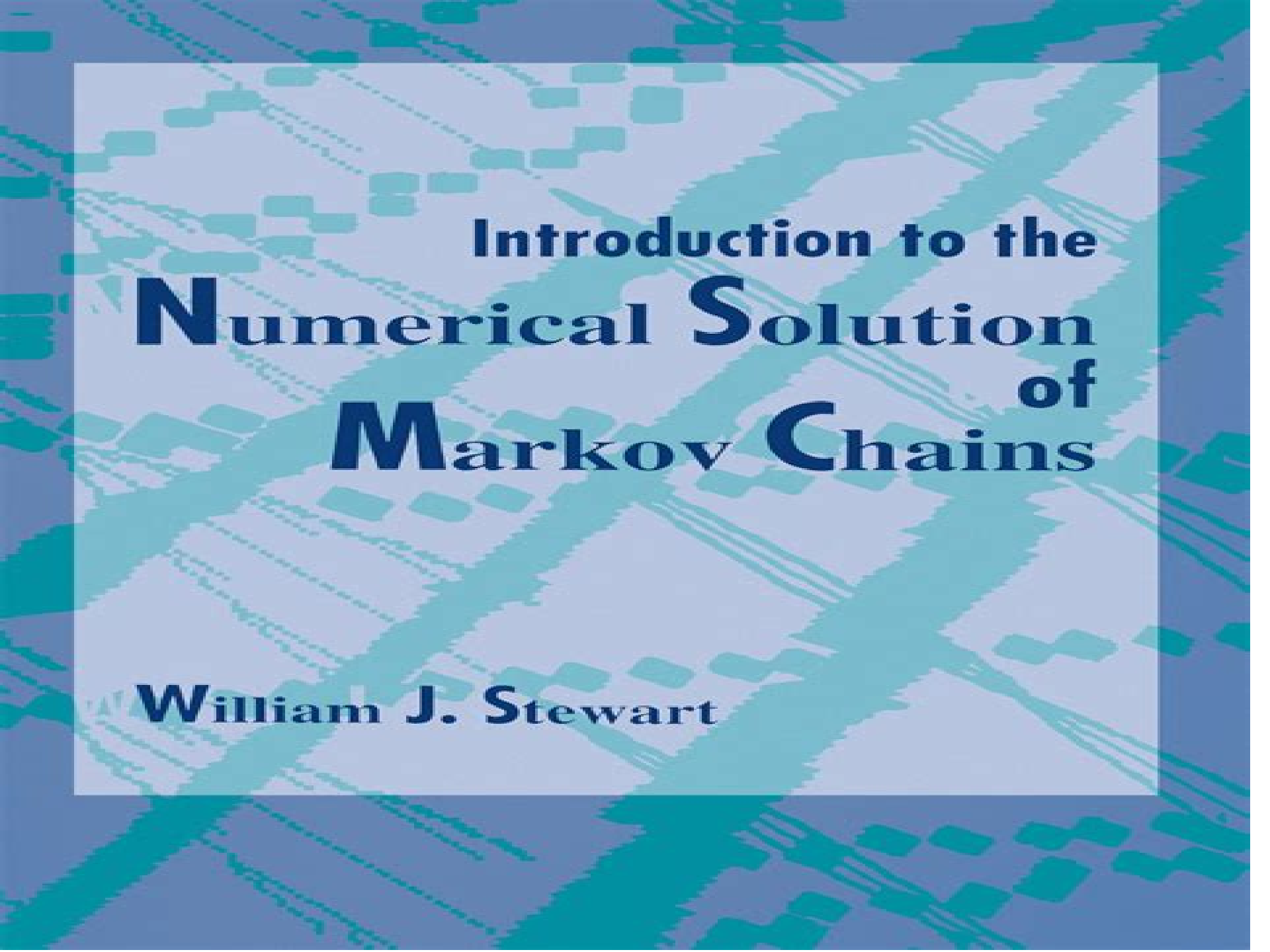




Introduction to the Numerical Solution of Markov Chains

William J. Stewart

Numerical Solution Of Markov Chains

Winfried Grassmann, Javad Tavakoli



Numerical Solution Of Markov Chains:

