

QUEUEING NETWORKS - CUSTOMERS, SIGNALS, AND PRODUCT FORM SOLUTIONS

by X. Chao, M. Miyazawa, and M. Pinedo

and

INTRODUCTION TO STOCHASTIC NETWORKS

by R.F. Serfozo

A BOOK REVIEW

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Networks of queues (= stochastic networks) have been a field of intensive research over the last three decades. The foundation for this research is classical queueing theory, which dealt mainly with single node queueing systems [4, 5, 8]. There is now a well-developed theory of stochastic networks accompanied by an unbounded set of open problems which originates directly from applications as well as from theoretical considerations. Most of these open problems are easily stated and put into a theoretical framework, but they often require either intricate techniques on an ad hoc basis or deep mathematical methods. Often, both of these approaches have to be combined to tackle successfully the solution of quickly formulated problem.

The development of queueing network theory, which provided application areas with solutions, formulas, and algorithms, commenced around 1950 in the area of Operations Research, with special emphasis on production, inventory, and transportation. The first breakthroughs were the works of Jackson [10] and Gordon and Newell [10]; both papers appeared in *Operations Research*. The second breakthrough in queueing network theory was already connected with Computer Science: the celebrated papers of Baskett, Chandy, Muntz, and Palacios [2], which appeared in the *Journal of the Association for Computing Machinery*, and of Kelly [11]. The two volumes of Kleinrock's book [13, 14] appeared at the same time as [11]. From that time on, queueing network theory and its applications have become intimately connected with performance analysis of complex systems in Computer and Communication Sciences, both at the hardware and software levels. Today's growth of production, manufacturing, and transportation, with information processing and communi-

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Queueing Networks Xiuli Chao, Masakiyo Miyazawa, Michael Pinedo, 1999-08-03 Wiley Interscience Series in Systems and Optimization Queueing Networks Customers Signals and Product Form Solutions Xiuli Chao New Jersey Institute of Technology USA Masakiyo Miyazawa Science University of Tokyo Japan Michael Pinedo New York University USA Mathematically beautiful and elegant yet has much practical application Professor Richard Weber The first mathematical analysis of a queueing problem concerned the use of early telephone switches Since then emerging technologies such as those in telecommunications and the manufacturing industry have prompted considerable interest and activity in the field Much of the current research has been enabled by recent rapid advances in computer technology making large scale simulations and complex approximations possible Today queueing systems play an integral role in the performance evaluation and optimization of computer communication manufacturing and transportation systems Includes Discussion on the fundamental structures of queueing network models The latest developments in the field Thorough examination of numerous applications Exercises at the end of each chapter Coverage of queueing networks with signals Discussion of future research developments With the advances in information technology many networks have in addition to conventional jobs signals and messages circulating throughout the system A signal carries information and instructions and may trigger complex simultaneous events The objective of this book is to present in a unified framework the latest developments in queueing networks with signals After introducing the foundations in the first four chapters Chapters 5 through to 8 cover a number of different queueing network models with various features Chapters 9 to 11 focus on more fundamental structures of queueing networks and Chapter 12 presents a framework for discrete time queueing network models The text is illustrated throughout with numerous examples Graduate students in operations research computer science electrical engineering and applied mathematics will find this text accessible and invaluable An essential reference for operation researchers and computer scientists working on queueing problems in computing manufacturing and communications networks Queueing Networks Xiuli Chao, 1999 Queueing Networks Richard J. Boucherie, Nico M. van Dijk, 2010-11-25 This handbook aims to highlight fundamental methodological and computational aspects of networks of queues to provide insights and to unify results that can be applied in a more general manner The handbook is organized into five parts Part 1 considers exact analytical results such as of product form type Topics include characterization of product forms by physical balance concepts and simple traffic flow equations classes of service and queue disciplines that allow a product form a unified description of product forms for discrete time queueing networks insights for insensitivity and aggregation and decomposition results that allow sub networks to be aggregated into single nodes to reduce computational burden Part 2 looks at monotonicity and comparison results such as for computational simplification by either of two approaches stochastic monotonicity and ordering results based on the ordering of the process generators and comparison results and explicit error bounds based on an

underlying Markov reward structure leading to ordering of expectations of performance measures Part 3 presents diffusion and fluid results It specifically looks at the fluid regime and the diffusion regime Both of these are illustrated through fluid limits for the analysis of system stability diffusion approximations for multi server systems and a system fed by Gaussian traffic Part 4 illustrates computational and approximate results through the classical MVA mean value analysis and QNA queueing network analyzer for computing mean and variance of performance measures such as queue lengths and sojourn times numerical approximation of response time distributions and approximate decomposition results for large open queueing networks spanPart 5 enlightens selected applications as spanloss networks originating from circuit switched telecommunications applications capacity sharing originating from packet switching in data networks and a hospital application that is of growing present day interest spanThe book shows that spanthe intertwined progress of theory and practicespan will remain to be most intriguing and will continue to be the basis of further developments in queueing networks

