

**Springer Series
in Statistics**

E. Seneta

**Non-negative
Matrices and
Markov Chains**

Second Edition



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Non Negative Matrices And Markov Chains Springer Series In Statistics

Miodrag Lovric



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Non-negative Matrices and Markov Chains E. Seneta, 1981-09-30 Since its inception by Perron and Frobenius the theory of non negative matrices has developed enormously and is now being used and extended in applied fields of study as diverse as probability theory numerical analysis demography mathematical economics and dynamic programming while its development is still proceeding rapidly as a branch of pure mathematics in its own right While there are books which cover this or that aspect of the theory it is nevertheless not uncommon for workers in one or another branch of its development to be unaware of what is known in other branches even though there is often formal overlap One of the purposes of this book is to relate several aspects of the theory insofar as this is possible The author hopes that the book will be useful to mathematicians but in particular to the workers in applied fields so the mathematics has been kept as simple as could be managed The mathematical requisites for reading it are some knowledge of real variable theory and matrix theory and a little knowledge of complex variable the emphasis is on real variable methods There is only one part of the book the second part of 55 5 which is of rather specialist interest and requires deeper knowledge Appendices provide brief expositions of those areas of mathematics needed which may be less generally known to the average reader

Nonlinearly Perturbed Semi-Markov Processes Dmitrii Silvestrov, Sergei Silvestrov, 2017-09-06 The book presents new methods of asymptotic analysis for nonlinearly perturbed semi Markov processes with a finite phase space These methods are based on special time space screening procedures for sequential phase space reduction of semi Markov processes combined with the systematical use of operational calculus for Laurent asymptotic expansions Effective recurrent algorithms are composed for getting asymptotic expansions without and with explicit upper bounds for remainders for power moments of hitting times stationary and conditional quasi stationary

distributions for nonlinearly perturbed semi Markov processes These results are illustrated by asymptotic expansions for birth death type semi Markov processes which play an important role in various applications The book will be a useful contribution to the continuing intensive studies in the area It is an essential reference for theoretical and applied researchers in the field of stochastic processes and their applications that will contribute to continuing extensive studies in the area and remain relevant for years to come

Engineering Mathematics II Sergei Silvestrov, Milica Rančić, 2017-02-10 This book highlights the latest advances in engineering mathematics with a main focus on the mathematical models structures concepts problems and computational methods and algorithms most relevant for applications in modern technologies and engineering It addresses mathematical methods of algebra applied matrix analysis operator analysis probability theory and stochastic processes geometry and computational methods in network analysis data classification ranking and optimisation The individual chapters cover both theory and applications and include a wealth of figures schemes algorithms tables and results of data analysis and simulation Presenting new methods and results reviews of cutting edge research and open problems for future research they equip readers to develop new mathematical methods and concepts of their own and to further compare and analyse the methods and results discussed The book consists of contributed chapters covering research developed as a result of a focused international seminar series on mathematics and applied mathematics and a series of three focused international research workshops on engineering mathematics organised by the Research Environment in Mathematics and Applied Mathematics at M lardalen University from autumn 2014 to autumn 2015 the International Workshop on Engineering Mathematics for Electromagnetics and Health Technology the International Workshop on Engineering Mathematics Algebra Analysis and Electromagnetics and the 1st Swedish Estonian International Workshop on Engineering Mathematics Algebra Analysis and Applications It serves as a source of inspiration for a broad spectrum of researchers and research students in applied mathematics as well as in the areas of applications of mathematics considered in the book

International Encyclopedia of Statistical Science Miodrag Lovric, 2025-06-19 The International Encyclopedia of Statistical Science stands as a monumental effort to enrich statistics education globally particularly in regions facing educational challenges By amalgamating the expertise of over 700 authors from 110 countries including Nobel Laureates and presidents of statistical societies it offers an unparalleled resource for readers worldwide This encyclopedia is not just a collection of entries it is a concerted effort to revive statistics as a vibrant critical field of study and application Providing a comprehensive and accessible account of statistical terms methods and applications it enables readers to gain a quick insight into the subject regardless of their background This work serves to refresh and expand the knowledge of researchers managers and practitioners highlighting the relevance and applicability of statistics across various fields from economics and business to healthcare and public policy Furthermore it aims to inspire students by demonstrating the significance of statistics in solving real world problems thus encouraging a new generation to explore and contribute to the field

Mathematical and

Statistical Models and Methods in Reliability V.V. Rykov, N. Balakrishnan, M.S. Nikulin, 2010-11-02 The book is a selection of invited chapters all of which deal with various aspects of mathematical and statistical models and methods in reliability Written by renowned experts in the field of reliability the contributions cover a wide range of applications reflecting recent developments in areas such as survival analysis aging lifetime data analysis artificial intelligence medicine carcinogenesis studies nuclear power financial modeling aircraft engineering quality control and transportation Mathematical and Statistical Models and Methods in Reliability is an excellent reference text for researchers and practitioners in applied probability and statistics industrial statistics engineering medicine finance transportation the oil and gas industry and artificial intelligence