Introduction to the Numerical Solution of Markov Chains William J. Stewart, 2021-01-12 A cornerstone of applied probability Markov chains can be used to help model how plants grow chemicals react and atoms diffuse and applications are increasingly being found in such areas as engineering computer science economics and education To apply the techniques to real problems however it is necessary to understand how Markov chains can be solved numerically In this book the first to offer a systematic and detailed treatment of the numerical solution of Markov chains William Stewart provides scientists on many levels with the power to put this theory to use in the actual world where it has applications in areas as diverse as engineering economics and education His efforts make for essential reading in a rapidly growing field Here Stewart explores all aspects of numerically computing solutions of Markov chains especially when the state is huge He provides extensive background to both discrete time and continuous time Markov chains and examines many different numerical computing methods direct single and multi vector iterative and projection methods More specifically he considers recursive methods often used when the structure of the Markov chain is upper Hessenberg iterative aggregation disaggregation methods that are particularly appropriate when it is NCD nearly completely decomposable and reduced schemes for cases in which the chain is periodic There are chapters on methods for computing transient solutions on stochastic automata networks and finally on currently available software Throughout Stewart draws on numerous examples and comparisons among the methods he so thoroughly explains

Numerical Solution of Markov Chains William J. Stewart, 1991-05-23 Papers presented at a workshop held January 1990 location unspecified cover just about all aspects of solving Markov models numerically There are papers on matrix generation techniques and generalized stochastic Petri nets the computation of stationary distributions including aggregation disagg

Computations with Markov Chains William J. Stewart, 2012-12-06 Computations with Markov Chains presents the edited and reviewed proceedings of the Second International Workshop on the Numerical Solution of Markov Chains held January 16 18 1995 in Raleigh North Carolina New developments of particular interest include recent work on stability and conditioning Krylov subspace based methods for transient solutions quadratic convergent procedures for matrix geometric problems further analysis of the GTH algorithm the arrival of stochastic automata networks at the forefront of modelling stratagems and more An authoritative overview of the field for applied probabilists numerical analysts and systems modelers including computer scientists and engineers

Numerical Methods for Structured Markov Chains Dario A. Bini, Guy Latouche, Beatrice Meini, 2005-02-03 Intersecting two large research areas numerical analysis and applied probability queueing theory this book is a self contained introduction to the numerical solution of structured Markov chains which have a wide applicability in queueing theory and stochastic modeling and include M/G/1 and GI/M/1 type Markov chain quasi birth death processes non skip free queues and tree like stochastic processes Written for applied probabilists and numerical analysts but accessible to engineers and scientists

working on telecommunications and evaluation of computer systems performances it provides a systematic treatment of the theory and algorithms for important families of structured Markov chains and a thorough overview of the current literature. The book consisting of nine Chapters is presented in three parts. Part 1 covers a basic description of the fundamental concepts related to Markov chains: a systematic treatment of the structure matrix tools including finite Toeplitz matrices, displacement operators, FFT and the infinite block Toeplitz matrices, their relationship with matrix power series and the fundamental problems of solving matrix equations and computing canonical factorizations. Part 2 deals with the description and analysis of structure Markov chains and includes M/G/1 quasi birth death processes, non skip free queues and tree like processes. Part 3 covers solution algorithms where new convergence and applicability results are proved. Each chapter ends with bibliographic notes for further reading and the book ends with an appendix collecting the main general concepts and results used in the book, a list of the main annotations and algorithms used in the book and an extensive index.

Numerical Solution of Markov Chains WJ Stewart (ed), 1991 **Numerical Solution Of Markov Chains** W.J. Stewart, Formal Methods for Performance Evaluation Marco Bernardo, Jane Hillston, 2007-06-06. This book presents a set of 11 papers accompanying the lectures of leading researchers given at the 7th edition of the International School on Formal Methods for the Design of Computer Communication and Software Systems SFM 2007 held in Bertinoro Italy in May/June 2007. SFM 2007 was devoted to formal techniques for performance evaluation and covered several aspects of the field.

