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KEY=QUEUEING - MADALYNN EVA

An Introduction to Queueing Networks

Introduction to Queueing Networks Theory n Practice

Springer The book examines the performance and optimization of systems where queueing and congestion are important constructs. Both finite and infinite queueing systems are examined. Many examples and case studies are utilized to indicate the breadth and depth of the queueing systems and their range of applicability. Blocking of these processes is very important and the book shows how to deal with this problem in an effective way and not only compute the performance measures of throughput, cycle times, and WIP but also to optimize the resources within these systems. The book is aimed at advanced undergraduate, graduate, and professionals and academics interested in network design, queueing performance models and their optimization. It assumes that the audience is fairly sophisticated in their mathematical understanding, although the explanations of the topics within the book are fairly detailed.

An Introduction to Queueing Systems

Springer Science & Business Media Queueing is an aspect of modern life that we encounter at every step in our daily activities. Whether it happens at the checkout counter in the supermarket or in accessing the Internet, the basic phenomenon of queueing arises whenever a shared facility needs to be accessed for service by a large number of jobs or customers. The study of queueing is important as it provides both a theoretical background to the kind of service that we may expect from such a facility and the way in which the facility itself may be designed to provide some specified grade of service to its customers. Our study of queueing was basically motivated by its use in the study of communication systems and computer networks. The various computers, routers and switches in such a network may be modelled as individual queues. The whole system may itself be modelled as a queueing network providing the required service to the messages, packets or cells that need to be carried. Application of queueing theory provides the theoretical framework for the design and study of such networks. The purpose of this book is to support a course on queueing systems at the senior undergraduate or graduate levels. Such a course would then provide the theoretical background on which a subsequent course on the performance modeling and analysis of computer networks may be based.

Introduction to Queueing Networks

Wiley-Blackwell Introduction to Queueing Networks Second Edition Erol Gelenbe, Duke University, North Carolina, USA and Guy Pujolle, University of Versailles, France With new concepts emerging in recent literature, this is a timely update to a highly successful and well established first edition. Queueing networks are particularly important as digital communications continue to grow; this text provides a thorough and comprehensive introduction to the concept of applying mathematical queueing network theory to data communications. New additions: * G-nets, i.e. generalized (or "Gelenbe") queueing networks which allow the analysis of on-line network control functions such as traffic re-routing, * discrete time queueing networks with application to ATM networks As leading authorities in this area, the authors' focus on the practical approach where aspects of queueing theory are applied directly to communications systems and networks. Included is a series of exercises and examples at the end of each chapter as well as a fully annotated bibliography. This book is of particular interest to communications and computer engineers and is essential reading for network managers and administrators. It will also benefit students and researchers in the area of networks, as well as Web server administrators and personal computer users. Visit Our Web Page!
<http://www.wiley.com/>

An Introduction to Queueing Theory and Matrix-Analytic Methods

Springer Science & Business Media *The present textbook contains the records of a two-semester course on queueing theory, including an introduction to matrix-analytic methods. This course comprises four hours of lectures and two hours of exercises per week and has been taught at the University of Trier, Germany, for about ten years in queueing. The course is directed to last year undergraduate and first year graduate students of applied probability and computer science, who have already completed an introduction to probability theory. Its purpose is to present material that is close enough to concrete queueing models and their applications, while providing a sound mathematical foundation for the analysis of these. Thus the goal of the present book is two-fold. On the one hand, students who are mainly interested in applications easily feel bored by elaborate mathematical questions in the theory of stochastic processes. The presentation of the mathematical foundations in our courses is chosen to cover only the necessary results, which are needed for a solid foundation of the methods of queueing analysis. Further, students oriented towards applications expect to have a justification for their mathematical efforts in terms of immediate use in queueing analysis. This is the main reason why we have decided to introduce new mathematical concepts only when they will be used in the immediate sequel. On the other hand, students of applied probability do not want any heuristic derivations just for the sake of yielding fast results for the model at hand.*

