# Higher Order Spectra Analysis A Non Linear Signal Processing Framework 1st Edition By Nikias Chrysostomos Petropulu Athina P 1993 Hardcover

This report discusses the detection performance of a variety of higher order spectra for a variety of signals. Of particular significance is the introduction of a new type of higher order spectra called nonstationary higher order spectra. Nonstationary higher order spectra are not the stationary higher order spectral representations of nonstationary process, but are in fact different spectra which contain the stationary higher order spectra as a subset of their domain. It is shown quantitatively through theoretical predictions and simulations that these type of spectra perform better at detecting nonstationary signals than do the traditional stationary spectra. For the first time, small sample statistics have been derived and applied to the detection performance rather than asymptotic statistics, resulting in a more accurate performance prediction for typical sample sizes for nonstationary signals.

This book presents a compact study on recent concepts and advances in biomedical engineering. The ongoing advancement of civilization and related

technological innovations are increasingly affecting many aspects of our lives. These changes are also visible in the development and practical application of new methods for medical diagnosis and treatment, which in turn are closely linked to expanding knowledge of the functions of the human body. This development is possible primarily due to the increasing cooperation of scientists from various disciplines, and related activities are referred to as "biomedical engineering." The combined efforts of doctors, physiotherapists and engineers from various fields of science have helped achieve dynamic advances in medicine that would have been impossible in the past. The reader will find here papers on biomaterials, biomechanics, as well as the use of information technology and engineering modeling methods in medicine. The respective papers will promote the development of biomedical engineering as a vital field of science, based on cooperation between doctors, physiotherapists and engineers. The editors would like to thank all the people who contributed to the creation of this book – both the authors, and those involved in technical aspects.

The current availability of powerful computers and huge data sets is creating new opportunities in computational mathematics to bring together concepts and tools from graph theory, machine learning and signal processing, creating Data Analytics on Graphs. In discrete mathematics, a graph is merely a collection of

points (nodes) and lines connecting some or all of them. The power of such graphs lies in the fact that the nodes can represent entities as diverse as the users of social networks or financial market data, and that these can be transformed into signals which can be analyzed using data analytics tools. Data Analytics on Graphs is a comprehensive introduction to generating advanced data analytics on graphs that allows us to move beyond the standard regular sampling in time and space to facilitate modelling in many important areas, including communication networks, computer science, linguistics, social sciences, biology, physics, chemistry, transport, town planning, financial systems, personal health and many others. The authors revisit graph topologies from a modern data analytics point of view, and proceed to establish a taxonomy of graph networks. With this as a basis, the authors show how the spectral analysis of graphs leads to even the most challenging machine learning tasks, such as clustering, being performed in an intuitive and physically meaningful way. The authors detail unique aspects of graph data analytics, such as their benefits for processing data acquired on irregular domains, their ability to finely-tune statistical learning procedures through local information processing, the concepts of random signals on graphs and graph shifts, learning of graph topology from data observed on graphs, and confluence with deep neural networks, multi-way

tensor networks and Big Data. Extensive examples are included to render the concepts more concrete and to facilitate a greater understanding of the underlying principles. Aimed at readers with a good grasp of the fundamentals of data analytics, this book sets out the fundamentals of graph theory and the emerging mathematical techniques for the analysis of a wide range of data acquired on graph environments. Data Analytics on Graphs will be a useful friend and a helpful companion to all involved in data gathering and analysis irrespective of area of application.

The aim of the book is to introduce basic concepts, main results, and widely applied mathematical tools in the spectral analysis of large dimensional random matrices. The core of the book focuses on results established under moment conditions on random variables using probabilistic methods, and is thus easily applicable to statistics and other areas of science. The book introduces fundamental results, most of them investigated by the authors, such as the semicircular law of Wigner matrices, the Marcenko-Pastur law, the limiting spectral distribution of the multivariate F matrix, limits of extreme eigenvalues, spectrum separation theorems, convergence rates of empirical distributions, central limit theorems of linear spectral statistics, and the partial solution of the famous circular law. While deriving the main results, the book simultaneously

emphasizes the ideas and methodologies of the fundamental mathematical tools, among them being: truncation techniques, matrix identities, moment convergence theorems, and the Stieltjes transform. Its treatment is especially fitting to the needs of mathematics and statistics graduate students and beginning researchers, having a basic knowledge of matrix theory and an understanding of probability theory at the graduate level, who desire to learn the concepts and tools in solving problems in this area. It can also serve as a detailed handbook on results of large dimensional random matrices for practical users. This second edition includes two additional chapters, one on the authors' results on the limiting behavior of eigenvectors of sample covariance matrices, another on applications to wireless communications and finance. While attempting to bring this edition up-to-date on recent work, it also provides summaries of other areas which are typically considered part of the general field of random matrix theory. This unique textbook provides the foundation for understanding and applying techniques commonly used in geophysics to process and interpret modern digital data. The geophysicist's toolkit contains a range of techniques which may be divided into two main groups: processing, which concerns time series analysis and is used to separate the signal of interest from background noise; and inversion, which involves generating some map or physical model from the data.