Stability and Conditioning Issues on the Numerical Solution of Markov Chains Tugral Dayar, 1994 *International Workshop on the Numerical Solution of Markov Chains*, 1991 Numerical Solution of Markov Chains Amr Lotfy Elsayad, 2002. This project deals with techniques to solve Markov Chains numerically. Numerical Methods in Markov Chains and Bulk Queues T. P. Bagchi, J. G. C. Templeton, 2012-12-06 *Computations with Markov Chains* William J Stewart, 1995-02-28 A First Course in Stochastic Models Henk C. Tijms, 2003-04-18. The field of applied probability has changed profoundly in the past twenty years. The development of computational methods has greatly contributed to a better understanding of the theory. A First Course in Stochastic Models provides a self contained introduction to the theory and applications of stochastic models. Emphasis is placed on establishing the theoretical foundations of the subject thereby providing a framework in which the applications can be understood. Without this solid basis in theory no applications can be solved. Provides an introduction to the use of stochastic models through an integrated presentation of theory, algorithms and applications. Incorporates recent developments in computational probability. Includes a wide range of examples that illustrate the models and make the methods of solution clear. Features an abundance of motivating exercises that help the student learn how to apply the theory. Accessible to anyone with a basic knowledge of probability. A First Course in Stochastic Models is suitable for senior undergraduate and graduate students from computer science, engineering, statistics, operations research and any other discipline where stochastic modelling takes place. It stands out amongst other textbooks on the subject because of its

integrated presentation of theory algorithms and applications

Optimization and Games for Controllable Markov

Chains Julio B. Clempner, Alexander Poznyak, 2023-12-13 This book considers a class of ergodic finite controllable Markov chains The main idea behind the method described in this book is to develop the original discrete optimization problems or game models in the space of randomized formulations where the variables stand in for the distributions mixed strategies or preferences of the original discrete pure strategies in the use The following suppositions are made a finite state space a limited action space continuity of the probabilities and rewards associated with the actions and a necessity for accessibility These hypotheses lead to the existence of an optimal policy The best course of action is always stationary It is either simple i.e. nonrandomized stationary or composed of two nonrandomized policies which is equivalent to randomly selecting one of two simple policies throughout each epoch by tossing a biased coin As a bonus the optimization procedure just has to repeatedly solve the time average dynamic programming equation making it theoretically feasible to choose the optimum course of action under the global restriction In the ergodic cases the state distributions generated by the corresponding transition equations exponentially quickly converge to their stationary final values This makes it possible to employ all widely used optimization methods such as Gradient like procedures Extra proximal method Lagrange's multipliers Tikhonov's regularization including the related numerical techniques In the book we tackle different problems and theoretical Markov models like controllable and ergodic Markov chains multi objective Pareto front solutions partially observable Markov chains continuous time Markov chains Nash equilibrium and Stackelberg equilibrium Lyapunov like function in Markov chains Best reply strategy Bayesian incentive compatible mechanisms Bayesian Partially Observable Markov Games bargaining solutions for Nash and Kalai Smorodinsky formulations multi traffic signal control synchronization problem Rubinstein's non cooperative bargaining solutions the transfer pricing problem as bargaining

Numerical Solution of Stochastic

Differential Equations with Jumps in Finance Eckhard Platen, Nicola Bruti-Liberati, 2010-07-23 In financial and actuarial modeling and other areas of application stochastic differential equations with jumps have been employed to describe the dynamics of various state variables The numerical solution of such equations is more complex than that of those only driven by Wiener processes described in Kloeden Platen Numerical Solution of Stochastic Differential Equations 1992 The present monograph builds on the above mentioned work and provides an introduction to stochastic differential equations with jumps in both theory and application emphasizing the numerical methods needed to solve such equations It presents many new results on higher order methods for scenario and Monte Carlo simulation including implicit predictor corrector extrapolation Markov chain and variance reduction methods stressing the importance of their numerical stability Furthermore it includes chapters on exact simulation estimation and filtering Besides serving as a basic text on quantitative methods it offers ready access to a large number of potential research problems in an area that is widely applicable and rapidly expanding Finance is chosen as the area of application because much of the recent research on stochastic numerical methods has been driven by

challenges in quantitative finance Moreover the volume introduces readers to the modern benchmark approach that provides a general framework for modeling in finance and insurance beyond the standard risk neutral approach It requires undergraduate background in mathematical or quantitative methods is accessible to a broad readership including those who are only seeking numerical recipes and includes exercises that help the reader develop a deeper understanding of the underlying mathematics