Fundamentals of Queueing Networks

Performance, Asymptotics, and Optimization

Springer Science & Business Media *This accessible book aims to collect in a single volume the essentials of stochastic networks. Stochastic networks have become widely used as a basic model of many physical systems in a diverse range of fields. Written by leading authors in the field, this book is meant to be used as a reference or supplementary reading by practitioners in operations research, computer systems, communications networks, production planning, and logistics.*

Performance Analysis of Queuing

and Computer Networks

CRC Press Performance Analysis of Queuing and Computer Networks develops simple models and analytical methods from first principles to evaluate performance metrics of various configurations of computer systems and networks. It presents many concepts and results of probability theory and stochastic processes. After an introduction to queues in computer networks, this self-contained book covers important random variables, such as Pareto and Poisson, that constitute models for arrival and service disciplines. It then deals with the equilibrium $M/M/1/\infty$ queue, which is the simplest queue that is amenable for analysis. Subsequent chapters explore applications of continuous time, state-dependent single Markovian queues, the $M/G/1$ system, and discrete time queues in computer networks. The author then proceeds to study networks of queues with exponential servers and Poisson external arrivals as well as the $G/M/1$ queue and Pareto interarrival times in a $G/M/1$ queue. The last two chapters analyze bursty, self-similar traffic, and fluid flow models and their effects on queues.

An Introduction to Queueing Theory Modeling and Analysis in Applications

Birkhäuser This introductory textbook is designed for a one-semester course on queueing theory that does not require a course on stochastic processes as a prerequisite. By integrating the necessary background on stochastic processes with the analysis of models, the work provides a sound foundational introduction to the modeling and analysis of queueing systems for a broad interdisciplinary audience of students in mathematics, statistics, and applied disciplines such as computer science, operations research, and engineering. This edition includes additional topics in methodology and applications. Key features:

- An introductory chapter including a historical account of the growth of queueing theory in more than 100 years.
- A modeling-based approach with emphasis on identification of models
- Rigorous treatment of the foundations of basic models commonly used in applications with appropriate references for advanced topics.
- A chapter on matrix-analytic method as an alternative to the traditional methods of analysis of queueing systems.
- A comprehensive treatment of statistical inference for queueing systems.
- Modeling exercises and review exercises when appropriate.

The second edition of An Introduction of Queueing Theory may be used as a textbook by first-year graduate students in fields such as computer science, operations research, industrial and systems engineering, as well as related fields such as manufacturing and communications engineering. Upper-level undergraduate students in mathematics, statistics, and engineering may also use the book in an introductory course on queueing theory. With its rigorous coverage of basic material and extensive

bibliography of the queueing literature, the work may also be useful to applied scientists and practitioners as a self-study reference for applications and further research. "...This book has brought a freshness and novelty as it deals mainly with modeling and analysis in applications as well as with statistical inference for queueing problems. With his 40 years of valuable experience in teaching and high level research in this subject area, Professor Bhat has been able to achieve what he aimed: to make [the work] somewhat different in content and approach from other books." - Assam Statistical Review of the first edition

Queueing Modelling Fundamentals With Applications in Communication Networks

John Wiley & Sons Queueing analysis is a vital tool used in the evaluation of system performance. Applications of queueing analysis cover a wide spectrum from bank automated teller machines to transportation and communications data networks. Fully revised, this second edition of a popular book contains the significant addition of a new chapter on Flow & Congestion Control and a section on Network Calculus among other new sections that have been added to remaining chapters. An introductory text, Queueing Modelling Fundamentals focuses on queueing modelling techniques and applications of data networks, examining the underlying principles of isolated queueing systems. This book introduces the complex queueing theory in simple language/proofs to enable the reader to quickly pick up an overview to queueing theory without utilizing the diverse necessary mathematical tools. It incorporates a rich set of worked examples on its applications to communication networks. Features include: Fully revised and updated edition with significant new chapter on Flow and Congestion Control as-well-as a new section on Network Calculus A comprehensive text which highlights both the theoretical models and their applications through a rich set of worked examples, examples of applications to data networks and performance curves Provides an insight into the underlying queueing principles and features step-by-step derivation of queueing results Written by experienced Professors in the field Queueing Modelling Fundamentals is an introductory text for undergraduate or entry-level post-graduate students who are taking courses on network performance analysis as well as those practicing network administrators who want to understand the essentials of network operations. The detailed step-by-step derivation of queueing results also makes it an excellent text for professional engineers.