These two groups of techniques are normally taught separately, but are here presented together as parts I and II of the book. Part III describes some real applications and includes case studies in seismology, geomagnetism, and gravity. This textbook gives students and practitioners the theoretical background and practical experience, through case studies, computer examples and exercises, to understand and apply new processing methods to modern geophysical datasets. Solutions to the exercises are available on a website at http://publishing.cambridge.org/resources/0521819652

In the signal-processing research community, a great deal of progress in higher-order statistics (HOS) began in the mid-1980s. These last fifteen years have witnessed a large number of theoretical developments as well as real applications. Blind Estimation Using Higher-Order Statistics focuses on the blind estimation area and records some of the major developments in this field. Blind Estimation Using Higher-Order Statistics is a welcome addition to the few books on the subject of HOS and is the first major publication devoted to covering blind estimation using HOS. The book provides the reader with an introduction to HOS and goes on to illustrate its use in blind signal equalisation (which has many applications including (mobile) communications), blind system identification, and blind sources separation (a generic problem in signal processing with many

applications including radar, sonar and communications). There is also a chapter devoted to robust cumulant estimation, an important problem where HOS results have been encouraging. Blind Estimation Using Higher-Order Statistics is an invaluable reference for researchers, professionals and graduate students working in signal processing and related areas.

In this book, leading researchers present their current work in the challenging area of chaos control in nonlinear circuits and systems, with emphasis on practical methodologies, system design techniques and applications. A combination of overview, tutorial and technical articles, the book describes state-of-the-art research on significant problems in this area. The scope and aim of this book are to bridge the gap between chaos control methods and circuits and systems. It is an ideal starting point for anyone who needs a fundamental understanding of controlling chaos in nonlinear circuits and systems.

About 123 attendees from the United States, France, United Kingdom, Italy, Japan, and Israel participated in the Workshop on Higher-Order Spectral Analysis. Held in Vail, Colorado, the three day event turned out to be very successful in terms of participation and quality of contributions. The objective of the workshop was to provide a forum for discussion of new theories and methods for processing signals that are based on Higher-Order Spectra. The

overwhelming response to its announcement, as well as the breadth and depth of contributions and informal discussions among participants, clearly established that higher-order spectra is a new and emerging technology in signal processing and is expanding rapidly. The workshop featured two tutorial sessions, two keynote addresses, one panel discussion and ten technical sessions. Total of fifty papers were presented. There were no parallel sessions at the workshop. The technical program was truly outstanding. In addition, the workshop provided a very relaxing atmosphere where many informal discussions took place. This final report describes the events, and subject matter. Keywords: Symposia. (kt). Higher-order Spectra AnalysisA Nonlinear Signal Processing FrameworkPrentice Hall

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 used 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.

The second volume will deal with a presentation of the main matrix and tensor decompositions and their properties of uniqueness, as well as very useful tensor networks for the analysis of massive data. Parametric estimation algorithms will be presented for the identification of the main tensor decompositions. After a brief historical review of the compressed sampling methods, an overview of the main methods of retrieving matrices and tensors with missing data will be performed under the low rank hypothesis. Illustrative examples will be provided.

Nuclear magnetic resonance spectroscopy, which has evolved only within the last 20 years, has become one of the very important tools in chemistry and physics. The literature on its theory and application has grown immensely and a

comprehensive and adequate treatment of all branches by one author, or even by several, becomes increasingly difficult. This series is planned to present articles written by experts working in various fields of nuclear magnetic resonance spectroscopy, and will contain review articles as well as progress reports and original work. Its main aim, however, is to fill a gap, existing in literature, by publishing articles written by specialists, which take the reader from the introductory stage to the latest development in the field. The editors are grateful to the authors for the time and effort spent in writing the articles, and for their invaluable cooperation. The Editors Analysis of NMR Spectra A Guide for Chemists R. A. HOFFMAN t S. FORSEN Division of Physical Chemistry, Chemical Center, Lund Institute of Technology, Lund, Sweden B. GESTBLOM Institute of Physics, University of Uppsala, Sweden Contents I. Principles of NMR Spectroscopy 4 1. 1. The Magnetic Resonance Phenomenon 4 a) Nuclear Moments. . . . . . . . 4 b) Magnetic Spin States and Energy Levels 5 c) The Magnetic Resonance Condition. 7 d) The Larmor Precession. . 7 e) Experimental Aspects . . . . 8 1. 2. Chemical Shifts . . . . . . . . 9 a) The Screening Constant 11. . . 9 b) Chemical Shift Scales (11 and r) 10 1. 3. Spin Coupling Constants 12 1. 4. Intensities. . . . . . . .