Queueing Networks with Discrete Time Scale Hans Daduna, 2003-05-15 Building on classical queueing theory mainly dealing with single node queueing systems networks of queues or stochastic networks has been a field of intensive research over the last three decades Whereas the first breakthrough in queueing network theory was initiated by problems and work in operations research the second breakthrough as well as subsequent major work in the area was closely related to computer science particularly to performance analysis of complex systems in computer and communication science The text reports on recent research and development in the area It is centered around explicit expressions for the steady behavior of discrete time queueing networks and gives a moderately positive answer to the question of whether there can be a product form calculus in discrete time Originating from a course given by the author at Hamburg University this book is ideally suited as a text for courses on discrete time stochastic networks

Fundamentals of Stochastic Networks Oliver C. Ibe, 2011-08-24 An interdisciplinary approach to understanding queueing and graphical networks In today's era of interdisciplinary studies and research activities network models are becoming increasingly important in various areas where they have not regularly been used Combining techniques from stochastic processes and graph theory to analyze the behavior of networks *Fundamentals of Stochastic Networks* provides an interdisciplinary approach by including practical applications of these stochastic networks in various fields of study from engineering and operations management to communications and the physical sciences The author uniquely unites different types of stochastic queueing and graphical networks that are typically studied independently of each other With balanced coverage the book is organized into three succinct parts Part I introduces basic concepts in probability and stochastic processes with coverage on counting Poisson renewal and Markov processes Part II addresses basic queueing theory with a focus on Markovian queueing systems and also explores advanced queueing theory queueing networks and approximations of queueing networks Part III focuses on graphical models presenting an introduction to graph theory along with Bayesian Boolean and random networks The author presents the

material in a self contained style that helps readers apply the presented methods and techniques to science and engineering applications Numerous practical examples are also provided throughout including all related mathematical details Featuring basic results without heavy emphasis on proving theorems Fundamentals of Stochastic Networks is a suitable book for courses on probability and stochastic networks stochastic network calculus and stochastic network optimization at the upper undergraduate and graduate levels The book also serves as a reference for researchers and network professionals who would like to learn more about the general principles of stochastic networks **Analysis of Queues** Natarajan Gautam,2012-04-26

Analysis of queues is used in a variety of domains including call centers web servers internet routers manufacturing and production telecommunications transportation hospitals and clinics restaurants and theme parks Combining elements of classical queueing theory with some of the recent advances in studying stochastic networks this book covers a broad range of applications It contains numerous real world examples and industrial applications in all chapters The text is suitable for graduate courses as well as researchers consultants and analysts that work on performance modeling or use queueing models as analysis tools *Analysis and Synthesis of Computer Systems* Erol Gelenbe,I. Mitrani,2010 This text presents an overview of methods that are used to evaluate the performance of computer systems and networks manufacturing systems and interconnected services systems It includes new chapters on numerical methods for queueing models on G networks

Stochastic Processes Alexander Zeifman,Victor Korolev,Alexander Sipin,2019-12-12 The aim of this special issue is to publish original research papers that cover recent advances in the theory and application of stochastic processes There is especial focus on applications of stochastic processes as models of dynamic phenomena in various research areas such as queueing theory physics biology economics medicine reliability theory and financial mathematics Potential topics include but are not limited to Markov chains and processes large deviations and limit theorems random motions stochastic biological model reliability availability maintenance inspection queueing models queueing network models computational methods for stochastic models applications to risk theory insurance and mathematical finance Queueing Theory P. P. Bocharov,C. D'Apice,A. V. Pechinkin,2011-09-08 The series is devoted to the publication of high level monographs and surveys which cover the whole spectrum of probability and statistics The books of the series are addressed to both experts and advanced students

Applied Probability and Queues Soeren Asmussen,2008-01-08 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 **Network Traffic Engineering** Andrea Baiocchi,2020-07-13 A comprehensive guide to the concepts and applications of queueing theory and traffic theory Network Traffic Engineering Models and Applications provides an advanced level queueing theory guide for students with a strong mathematical

background who are interested in analytic modeling and performance assessment of communication networks The text begins with the basics of queueing theory before moving on to more advanced levels The topics covered in the book are derived from the most cutting edge research project development teaching activity and discussions on the subject They include applications of queueing and traffic theory in LTE networks Wi Fi networks Ad hoc networks Automated vehicles Congestion control on the Internet The distinguished author seeks to show how insight into practical and real world problems can be gained by means of quantitative modeling Perfect for graduate students of computer engineering computer science telecommunication engineering and electrical engineering Network Traffic Engineering offers a supremely practical approach to a rapidly developing field of study and industry

Analytical and Stochastic Modeling Techniques and Applications Khalid Al-Begain,Dieter Fiems,William Knottenbelt,2010-06 This book constitutes the refereed proceedings of the 17th International Conference on Analytical and Stochastic Modeling Techniques and Applications ASMTA 2010 held in Cardiff UK in June 2010 The 28 revised full papers presented were carefully reviewed and selected from numerous submissions for inclusion in the book The papers are organized in topical sections on queueing theory specification languages and tools telecommunication systems estimation prediction and stochastic modelling