Numerical solution of Markov chains (NSMC'99) Brigitte Plateau, William J. Stewart, Manuel Silva, 1999 *Continuous-Time Markov Chains and Applications* George G. Yin, Qing Zhang, 2012-12-06 This book is concerned with continuous time Markov chains It develops an integrated approach to singularly perturbed Markovian systems and reveals interrelations of stochastic processes and singular perturbations In recent years Markovian formulations have been used routinely for numerous real world systems under uncertainties Quite often the underlying Markov chain is subject to rather frequent fluctuations and the corresponding states are naturally divisible to a number of groups such that the chain fluctuates very rapidly among different states within a group but jumps less frequently from one group to another Various applications in engineering economics and biological and physical sciences have posed increasing demands on an in depth study of such systems A basic issue common to many different fields is the understanding of the distribution and the structure of the underlying uncertainty Such needs become even more pressing when we deal with complex and or large scale Markovian models whose closed form solutions are usually very difficult to obtain Markov chain a well known subject has been studied by a host of researchers for many years While nonstationary cases have been treated in the literature much emphasis has been on stationary Markov chains and their basic properties such as ergodicity recurrence and stability In contrast this book focuses on singularly perturbed nonstationary Markov chains and their asymptotic properties Singular perturbation theory has a long history and is a powerful tool for a wide variety of applications

Numerical Methods for Solving Discrete Event Systems Winfried Grassmann, Javad Tavakoli, 2022-11-05 This graduate textbook provides an alternative to discrete event simulation It describes how to formulate discrete event systems how to convert them into Markov chains and how to calculate their transient and equilibrium probabilities The most appropriate methods for finding these probabilities are described in some detail and templates for efficient algorithms are provided These algorithms can be executed on any laptop even in cases where the Markov chain has hundreds of thousands of states This book features the probabilistic interpretation of Gaussian elimination a concept that unifies many of the topics covered such as embedded Markov chains and matrix analytic methods The material provided should aid practitioners significantly to solve their problems This book also provides an interesting approach to teaching courses of stochastic processes

Queueing Networks and Markov Chains Gunter Bolch, Stefan Greiner, Hermann de Meer, Kishor S. Trivedi, 2006-04-27 Critically acclaimed text for computer performance analysis now in its second edition The Second Edition of this now classic text provides a current and thorough treatment of queueing systems queueing networks continuous and discrete time Markov

chains and simulation Thoroughly updated with new content as well as new problems and worked examples the text offers readers both the theory and practical guidance needed to conduct performance and reliability evaluations of computer communication and manufacturing systems Starting with basic probability theory the text sets the foundation for the more complicated topics of queueing networks and Markov chains using applications and examples to illustrate key points Designed to engage the reader and build practical performance analysis skills the text features a wealth of problems that mirror actual industry challenges New features of the Second Edition include Chapter examining simulation methods and applications Performance analysis applications for wireless Internet J2EE and Kanban systems Latest material on non Markovian and fluid stochastic Petri nets as well as solution techniques for Markov regenerative processes Updated discussions of new and popular performance analysis tools including ns 2 and OPNET New and current real world examples including DiffServ routers in the Internet and cellular mobile networks With the rapidly growing complexity of computer and communication systems the need for this text which expertly mixes theory and practice is tremendous Graduate and advanced undergraduate students in computer science will find the extensive use of examples and problems to be vital in mastering both the basics and the fine points of the field while industry professionals will find the text essential for developing systems that comply with industry standards and regulations

Numerical Solution of Stochastic Differential Equations Peter E. Kloeden, Eckhard Platen, 2013-04-17 The aim of this book is to provide an accessible introduction to stochastic differential equations and their applications together with a systematic presentation of methods available for their numerical solution During the past decade there has been an accelerating interest in the development of numerical methods for stochastic differential equations SDEs This activity has been as strong in the engineering and physical sciences as it has in mathematics resulting inevitably in some duplication of effort due to an unfamiliarity with the developments in other disciplines Much of the reported work has been motivated by the need to solve particular types of problems for which even more so than in the deterministic context specific methods are required The treatment has often been heuristic and ad hoc in character Nevertheless there are underlying principles present in many of the papers an understanding of which will enable one to develop or apply appropriate numerical schemes for particular problems or classes of problems

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