"This book is a comprehensive and in-depth reference to the most recent

developments in the field covering theoretical developments, techniques, technologies, among others"--Provided by publisher.

This text covering the 1997 IEEE Signal Processing Workshop on High-Order Statistics is designed for researchers, professors, practitioners, students and other computing professionals.

Bernard Helffer's graduate-level introduction to the basic tools in spectral analysis is illustrated by numerous examples from the Schrödinger operator theory and various branches of physics: statistical mechanics, superconductivity, fluid mechanics and kinetic theory. The later chapters also introduce non self-adjoint operator theory with an emphasis on the role of the pseudospectra. The author's focus on applications, along with exercises and examples, enables readers to connect theory with practice so that they develop a good understanding of how the abstract spectral theory can be applied. The final chapter provides various problems that have been the subject of active research in recent years and will challenge the reader's understanding of the material covered.

Tensors, or hypermatrices, are multi-arrays with more than two indices. In the last decade or so, many concepts and results in matrix theory?some of which are nontrivial?have been extended to tensors and have a wide range of applications (for example, spectral hypergraph theory, higher order Markov chains, polynomial

optimization, magnetic resonance imaging, automatic control, and quantum entanglement problems). The authors provide a comprehensive discussion of this new theory of tensors. Tensor Analysis: Spectral Theory and Special Tensors is unique in that it is the first book on these three subject areas: spectral theory of tensors; the theory of special tensors, including nonnegative tensors, positive semidefinite tensors, completely positive tensors, and copositive tensors; and the spectral hypergraph theory via tensors.

Presents the account of the use of mechanical ventilation in critically ill patients. This title features coverage that addresses important scientific, clinical, and technical aspects of the field as well as chapters that encompass the full scope of mechanical ventilation, including the physical basis of mechanical ventilation.

were published in the series as the contributed volume, Process Control Performance Assessment: From Theory to Implementation with Andrzej Ordys, Damian Uduehi, and Michael Johnson as Editors (ISBN 978-1-84628-623-0, 2007). Along with this good progress in process controller assessment methods, researchers have also been investigating techniques to diagnose what is causing the process or control loop degradation. This requires the use of on-line data to identify faults via new diagnostic indicators of typical process problems. A significant focus of some of this research has been the issue of valve problems; a

research direction that has been motivated by some industrial statistics that show up to 40% of control loops having performance degradation attributable to valve problems. Shoukat Choudhury, Sirish Shah, and Nina Thornhill have been very active in this research field for a number of years and have written a coherent and consistent presentation of their many research results as this monograph, Diagnosis of Process Nonlinearities and Valve Stiction. The Advances in Industrial Control series is pleased to welcome this new and substantial contribution to the process diagnostic literature. The reader will find the exploitation of the extensive process data archives created by today's process computer systems one theme in the monograph. From another viewpoint, the use of higher-order statistics could be considered to provide a continuing link to the earlier methods of the statistical process control paradigm.

Distills key concepts from linear algebra, geometry, matrices, calculus, optimization, probability and statistics that are used in machine learning.

Time series with mixed spectra are characterized by hidden periodic components buried in random noise. Despite strong interest in the statistical and signal processing communities, no book offers a comprehensive and up-to-date treatment of the subject. Filling this void, Time Series with Mixed Spectra focuses on the methods and theory for the statistical analysis of time series with mixed

spectra. It presents detailed theoretical and empirical analyses of important methods and algorithms. Using both simulated and real-world data to illustrate the analyses, the book discusses periodogram analysis, autoregression, maximum likelihood, and covariance analysis. It considers real- and complex-valued time series, with and without the Gaussian assumption. The author also includes the most recent results on the Laplace and quantile periodograms as extensions of the traditional periodogram. Complete in breadth and depth, this book explains how to perform the spectral analysis of time series data to detect and estimate the hidden periodicities represented by the sinusoidal functions. The book not only extends results from the existing literature but also contains original material, including the asymptotic theory for closely spaced frequencies and the proof of asymptotic normality of the nonlinear least-absolute-deviations frequency estimator.