Handbook of Scheduling Joseph Y-T. Leung,2004-04-27 This handbook provides full coverage of the most recent and advanced topics in scheduling assembling researchers from all relevant disciplines to facilitate new insights Presented in six parts these experts provides introductory material complete with tutorials and algorithms then examine classical scheduling problems Part 3 explores scheduling models that originate in areas such as computer science operations research The following section examines scheduling problems that arise in real time systems Part 5 discusses stochastic scheduling and queueing networks and the final section discusses a range of applications in a variety of areas from airlines to hospitals

Quantitative Evaluation of Systems Nils Jansen,Mirco Tribastone,2023-09-14 This book constitutes the proceedings of the 20th International Conference on Quantitative Evaluation of Systems QEST 2023 which took place in Antwerp Belgium in September 2023 The 23 papers included in this book were carefully reviewed and selected from 44 submissions They deal with current topics in quantitative evaluation and verification of computer systems and networks focusing on data driven and machine learning systems case studies and tool papers The book also contains the extended abstract of the invited talk from David Parker

The Routledge Companion to Production and Operations Management Martin K. Starr,Sushil K. Gupta,2017-03-27 This remarkable volume highlights the importance of Production and Operations Management POM as a field of study and research contributing to substantial business and social growth The editors emphasize how POM works with a range of systems agriculture disaster management e commerce healthcare hospitality military systems not for profit retail sports sustainability telecommunications and transport and how it contributes to the growth of each Martin K Starr and Sushil K Gupta gather an international team of experts to provide researchers and students with a panoramic vision of the field

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Fundamentals of Matrix-Analytic Methods Qi-Ming He, 2013-08-13

Fundamentals of Matrix Analytic Methods targets advanced level students in mathematics, engineering and computer science. It focuses on the fundamental parts of Matrix Analytic Methods: Phase Type Distributions, Markovian arrival processes and Structured Markov chains and matrix geometric solutions. New materials and techniques are presented for the first time in research and engineering design. This book emphasizes stochastic modeling by offering probabilistic interpretation and constructive proofs for Matrix Analytic Methods. Such an approach is especially useful for engineering analysis and design. Exercises and examples are provided throughout the book.

Computer and Information Sciences -

ISCIS 2006 Albert Levi, Erkay Savas, Hüsnü Yenigün, Selim Balcisoy, Yücel Saygin, 2006-10-28. This book constitutes the refereed proceedings of the 21st International Symposium on Computer and Information Sciences (ISCIS 2006) held in Istanbul, Turkey, in October 2006. The 106 revised full papers presented together with five invited lectures were carefully reviewed and selected from 606 submissions.

Fundamentals of Queueing Networks Hong Chen, David D.

Yao, 2013-04-17. The objective of this book is to collect in a single volume the essentials of stochastic networks from the classical product form theory to the more recent developments such as diffusion and fluid limits, stochastic comparisons, stability, control, dynamic scheduling and optimization. The selection of materials inevitably is a reflection upon our bias and preference but it is also driven to a large extent by our desire to provide a graduate level text that is well balanced in breadth and depth, suitable for the classroom. Given the wide ranging applications of stochastic networks in recent years from supply chains to telecommunications, it is also our hope that the book will serve as a useful reference for researchers and students alike in these diverse fields. The book consists of three parts. The first part, Chapters 1 through 4, covers continuous time Markov chain models including the classical Jackson and Kelly networks, the notion of quasi-reversible queues and stochastic comparisons. The second part, Chapters 5 through 10, focuses on Brownian models including limit theorems for generalized Jackson networks and multiclass feedforward networks, an in-depth examination of stability in a Kumar-Seidman network and Brownian approximations for general multiclass networks with a mixture of priority and first-in-first-out disciplines. The third part, Chapters 11 and 12, discusses scheduling in both queueing stochastic and fluid deterministic networks along with topics such as conservation laws, polymatroid optimization and linear programming.

International Symposium on Computer and

Information Sciences Erol Gelenbe, 2022-09-16 Papers from an October 2002 symposium describe research in areas including algorithms artificial intelligence computer graphics computer networks databases evolutionary computation graph theory image processing multimedia technology software engineering and software performance engineering **Performance**

Evaluation and Planning Methods for the Next Generation Internet Andre Girard, Brunilde Sansò, Felida

Vazquez-Abad, 2006-03-30 GERAD celebrates this year its 25th anniversary The Center was created in 1980 by a small group of professors and researchers of HEC Montreal McGill University and of the Ecole Polytechnique de Montreal GERAD's activities achieved sufficient scope to justify its conversion in June 1988 into a Joint Research Centre of HEC Montreal the Ecole Polytechnique de Montreal and McGill University In 1996 the Université du Québec à Montreal joined these three institutions GERAD has fifty members professors more than twenty research associates and post doctoral students and more than two hundreds master and Ph D students GERAD is a multi university center and a vital forum for the development of operations research Its mission is defined around the following four complementary objectives The original and expert contribution to all research fields in GERAD's area of expertise The dissemination of research results in the best scientific outlets as well as in the society in general The training of graduate students and post doctoral researchers The contribution to the economic community by solving important problems and providing transferable tools

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