Probability Markov Chains Queues And Simulation The Mathematical Basis Of Performance Modeling Author William J Stewart Jul 2009

An Introduction, Second Edition
From Markov Jump Processes to Spatial Queues
Gibbs Fields, Monte Carlo Simulation, and Queues
Markov Processes and Controlled Markov Chains
Markov Processes and Applications
Fundamentals of Queueing Theory
Markov Processes for Stochastic Modeling
Probability and Statistics with Reliability, Queuing, and Computer Science Applications
Numerical Methods in Markov Chains and Bulk Queues
Numerical Solution of Markov Chains
Computational Probability
Theory and Applications
Examples and Applications
Palm Probabilities and Stationary Queues
Queues
Probability Models
Queueing Theory in Action
An Introduction to Stochastic Modeling
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Computational Probability
Understanding Markov Chains
Statistical Inference Via Convex Optimization
Markov Chains and Mixing Times
An Introduction to Queueing Theory
The Mathematical Basis of Performance Modeling
Probability, Markov Chains, Queues, and Simulation
Markov Chains
Markov Chains
Markov Chains and Stochastic Stability
Stochastic Networks
Introduction to Probability with R
General Irreducible Markov Chains and Non-Negative Operators

Introduction to the Numerical Solution of Markov Chains
Essentials of Stochastic Processes
Applied Probability and Queues
Probability, Markov Chains, Queues

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An Introduction, Second Edition John Wiley & Sons
Building upon the previous editions, this textbook is a first course in stochastic processes taken by undergraduate and graduate students (MS and PhD students from math, statistics, economics, computer science, engineering, and finance departments) who have had a course in probability theory. It covers Markov chains in discrete and continuous time, Poisson processes, renewal processes, martingales, and option pricing. One can only learn a subject by seeing it in action, so there are a large number of examples and more than 300 carefully chosen exercises to deepen the reader's understanding. Drawing from teaching experience and student feedback, there are many new examples and problems with solutions that use TI-83 to eliminate the tedious details of solving linear equations by hand, and the collection of exercises is much improved, with many more biological examples. Originally included in previous editions, material too advanced for this first course in stochastic processes has been eliminated while treatment of other topics useful for applications has been expanded. In addition, the ordering of topics has been improved; for example, the difficult subject of martingales is delayed until its usefulness can be applied in the treatment of mathematical finance.
From Markov Jump Processes to Spatial Queues CRC Press
Markov processes are processes that have limited memory. In particular, their dependence on the past is only through the previous state. They are used to model the behavior of many systems including communications systems, transportation networks, image segmentation and analysis, biological systems and DNA sequence analysis, random atomic motion and diffusion in physics, social mobility, population studies, epidemiology, animal and insect migration, queueing systems, resource management, dams, financial engineering, actuarial science, and decision systems. Covering a wide range of areas of application of Markov processes, this second edition is revised to highlight the most important aspects as well as the most recent trends and applications of Markov processes. The author spent over 16 years in the industry before returning to academia, and he has applied many of the principles covered in this book in multiple research projects. Therefore, this is an applications-oriented book that also includes enough theory to provide a solid ground in the subject for the reader. Presents both the theory and applications of the different aspects of Markov processes Includes numerous solved examples as well as detailed diagrams that make it easier to understand the principle being presented Discusses different applications of hidden Markov models, such as DNA sequence analysis and speech analysis.
Gibbs Fields, Monte Carlo Simulation, and Queues Springer
Written with computer scientists and engineers in mind, this book brings queueing theory decisively back to computer science.
Markov Processes and Controlled Markov Chains John Wiley & Sons Incorporated
Probability, Markov Chains, Queues, and SimulationThe Mathematical Basis of Performance ModelingPrinceton University Press
Markov Processes and Applications Springer Nature
"This book is a highly recommendable survey of mathematical tools and results in applied probability with special emphasis on queueing theory....The second edition at hand is a thoroughly updated and considerably expended version of the first edition.... This book and the way the various topics are balanced are a welcome addition to the literature. It is an indispensable source of information for both advanced graduate students and researchers." --MATHEMATICAL REVIEWS
Fundamentals of Queueing Theory Oxford University Press on Demand
Queueing theory (the mathematical theory of waiting lines in all its configurations) continues to be a standard major area of operations research on the stochastic side. Therefore, universities with an active program in operations research sometimes will have an entire course devoted mainly or entirely to queueing theory, and the course is also taught in computer science, electrical engineering, mathematics, and industrial engineering programs. The basic course in queueing theory is often taught at first year graduate level, though can be taught at senior level undergraduate as well. This text evolved from the author's preferred syllabus for teaching the course, presenting the material in a more logical order than other texts and so being more effective in teaching the basics of queueing theory. The first three chapters focus on the needed preliminaries, including exposition distributions, Poisson processes and generating functions, renewal theory, and Markov chains, Then, rather than switching to first-come first-served memoryless queues here as most texts do, Haviv discusses the M/G/1 model instead of the M/M/1, and then covers priority queues. Later chapters cover the G/M/1 model, thirteen examples of continuous-time Markov processes, open networks of memoryless queues and closed networks, queueing regimes with insensitive parameters, and then concludes with two-dimensional queueing models which are quasi birth and death processes. Each chapter ends with exercises.
Markov Processes for Stochastic Modeling CRC Press
The definitive guide to queueing theory and its practical applications—features numerous real-world examples of scientific, engineering, and business applications Thoroughly updated and expanded to reflect the latest developments in the field, Fundamentals of Queueing Theory, Fifth Edition presents the statistical principles and processes involved in the analysis of the probabilistic nature of queues. Rather than focus narrowly on a particular application area, the authors illustrate the theory in practice across a range of fields, from computer science and various engineering disciplines to business and operations research. Critically, the text also provides a numerical approach to understanding and making estimations with queueing theory

