estimators of statistical functions of generalized almost-cyclostationary processes and spectrally correlated processes. Provides analysis of mean-square consistency and asymptotic Normality of statistical function estimators. Offers extensive analysis of Doppler channels owing to the relative motion between transmitter and receiver and/or surrounding scatterers. Performs signal analysis using both the classical stochastic-process approach and the functional approach, where statistical functions are built starting from a single function of time. Digital Signal Processing, Second Edition enables electrical engineers and technicians in the fields of biomedical, computer, and electronics engineering to master the

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essential fundamentals of DSP principles and practice. Many instructive worked examples are used to illustrate the material, and the use of mathematics is minimized for easier grasp of concepts. As such, this title is also useful to undergraduates in electrical engineering, and as a reference for science students and practicing engineers. The book goes beyond DSP theory, to show implementation of algorithms in hardware and software. Additional topics covered include adaptive filtering with noise reduction and echo cancellations, speech compression, signal sampling, digital filter realizations, filter design, multimedia applications, over-sampling, etc. More advanced topics are also covered, such as adaptive filters, speech compression such as PCM, u-law, ADPCM, and multi-rate DSP and over-sampling ADC. New to this edition: MATLAB projects dealing with practical applications added throughout the book New chapter (chapter 13) covering sub-band coding and wavelet transforms, methods that have become popular in the DSP field New applications included in many chapters, including applications of DFT to seismic signals, electrocardiography data, and vibration signals All real-time C programs revised for the TMS320C6713 DSK Covers DSP principles with emphasis on communications and control applications Chapter objectives, worked examples, and end-of-chapter exercises aid the reader in grasping key concepts and solving related problems Website with MATLAB programs for simulation and C programs for real-time DSP

This up-to-date introduction to univariate spectral analysis at the graduate level reflects

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a new scientific awareness of its complexity, as well as its widespread usage on digital computers with considerable computational power.

Digital Spectral Analysis provides a single source that offers complete coverage of the spectral analysis domain. This self-contained work includes details on advanced topics that are usually presented in scattered sources throughout the literature. The theoretical principles necessary for the understanding of spectral analysis are discussed in the first four chapters: fundamentals, digital signal processing, estimation in spectral analysis, and time-series models. An entire chapter is devoted to the non-parametric methods most widely used in industry. High resolution methods are detailed in a further four chapters: spectral analysis by stationary time series modeling, minimum variance, and subspace-based estimators. Finally, advanced concepts are the core of the last four chapters: spectral analysis of non-stationary random signals, space time adaptive processing: irregularly sampled data processing, particle filtering and tracking of varying sinusoids. Suitable for students, engineers working in industry, and academics at any level, this book provides a rare complete overview of the spectral analysis domain.

"Spectral Audio Signal Processing is the fourth book in the music signal processing series by Julius O. Smith. One can say that human hearing occurs in terms of spectral models. As a result, spectral models are especially useful in audio applications. For example, with the right spectral model, one can discard most of the information contained in a sound waveform without changing how it

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sounds. This is the basis of modern audio compression techniques."--Publisher's description.

Spectral analysis is widely used to interpret time series collected in diverse areas. This book covers the statistical theory behind spectral analysis and provides data analysts with the tools needed to transition theory into practice. Actual time series from oceanography, metrology, atmospheric science and other areas are used in running examples throughout, to allow clear comparison of how the various methods address questions of interest. All major nonparametric and parametric spectral analysis techniques are discussed, with emphasis on the multitaper method, both in its original formulation involving Slepian tapers and in a popular alternative using sinusoidal tapers. The authors take a unified approach to quantifying the bandwidth of different nonparametric spectral estimates. An extensive set of exercises allows readers to test their understanding of theory and practical analysis. The time series used as examples and R language code for recreating the analyses of the series are available from the book's website.

This book presents an introduction to spectral analysis that is designed for either course use or self-study. Clear and concise in approach, it develops a firm understanding of tools and techniques as well as a solid background for

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performing research. Topics covered include nonparametric spectrum analysis (both periodogram-based approaches and filter-bank approaches), parametric spectral analysis using rational spectral models (AR, MA, and ARMA models), parametric method for line spectra, and spatial (array) signal processing. Analytical and Matlab-based computer exercises are included to develop both analytical skills and hands-on experience.

Window functions—otherwise known as weighting functions, tapering functions, or apodization functions—are mathematical functions that are zero-valued outside the chosen interval. They are well established as a vital part of digital signal processing. *Window Functions and their Applications in Signal Processing* presents an exhaustive and detailed account of window functions and their applications in signal processing, focusing on the areas of digital spectral analysis, design of FIR filters, pulse compression radar, and speech signal processing. Comprehensively reviewing previous research and recent developments, this book:

- Provides suggestions on how to choose a window function for particular applications
- Discusses Fourier analysis techniques and pitfalls in the computation of the DFT
- Introduces window functions in the continuous-time and discrete-time domains
- Considers two implementation strategies of window functions in the time- and frequency domain
- Explores well-

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known applications of window functions in the fields of radar, sonar, biomedical signal analysis, audio processing, and synthetic aperture radar

"This thesis describes applications of digital spectral analysis and Monte Carlo simulations to the measurement of signal characteristics. Specifically, it treats two applications of Digital Signal Processing: 1) analysis of a Doppler experiment, and 2) measurement of sonar echo parameters in the presence of noise. The first experiment is meant as a teaching tool and consists of analyzing an audio signal received from a rotating buzzer. Measurements of the rotation frequency and the speed of sound are made from the signal's static and dynamic spectra. Monte Carlo simulations are performed in the second application to find Butterworth filter order and bandwidth required for sufficiently accurate and precise measurements sonar echo parameters. These optimum filter settings are given as a function of the signal-to-noise ratio. Better measurements of these echo parameters are needed in fisheries acoustics to characterize, track and count fish"--Leaf 3.