Introduction to Stochastic Networks

Springer Science & Business Media Beginning with Jackson networks and ending with spatial queueing systems, this book describes several basic stochastic network processes, with the focus on network processes that have tractable expressions for

the equilibrium probability distribution of the numbers of units at the stations. Intended for graduate students and researchers in engineering, science and mathematics interested in the basics of stochastic networks that have been developed over the last twenty years, the text assumes a graduate course in stochastic processes without measure theory, emphasising multi-dimensional Markov processes. Alongside self-contained material on point processes involving real analysis, the book also contains complete introductions to reversible Markov processes, Palm probabilities for stationary systems, Little laws for queueing systems and space-time Poisson processes.

Introduction to Queueing Networks

Theory n Practice

The book examines the performance and optimization of systems where queueing and congestion are important constructs. Both finite and infinite queueing systems are examined. Many examples and case studies are utilized to indicate the breadth and depth of the queueing systems and their range of applicability. Blocking of these processes is very important and the book shows how to deal with this problem in an effective way and not only compute the performance measures of throughput, cycle times, and WIP but also to optimize the resources within these systems. The book is aimed at advanced undergraduate, graduate, and professionals and academics interested in network design, queueing performance models and their optimization. It assumes that the audience is fairly sophisticated in their mathematical understanding, although the explanations of the topics within the book are fairly detailed.

Computer Networks and Systems

Queueing Theory and Performance Evaluation

Springer Science & Business Media *Intended for a first course in performance evaluation, this is a self-contained treatment covering all aspects of queueing theory. It starts by introducing readers to the terminology and usefulness of queueing theory and continues by considering Markovian queues in equilibrium, Little's law, reversibility, transient analysis, and computation, plus the M/G/1 queueing system. It then moves on to cover networks of queues, and concludes with techniques for numerical solutions, a discussion of the PANACEA technique, discrete time queueing systems and simulation, and stochastic Petri networks. The whole is backed by case studies of distributed queueing networks arising in industrial applications. This third edition includes a new chapter on self-similar traffic, many new problems, and solutions for many exercises.*

Analysis of Queueing Networks with Blocking

Springer Science & Business Media Queueing network models have been widely applied as a powerful tool for modelling, performance evaluation, and prediction of discrete flow systems, such as computer systems, communication networks, production lines, and manufacturing systems. Queueing network models with finite capacity queues and blocking have been introduced and applied as even more realistic models of systems with finite capacity resources and with population constraints. In recent years, research in this field has grown rapidly. Analysis of Queueing Networks with Blocking introduces queueing network models with finite capacity and various types of blocking mechanisms. It gives a comprehensive definition of the analytical model underlying these blocking queueing networks. It surveys exact and approximate analytical solution methods and algorithms and their relevant properties. It also presents various application examples of queueing networks to model computer systems and communication networks. This book is organized in three parts. Part I introduces queueing networks with blocking and various application examples. Part II deals with exact and approximate analysis of queueing networks with blocking and the condition under which the various techniques can be applied. Part III presents a review of various properties of networks with blocking, describing several equivalence properties both between networks with and without blocking and between different blocking types. Approximate solution methods for the buffer allocation problem are presented.