and provides comprehensive coverage of both simple and advanced queueing models. As with all preceding editions, this latest update of the classic text features a unique blend of the theoretical and timely real-world applications. The introductory section has been reorganized with expanded coverage of qualitative/non-mathematical approaches to queueing theory, including a high-level description of queues in everyday life. New sections on non-stationary fluid queues, fairness in queueing, and Little's Law have been added, as has expanded coverage of stochastic processes, including the Poisson process and Markov chains. • Each chapter provides a self-contained presentation of key concepts and formulas, to allow readers to focus independently on topics relevant to their interests • A summary table at the end of the book outlines the queues that have been discussed and the types of results that have been obtained for each queue • Examples from a range of disciplines highlight practical issues often encountered when applying the theory to real-world problems • A companion website features QtsPlus, an Excel-based software platform that provides computer-based solutions for most queueing models presented in the book. Featuring chapter-end exercises and problems—all of which have been classroom-tested and refined by the authors in advanced undergraduate and graduate-level courses—Fundamentals of Queueing Theory, Fifth Edition is an ideal textbook for courses in applied mathematics, queueing theory, probability and statistics, and stochastic processes. This book is also a valuable reference for practitioners in applied mathematics, operations research, engineering, and industrial engineering.

Probability and Statistics with Reliability, Queuing, and Computer Science Applications Cambridge University Press

The general theory of stochastic processes and the more specialized theory of Markov processes evolved enormously in the second half of the last century. In parallel, the theory of controlled Markov chains (or Markov decision processes) was being pioneered by control engineers and operations researchers. Researchers in Markov processes and controlled Markov chains have been, for a long time, aware of the synergies between these two subject areas. However, this may be the first volume dedicated to highlighting these synergies and, almost certainly, it is the first volume that emphasizes the contributions of the vibrant and growing Chinese school of probability. The chapters that appear in this book reflect both the maturity and the vitality of modern day Markov processes and controlled Markov chains. They also will provide an opportunity to trace the connections that have emerged between the work done by members of the Chinese school of probability and the work done by the European, US, Central and South American and Asian scholars.

Numerical Methods in Markov Chains and Bulk Queues John Wiley & Sons

An Introduction to Stochastic Modeling provides information pertinent to the standard concepts and methods of stochastic modeling. This book presents the rich diversity of applications of stochastic processes in the sciences. Organized into nine chapters, this book begins with an overview of diverse types of stochastic models, which predicts a set of possible outcomes weighed by their likelihoods or probabilities. This text then provides exercises in the applications of simple stochastic analysis to appropriate problems. Other chapters consider the study of general functions of independent, identically distributed, nonnegative random variables representing the successive intervals between renewals. This book discusses as well the numerous examples of Markov branching processes that arise naturally in various scientific disciplines. The final chapter deals with queueing models, which aid the design process by predicting system performance. This book is a valuable resource for students of engineering and management science. Engineers will also find this book useful.