The report describes the application of higher-order spectra to linear systems where a non-Gaussian input is measured without noise contamination, so that use of higher-order spectral analysis is not necessary to obtain an expression for the transfer function, which is simply the ratio of the cross spectrum between the input and the output to the spectrum of the input. However, because the input is non-Gaussian it is meaningful to consider use of higher-order spectra in

connection with study of the system. We shall obtain relationships among various higher-order cross spectra. Mixed spectra will also be applied to the problem. Understanding Mass Spectra: A Basic Approach, Second Editioncombines coverage of the principles underlying mass spectralanalysis with clear guidelines on how to apply them in a laboratorysetting. Completely revised from the first edition, an updated andunified approach to mass spectral interpretation emphasizes theapplication of basic principles from undergraduate organic,analytical, and physical chemistry courses. A detailed overview of theory and instrumentation, this usefulguide contains step-by-step descriptions of interpretativestrategies and convenient lists and tables detailing theinformation needed to solve unknowns. Other features includereal-world case studies and examples, skill-building problems withclearly explained answers, and easy-to-follow explanations of theimportant mathematical derivations.

Analyzing the behavior of complex networks is an important element in the design of new man-made structures such as communication systems and biologically engineered molecules. Because any complex network can be represented by a graph, and therefore in turn by a matrix, graph theory has become a powerful tool in the investigation of network performance. This self-contained 2010 book provides a concise introduction to the theory of graph

spectra and its applications to the study of complex networks. Covering a range of types of graphs and topics important to the analysis of complex systems, this guide provides the mathematical foundation needed to understand and apply spectral insight to real-world systems. In particular, the general properties of both the adjacency and Laplacian spectrum of graphs are derived and applied to complex networks. An ideal resource for researchers and students in communications networking as well as in physics and mathematics.

This manual will be valuable to practicing engineers who need an introduction to polyspectra from a signal processing perspective. In response to the recent growth of interest in polyspectra, this timely text provides an introduction to signal processing methods that are based on polyspectra and cumulants concepts. The emphasis of the book is placed on the presentation of signal processing tools for use in situations where the more common power spectrum estimation techniques fall short.

In this dissertation, we investigate the theory and application of higher-order spectral analysis techniques to condition monitoring in shipboard electrical power systems. Monitoring and early detection of faults in rotating machines, such as induction motors, are essential for both preventive maintenance and to avoid potentially severe damage. As machines degrade, they often tend to become more nonlinear. This increased

nonlinearity results in the introduction of new frequencies which satisfy particular frequency selection rules; the exact selection rule depends on the order of the nonlinearity. In addition, the phases of the newly generated frequencies satisfy a similar phase selection rule. This results in a phase coherence, or phase coupling, between the "original" interacting frequencies and the "new" frequencies. This phase coupling is a true signature of nonlinearity. Since the classical auto-power spectrum contains no phase information, the phase coupling signature associated with nonlinear interactions is not available. However, various higher-order spectra (HOS) are capable of detecting such nonlinear-induced phase coupling. The efficacy of the various proposed HOS-based methodologies is investigated using real-world vibration time-series data from a faulted induction motor driving a dc generator. The fault is controlled by varying a resistor placed in one phase of the three-phase line to the induction motor. First, we propose a novel method using a bispectral change detection (BCD) for condition monitoring. Even though the bicoherence is dominant and powerful in the detection of phase coupling of nonlinearly interacting frequencies, it has some difficulties in its application to machine condition monitoring. Basically, the bicoherence may not be able to distinguish between intrinsic nonlinearities associated with healthy machines and fault-induced nonlinearities. Therefore, the ability to discriminate the fault-only nonlinearities from the intrinsic nonlinearities is very important. The proposed BCD method can suppress the intrinsic nonlinearities of a healthy machine by nulling them

out and thereby identify the fault-only nonlinearities. In addition, most machines contain rotating components, and the vibration fields they generate are periodic. These periodic impulse train signals may produce artificially high bicoherence values and can lead to ambiguous indications of faults in machine condition monitoring. The proposed BCD method can remove the artificially high bicoherence values caused by periodic impulse-train signals. With these advantages, the proposed BCD method is a new and sensitive indicator for condition monitoring. Second, we propose a novel method to estimate, from a measured single time-series data record, complex coupling coefficients in order to quantify the "strength" of nonlinear frequency interactions associated with rotating machine degradation. The estimation of the coupling coefficients is based on key concepts from higher-order spectral analysis and least mean-square-error analysis. The estimated coupling coefficients embody the physics of the nonlinear interactions associated with machine degradation and provide a quantitative measure of the "strength" of the nonlinear interactions. In addition, as an auto-quantity method utilizing a single time-series data record, the proposed method adds supplemental fault signature information to conventional tools. Such knowledge has the potential to advance the state-of-the-art of machine condition monitoring. Third, we propose a bispectral power transfer analysis methodology to quantify power transfer between nonlinearly interacting frequency modes associated with machine degradation. Our proposed method enables us to identify the relative amounts of power transferred by

various nonlinear interactions, and thereby identify the predominant interactions. Such knowledge provides important new signature, or feature, information for machine condition monitoring diagnostics.