Markov Processes, Feller Semigroups and Evolution Equations J. A. van Casteren, 2011 The book provides a systemic treatment of time dependent strong Markov processes with values in a Polish space It describes its generators and the link with stochastic differential equations in infinite dimensions In a unifying way where the square gradient operator is employed new results for backward stochastic differential equations and long time behavior are discussed in depth The book also establishes a link between propagators or evolution families with the Feller property and time inhomogeneous Markov processes This mathematical material finds its applications in several branches of the scientific world among which are mathematical physics hedging models in financial mathematics and population models

Markov Chains and Mixing Times David A. Levin, Yuval Peres, 2017-10-31 This book is an introduction to the modern theory of Markov chains whose goal is to determine the rate of convergence to the stationary distribution as a function of state space size and geometry This topic has important connections to combinatorics statistical physics and theoretical computer science Many of the techniques presented originate in these disciplines The central tools for estimating convergence times including coupling strong stationary times and spectral methods are developed The authors discuss many examples including card shuffling and the Ising model from statistical mechanics and present the connection of random walks to electrical networks and apply it to estimate hitting and cover times The first edition has been used in courses in mathematics and computer science departments of numerous universities The second edition features three new chapters on monotone chains the exclusion process and stationary times and also includes smaller additions and corrections throughout Updated notes at the end of each chapter inform the reader of recent research developments

Large Deviations for Markov Chains Alejandro D. de Acosta, 2022-10-12 This book studies the large deviations for empirical measures and vector valued additive functionals of Markov chains with general state space Under suitable recurrence conditions the ergodic theorem for additive functionals of a Markov chain asserts the almost sure convergence of the averages of a real or vector valued function of the chain to the mean of the function with respect to the invariant distribution In the case of empirical measures the ergodic theorem states the almost sure convergence in a suitable sense to the invariant distribution The large deviation theorems provide precise asymptotic estimates at logarithmic level of the probabilities of deviating from the

preponderant behavior asserted by the ergodic theorems *Entropy of Hidden Markov Processes and Connections to Dynamical Systems* Brian Marcus, Karl Petersen, Tsachy Weissman, 2011-05-26 Hidden Markov processes HMPs are important objects of study in many areas of pure and applied mathematics including information theory probability theory dynamical systems and statistical physics with applications in electrical engineering computer science and molecular biology This collection of research and survey papers presents important new results and open problems serving as a unifying gateway for researchers in these areas Based on talks given at the Banff International Research Station Workshop 2007 this volume addresses a central problem of the subject computation of the Shannon entropy rate of an HMP This is a key quantity in statistical physics and information theory characterising the fundamental limit on compression and closely related to channel capacity the limit on reliable communication Also discussed from a symbolic dynamics and thermodynamical viewpoint is the problem of characterizing the mappings between dynamical systems which map Markov measures to Markov or Gibbs measures and which allow for Markov lifts of Markov chains **Information Processing and Management of**

Uncertainty in Knowledge-Based Systems Eyke Hüllermeier, Rudolf Kruse, Frank Hoffmann, 2010-06-25 The International Conference on Information Processing and Management of certainty in Knowledge Based Systems IPMU is organized every two years with the aim of bringing together scientists working on methods for the management of uncertainty and aggregation of information in intelligent systems Since 1986 this conference has been providing a forum for the exchange of ideas between the theoreticians and practitioners working in these areas and related fields The 13 IPMU conference took place in Dortmund Germany June 28 July 2 2010 This volume contains 79 papers selected through a rigorous reviewing process The contributions reflect the richness of research on topics within the scope of the conference and represent several important developments specially focused on theoretical foundations and methods for information processing and management of uncertainty in knowledge based systems We were delighted that Melanie Mitchell Portland State University USA Nihkil R Pal Indian Statistical Institute Bernhard Scholkopf Max Planck Institute for Biological Cybernetics Tübingen Germany and Wolfgang Wahlster German Research Center for Artificial Intelligence Saarbrücken accepted our invitations to present keynote lectures Jim Bezdek received the Kampfede Frieriet Award granted every two years on the occasion of the IPMU conference in view of his eminent research contributions to the handling of uncertainty in clustering data analysis and pattern recognition **Algebraic Methods in Statistics and Probability II** Marlos A. G. Viana, 2010 A decade after the

publication of Contemporary Mathematics Vol 287 the present volume demonstrates the consolidation of important areas such as algebraic statistics computational commutative algebra and deeper aspects of graphical models Aspects of Risk Theory Jan Grandell, 2012-12-06 Risk theory which deals with stochastic models of an insurance business is a classical application of probability theory The fundamental problem in risk theory is to investigate the ruin possibility of the risk business Traditionally the occurrence of the claims is described by a Poisson process and the cost of the claims by a sequence

of random variables This book is a treatise of risk theory with emphasis on models where the occurrence of the claims is described by more general point processes than the Poisson process such as renewal processes Cox processes and general stationary point processes In the Cox case the possibility of risk fluctuation is explicitly taken into account The presentation is based on modern probabilistic methods rather than on analytic methods The theory is accompanied with discussions on practical evaluation of ruin probabilities and statistical estimation Many numerical illustrations of the results are given