Numerical Solution of Markov Chains Springer Science & Business Media

Probability, Markov Chains, Queues, and Simulation provides a modern and authoritative treatment of the mathematical processes that underlie performance modeling. The detailed explanations of mathematical derivations and numerous illustrative examples make this textbook readily accessible to graduate and advanced undergraduate students taking courses in which stochastic processes play a fundamental role. The textbook is relevant to a wide variety of fields, including computer science, engineering, operations research, statistics, and mathematics. The textbook looks at the fundamentals of probability theory, from the basic concepts of set-based probability, through probability distributions, to bounds, limit theorems, and the laws of large numbers. Discrete and continuous-time Markov chains are analyzed from a theoretical and computational point of view. Topics include the Chapman-Kolmogorov equations; irreducibility; the potential, fundamental, and reachability matrices; random walk problems; reversibility; renewal processes; and the numerical computation of stationary and transient distributions. The M/M/1 queue and its extensions to more general birth-death processes are analyzed in detail, as are queues with phase-type arrival and service processes. The M/G/1 and G/M/1 queues are solved using embedded Markov chains; the busy period, residual service time, and priority scheduling are treated. Open and closed queueing networks are analyzed. The final part of the book addresses the mathematical basis of simulation. Each chapter of the textbook concludes with an extensive set of exercises. An instructor's solution manual, in which all exercises are completely worked out, is also available (to professors only). Numerous examples illuminate the mathematical theories Carefully detailed explanations of mathematical derivations guarantee a valuable pedagogical approach Each chapter concludes with an extensive set of exercises Professors: A supplementary Solutions Manual is available for this book. It is restricted to teachers using the text in courses. For information on how to obtain a copy, refer to: http://press.princeton.edu/class_use/solutions.html

Computational Probability Springer Science & Business Media

Queues and stochastic networks are analyzed in this book with purely probabilistic methods. The purpose of these lectures is to show that general results from Markov processes, martingales or ergodic theory can be used directly to study the corresponding stochastic processes. Recent developments have shown that, instead of having ad-hoc methods, a better understanding of fundamental results on stochastic processes is crucial to study the complex behavior of stochastic networks. In this book, various aspects of these stochastic models are investigated in depth in an elementary way: Existence of equilibrium, characterization of stationary regimes, transient behaviors (rare events, hitting times) and critical regimes, etc. A simple presentation of stationary point processes and Palm measures is given. Scaling methods and functional limit theorems are a major theme of this book. In particular, a complete chapter is devoted to fluid limits of Markov processes.

Springer Science & Business Media

From Markov Jump Processes to Spatial Queues aims to develop a

unified theory of spatial queues that yields concrete results for the performance analysis of mobile communication networks. A particular objective is to develop the most natural generalization of existing concepts (e.g. the BMAP) toward the needs of mobile communication networks. To these belong the spatial distribution of batch arrivals and users in the system as well as time-inhomogeneous (e.g. periodic) arrival intensities and user movements. One of the major recent challenges for the stochastic modelling of communication systems is the emergence of wireless networks, which are used by more and more subscribers today. The main new feature of those, which is not covered by classical queuing theory, clearly is the importance of the user location within the area that is served by the base stations of the network. In the framework of queuing theory, this opens up the natural extension of classical queuing models towards queues with a structured space in which users are served. The present book is intended to introduce this extension under the name of spatial queues. The main point of view and the general approach will be that of Markov jump processes. We start with a closer look into the theory. Then we present new results for the theory of stochastic processes as well as for classical queuing theory. Finally we introduce the new concepts of spatial Markovian arrival processes and spatial queues. The main text is divided into three parts. The first part provides a new presentation of the theory of Markov jump processes. We derive a number of new results, especially for time-inhomogeneous processes, which have been neglected too much in the current textbooks on stochastic processes. For the first time, the class of Markov-additive jump processes is analysed in detail. This extends and unifies all Markovian arrival processes that have been proposed up to now (including arrivals for fluid queues) and provides a foundation for the subsequent introduction of spatial Markovian arrival processes. The second part contains new results for classical queues with BMAP input. These include the first explicit formulae for the distribution of periodic queues. The class of fluid Markovian arrival processes is introduced, and we give statistical estimates for the parameters of a BMAP. In the third part, the concepts of spatial Markovian arrival processes (abbreviated: SMAPs) and spatial queues are introduced. After that, periodic spatial Markovian queues are analysed as a model for the cells of a wireless communication network. From Markov Jump Processes to Spatial Queues is intended to reach queuing theorists, researchers in the field of communication systems, as well as engineers with some background in probability theory. Furthermore, it is suitable as a textbook for advanced queuing theory on the graduate or post-graduate level.