Miller and Childers have focused on creating a clear presentation of foundational concepts with specific applications to signal processing and communications, clearly the two areas of most interest to students and instructors in this course. It is aimed at graduate students as well as practicing engineers, and includes

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unique chapters on narrowband random processes and simulation techniques. The appendices provide a refresher in such areas as linear algebra, set theory, random variables, and more. Probability and Random Processes also includes applications in digital communications, information theory, coding theory, image processing, speech analysis, synthesis and recognition, and other fields. * Exceptional exposition and numerous worked out problems make the book extremely readable and accessible * The authors connect the applications discussed in class to the textbook * The new edition contains more real world signal processing and communications applications * Includes an entire chapter devoted to simulation techniques

Digital Spectral Analysis Second Edition Courier Dover Publications

Describes the leading techniques for analyzing noise. Discusses methods that are applicable to periodic signals, aperiodic signals, or random processes over finite or infinite intervals. Provides readers with a useful reference when designing or modeling communications systems.

This state-of-the-art survey serves as a complete overview of the subject. Besides the principles and theoretical foundations, emphasis is laid on practical applicability -- describing not only classical methods, but also modern developments and their applications. Students, researchers and practitioners, especially in the fields of data registration, treatment and evaluation, will find this a wealth of information.

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Quantum-Mechanical Signal Processing and Spectral Analysis describes the novel application of quantum mechanical methods to signal processing across a range of interdisciplinary research fields. Conventionally, signal processing is viewed as an engineering discipline with its own specific scope, methods, concerns and priorities, not usually encompassing quantum mechanics. However, the dynamics of systems that generate time signals can be successfully described by the general principles and methods of quantum physics, especially within the Schroedinger framework. Most time signals that are measured experimentally are mathematically equivalent to quantum-mechanical auto-correlation functions built from the evolution operator and wavefunctions. This fact allows us to apply the rich conceptual strategies and mathematical apparatus of quantum mechanics to signal processing. Among the leading quantum-mechanical signal processing methods, this book emphasizes the role of Pade approximant and the Lanczos algorithm, highlighting the major benefits of their combination. These two methods are carefully incorporated within a unified framework of scattering and spectroscopy, developing an algorithmic power that can be exported to other disciplines. The novelty of the author's approach to key signal processing problems, the harmonic inversion and the moment problem, is in establishing the Pade approximant and Lanczos algorithm as entirely algebraic spectral estimators. This is of paramount theoretical and practical importance, as now spectral analysis can be carried out from closed analytical expressions. This overrides the notorious mathematical ill-conditioning problems with round-off errors that plague inverse reconstructions in those fields that rely upon signal processing. Quantum-Mechanical Signal Processing and Spectral Analysis will be an invaluable resource for researchers involved in signal processing across a wide range of disciplines.

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Digital signal processing plays a central role in the development of modern communication and information processing systems. The theory and application of signal processing is concerned with the identification, modelling and utilisation of patterns and structures in a signal process. The observation signals are often distorted, incomplete and noisy and therefore noise reduction, the removal of channel distortion, and replacement of lost samples are important parts of a signal processing system. The fourth edition of *Advanced Digital Signal Processing and Noise Reduction* updates and extends the chapters in the previous edition and includes two new chapters on MIMO systems, Correlation and Eigen analysis and independent component analysis. The wide range of topics covered in this book include Wiener filters, echo cancellation, channel equalisation, spectral estimation, detection and removal of impulsive and transient noise, interpolation of missing data segments, speech enhancement and noise/interference in mobile communication environments. This book provides a coherent and structured presentation of the theory and applications of statistical signal processing and noise reduction methods. Two new chapters on MIMO systems, correlation and Eigen analysis and independent component analysis Comprehensive coverage of advanced digital signal processing and noise reduction methods for communication and information processing systems Examples and applications in signal and information extraction from noisy data Comprehensive but accessible coverage of signal processing theory including probability models, Bayesian inference, hidden Markov models, adaptive filters and Linear prediction models *Advanced Digital Signal Processing and Noise Reduction* is an invaluable text for postgraduates, senior undergraduates and researchers in the fields of digital signal processing, telecommunications and statistical data analysis. It will also be of interest to professional

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engineers in telecommunications and audio and signal processing industries and network planners and implementers in mobile and wireless communication communities.

Spectral analysis requires subjective decisions which influence the final estimate and mean that different analysts can obtain different results from the same stationary stochastic observations. Statistical signal processing can overcome this difficulty, producing a unique solution for any set of observations but that is only acceptable if it is close to the best attainable accuracy for most types of stationary data. This book describes a method which fulfils the above near-optimal-solution criterion, taking advantage of greater computing power and robust algorithms to produce enough candidate models to be sure of providing a suitable candidate for given data.

In pioneering work in the 1950s, S. Karlin and J. McGregor showed that probabilistic aspects of certain Markov processes can be studied by analyzing orthogonal eigenfunctions of associated operators. In the decades since, many authors have extended and deepened this surprising connection between orthogonal polynomials and stochastic processes. This book gives a comprehensive analysis of the spectral representation of the most important one-dimensional Markov processes, namely discrete-time birth-death chains, birth-death processes and diffusion processes. It brings together the main results from the extensive literature on the topic with detailed examples and applications. Also featuring an introduction to the basic theory of orthogonal polynomials and a selection of exercises at the end of each chapter, it is suitable for graduate students with a solid background in stochastic processes as well as researchers in orthogonal polynomials and special functions who want to learn about applications of their work to probability.

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