The object of the present work is a systematic statistical analysis of bilinear processes in the frequency domain. The first two chapters are devoted to the basic theory of nonlinear functions of stationary Gaussian processes, Hermite polynomials, cumulants and higher order spectra, multiple Wiener-Itô integrals and finally chaotic Wiener-Itô spectral representation of subordinated processes. There are two chapters for general nonlinear time series problems.

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

Higher-Order Statistical Signal Processing brings together some most recent innovations in the field of higher-order statistical signal processing. It is structured to provide a comprehensive understanding of the fundamentals of the discipline, as well as a treatment of recent advances.

This work is essentially an extensive revision of my Ph.D. dissertation, [1J. It 1S

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 elfort. From the time the dissertation was 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 docu ment: Dr. C. Ray Smith, Steve Finney, Juana Sunchez, 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.

The theory of time series models has been well developed over the last thirt,y years. Both the frequenc.y domain and time domain approaches have been widely used in the analysis of linear time series models. However. many physical phenomena cannot be adequately represented by linear models; hence the necessity of nonlinear models and higher order spectra. Recently a number of nonlinear models have been proposed. In this monograph we restrict attention to one particular nonlinear model. known as the "bilinear model". The most interesting feature of such a model is that its second order

covariance analysis is ve~ similar to that for a linear model. This demonstrates the importance of higher order covariance analysis for nonlinear models. For bilinear models it is also possible to obtain analytic expressions for covariances. spectra. etc. which are often difficult to obtain for other proposed nonlinear models. Estimation of bispectrum and its use in the construction of tests for linearit,y and symmetry are also discussed. All the methods are illustrated with simulated and real data. The first author would like to acknowledge the benefit he received in the preparation of this monograph from delivering a series of lectures on the topic of bilinear models at the University of Bielefeld. Ecole Normale Superieure. University of Paris (South) and the Mathematisch Cen trum. Ams terdam.

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 scripts and several data files:

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

This book presents high-quality research on the concepts and developments in the field of information and communication technologies, and their applications. It features 134 rigorously selected papers (including 10 poster papers) from the Future of Information and Communication Conference 2020 (FICC 2020), held in San Francisco, USA, from March 5 to 6, 2020, addressing state-of-the-art intelligent methods and techniques for solving real-world problems along with a vision of future research Discussing various aspects of communication, data science, ambient intelligence, networking, computing, security and Internet of Things, the book offers researchers, scientists, industrial engineers and students valuable insights into the current research and next generation information science and communication technologies.

A comprehensive and mathematically accessible introduction to digital signal

processing, covering theory, advanced topics, and applications.

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.

A natural evolution of statistical signal processing, in connection with the progressive increase in computational power, has been exploiting higher-order information. Thus, high-order spectral analysis and nonlinear adaptive filtering have received the attention of many researchers. One of the most successful techniques for non-linear processing of data with complex non-Gaussian distributions is the independent component analysis mixture modelling (ICAMM). This thesis defines a novel formalism for pattern recognition and classification based on ICAMM, which unifies a certain number of pattern recognition tasks allowing generalization. The versatile and powerful framework developed in this work can deal with data obtained from quite different areas, such as image processing, impact-echo testing, cultural heritage, hypnograms analysis, web-mining and might therefore be employed to solve many different real-world problems.

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 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.

This book provides a thorough introduction to methods for detecting and describing cyclic patterns in time-series data. It is written both for researchers and students new to the area and for those who have already collected time-series data but wish to learn new ways of understanding and presenting them. Facilitating the interpretation of observations of behavior, physiology, mood, perceptual threshold, social indicator variables, and other responses, the book focuses on practical applications and requires much less mathematical background than most comparable texts. Using real data sets and currently available software (SPSS for Windows), the author employs extensive examples to clarify key concepts. Topics covered include research design issues, preliminary data screening, identification and description of cycles, summary of results

across time series, and assessment of relations between time series. Also considered are theoretical questions, problems of interpretation, and potential sources of artifact. 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 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.

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