Nonlinear Estimation Gavin J.S. Ross, 2012-12-06 Non Linear Estimation is a handbook for the practical statistician or modeller interested in fitting and interpreting non linear models with the aid of a computer A major theme of the book is the use of stable parameter systems these provide rapid convergence of optimization algorithms more reliable dispersion matrices and confidence regions for parameters and easier comparison of rival models The book provides insights into why some models are difficult to fit how to combine fits over different data sets how to improve data collection to reduce prediction variance and how to program particular models to handle a full range of data sets The book combines an algebraic a geometric and a computational approach and is illustrated with practical examples A final chapter shows how this approach is implemented in the author's Maximum Likelihood Program MLP

Quasi-Stationary Phenomena in Nonlinearly Perturbed Stochastic Systems Mats Gyllenberg, Dmitrii S. Silvestrov, 2008-10-31 The book is devoted to studies of quasi stationary phenomena in nonlinearly perturbed stochastic systems New methods of asymptotic analysis for nonlinearly perturbed stochastic processes based on new types of asymptotic expansions for perturbed renewal equation and recurrence algorithms for construction of asymptotic expansions for Markov type processes with absorption are presented Asymptotic expansions are given in mixed ergodic for processes and large deviation theorems for absorption times for nonlinearly perturbed regenerative processes semi Markov processes and Markov chains Applications to analysis of quasi stationary phenomena in nonlinearly perturbed queueing systems population dynamics and epidemic models and for risk processes are presented The book also contains an extended bibliography of works in the area It is an essential reference for theoretical and applied researchers in the field of stochastic processes and their applications and may be also useful for doctoral and advanced undergraduate students

Markov Chains and Dependability Theory Gerardo Rubino, Bruno Sericola, 2014-06-12 Dependability metrics are omnipresent in every engineering field from simple ones through to more complex measures combining performance and dependability aspects of systems This book presents the mathematical basis of the analysis of these metrics in the most used framework Markov models describing both basic results and specialised techniques The authors first present both discrete and continuous time Markov chains before focusing on dependability measures which necessitate the study of Markov chains on a subset of states representing different user satisfaction levels for the modelled system Topics covered include Markovian state lumping analysis of sojourns on subset of states of Markov chains analysis of most dependability metrics fundamentals of performability analysis and bounding and simulation techniques designed to

evaluate dependability measures The book is of interest to graduate students and researchers in all areas of engineering where the concepts of lifetime repair duration availability reliability and risk are important **Copositive And Completely Positive Matrices** Naomi Shaked-monderer, Abraham Berman, 2021-02-09 This book is an updated and extended version of Completely Positive Matrices Abraham Berman and Naomi Shaked Monderer World Scientific 2003 It contains new sections on the cone of copositive matrices which is the dual of the cone of completely positive matrices and new results on both copositive matrices and completely positive matrices The book is an up to date comprehensive resource for researchers in Matrix Theory and Optimization It can also serve as a textbook for an advanced undergraduate or graduate course

Companion Encyclopedia of the History and Philosophy of the Mathematical Sciences Ivor Grattan-Guinness, 2004-11-11 First published in 2004 Routledge is an imprint of Taylor Francis an informa company
 Markov Processes for Stochastic Modeling Masaaki Kijima, 1997-01-01 This book presents an algebraic development of the theory of countable state space Markov chains with discrete and continuous time parameters **Convex Analysis and Optimization in Hadamard Spaces** Miroslav Bacak, 2014-10-29 In the past two decades convex analysis and optimization have been developed in Hadamard spaces This book represents a first attempt to give a systematic account on the subject Hadamard spaces are complete geodesic spaces of nonpositive curvature They include Hilbert spaces Hadamard manifolds Euclidean buildings and many other important spaces While the role of Hadamard spaces in geometry and geometric group theory has been studied for a long time first analytical results appeared as late as in the 1990s Remarkably it turns out that Hadamard spaces are appropriate for the theory of convex sets and convex functions outside of linear spaces Since convexity underpins a large number of results in the geometry of Hadamard spaces we believe that its systematic study is of substantial interest Optimization methods then address various computational issues and provide us with approximation algorithms which may be useful in sciences and engineering We present a detailed description of such an application to computational phylogenetics The book is primarily aimed at both graduate students and researchers in analysis and optimization but it is accessible to advanced undergraduate students as well

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