Theory and Applications Springer Science & Business Media

Markov chains are a fundamental class of stochastic processes.They are widely used to solve problems in a large number of domainssuch as operational research, computer science, communicationnetworks and manufacturing systems. The success of Markov chains ismainly due to their simplicity of use, the large number ofavailable theoretical results and the quality of algorithmsdeveloped for the numerical evaluation of many metrics ofinterest. The author presents the theory of both discrete-time andcontinuous-time homogeneous Markov chains. He carefully examinesthe explosion phenomenon, the Kolmogorov equations, the convergenceto equilibrium and the passage time distributions to a state and toa subset of states. These results are applied to birth-and-deathprocesses. He then proposes a detailed study of the uniformizationtechnique by means of Banach algebra. This technique is used forthe transient analysis of several queuing systems. Contents 1. Discrete-Time Markov Chains 2. Continuous-Time Markov Chains 3. Birth-and-Death Processes 4. Uniformization 5. Queues About the Authors Bruno Sericola is a Senior Research Scientist at Inria Rennes– Bretagne Atlantique in France. His main research activityis in performance evaluation of computer and communication systems,dependability analysis of fault-tolerant systems and stochasticmodels.

Examples and Applications Springer Science & Business Media

Intersecting two large research areas - numerical analysis and applied probability/queuing theory - this book is a self-contained introduction to the numerical solution of structured Markov chains, which have a wide applicability in queuing 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 toengineers 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 andanalysis 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 bookends 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.

Palm Probabilities and Stationary Queues Probability, Markov Chains, Queues, and SimulationThe Mathematical Basis of Performance Modeling

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.

Queues Springer Science & Business Media

Presents the theory of general irreducible Markov chains and its connection to the Perron-Frobenius theory of nonnegative operators.

Probability Models Academic Press

This book is an introduction to the modern approach to the theory of Markov chains. The main goal of this approach is to determine the rate of convergence of a Markov chain to the stationary distribution as a function of the size and geometry of the state space. The authors develop the key tools for estimating convergence times, including coupling, strong stationary times,

and spectral methods. Whenever possible, probabilistic methods are emphasized. The book includes many examples and provides brief introductions to some central models of statistical mechanics. Also provided are accounts of random walks on networks, including hitting and cover times, and analyses of several methods of shuffling cards. As a prerequisite, the authors assume a modest understanding of probability theory and linear algebra at an undergraduate level. Markov Chains and Mixing Times is meant to bring the excitement of this active area of research to a wide audience.

Queueing Theory in Action John Wiley & Sons

Based on a popular course taught by the late Gian-Carlo Rota of MIT, with many new topics covered as well, Introduction to Probability with R presents R programs and animations to provide an intuitive yet rigorous understanding of how to model natural phenomena from a probabilistic point of view. Although the R programs are small in length, they are just as sophisticated and powerful as longer programs in other languages. This brevity makes it easy for students to become proficient in R. This calculus-based introduction organizes the material around key themes. One of the most important themes centers on viewing probability as a way to look at the world, helping students think and reason probabilistically. The text also shows how to combine and link stochastic processes to form more complex processes that are better models of natural phenomena. In addition, it presents a unified treatment of transforms, such as Laplace, Fourier, and z; the foundations of fundamental stochastic processes using entropy and information; and an introduction to Markov chains from various viewpoints. Each chapter includes a short biographical note about a contributor to probability theory, exercises, and selected answers. The book has an accompanying website with more information.

An Introduction to Stochastic Modeling Springer Science & Business Media

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.

The Mathematics of Computer Performance Modeling Springer Science & Business Media

This text is designed for an introductory probability course at the university level for sophomores, juniors, and seniors in mathematics, physical and social sciences, engineering, and computer science. It presents a thorough treatment of ideas and techniques necessary for a firm understanding of the subject. The text is also recommended for use in discrete probability courses. The material is organized so that the discrete and continuous probability discussions are presented in a separate, but parallel, manner. This organization does not emphasize an overly rigorous or formal view of probability and therefore offers some strong pedagogical value. Hence, the discrete discussions can sometimes serve to motivate the more abstract continuous probability discussions. Features: Key ideas are developed in a somewhat leisurely style, providing a variety of interesting applications to probability and showing some nonintuitive ideas. Over 600 exercises provide the opportunity for practicing skills and developing a sound understanding of ideas. Numerous historical comments deal with the development of discrete probability. The text includes many computer programs that illustrate the algorithms or the methods of computation for important problems. The book is a beautiful introduction to probability theory at the beginning level. The book contains a lot of examples and an easy development of theory without any sacrifice of rigor, keeping the abstraction to a minimal level. It is indeed a valuable addition to the study of probability theory. -- Zentralblatt MATH