Foundations of Queueing Theory

Springer Science & Business Media 3. 2 The Busy Period 43 3. 3 The M/M/1 System with Last Come, First Served 50 3. 4 Comparison of FCFS and LCFS 51 3. 5 Time-Reversibility of Markov Processes 52 The Output Process 54 3. 6 3. 7 The Multi-Server System in a Series 55 Problems for Solution 3. 8 56 4 ERLANGIAN QUEUEING SYSTEMS 59 4. 1 Introduction 59 4. 2 The System M/M/1 60 4. 3 The System E/c/1 67 4. 4 The System M/D/1 72 4. 5 Problems for Solution 74 PRIORITY SYSTEMS 79 5 5. 1 Description of a System with Priorities 79 Two Priority Classes with Pre-emptive Resume Discipline 5. 2 82 5. 3 Two Priority Classes with Head-of-Line Discipline 87 5. 4 Summary of Results 91 5. 5 Optimal Assignment of Priorities 91 5. 6 Problems for Solution 93 6 QUEUEING NETWORKS 97 6. 1 Introduction 97 6. 2 A Markovian Network of Queues 98 6. 3 Closed Networks 103 Open Networks: The Product Formula 104 6. 4 6. 5 Jackson Networks 111 6. 6 Examples of Closed Networks; Cyclic Queues 112 6. 7 Examples of Open Networks 114 6. 8 Problems for Solution 118 7 THE SYSTEM M/G/1; PRIORITY SYSTEMS 123 7. 1 Introduction 123 Contents ix 7. 2 The Waiting Time in M/G/1 124 7. 3 The Sojourn Time and the Queue Length 129 7. 4 The Service Interval 132 7.

Computer Networks and Systems: Queueing Theory and Performance Evaluation

Springer Science & Business Media Statistical performance evaluation has assumed an increasing amount of importance as we seek to design more and more sophisticated communication and information processing systems. The ability to predict a proposed system's performance without actually having to construct it is an extremely cost effective design tool. This book is meant to be a first year graduate level introduction to the field of statistical performance evaluation. As such, it covers queueing theory (chapters 1-4) and stochastic Petri networks (chapter 5). There is a short appendix at the end of the book which reviews basic probability theory. At Stony Brook, this material would be covered in the second half of a two course sequence (the first half is a computer networks course using a text such as Schwartz's Telecommunications Networks). Students seem to be encouraged to pursue the analytical material of this book if they first have some idea of the potential applications. I am grateful to B.L. Bodnar, J. Blake, J.S. Emer, M. Garrett, W. Hagen, Y.C. Jenq, M. Karol, J.F. Kurose, S.-Q. Li, A.C. Liu, J. McKenna, H.T. Mouftah and W.G. Nichols, I.Y. Wang, the IEEE and Digital Equipment Corporation for allowing previously published material to appear in this book.

Queueing Networks and Markov Chains

Modeling and Performance Evaluation with Computer Science Applications

John Wiley & Sons 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.*

Introduction to Queueing Networks

John Wiley & Sons Incorporated *Mathematics of Computing -- Miscellaneous.*

Delayed and Network Queues

John Wiley & Sons *Presents an introduction to differential equations, probability, and stochastic processes with real-world applications of queues with delay and delayed network queues Featuring recent advances in queueing theory and modeling, Delayed and Network Queues provides the most up-to-date theories in queueing model applications. Balancing both theoretical and practical applications of queueing theory, the book introduces queueing network models as tools to assist in the answering of questions on cost and performance that arise throughout the life of a computer system and signal processing. Written by well-known researchers in the field, the book presents key information for understanding the essential aspects of queues with delay and networks of queues with unreliable nodes and vacationing servers. Beginning with simple analytical fundamentals, the book contains a selection of realistic and advanced queueing models that address current deficiencies. In addition, the book presents the treatment of queues with delay and networks of queues, including possible breakdowns and disruptions that may cause delay. Delayed and Network Queues also features: Numerous examples and exercises with applications in various fields of study such as mathematical sciences, biomathematics, engineering, physics, business, health industry, and economics A wide array of practical applications of network queues and queueing systems, all of which are related to the appropriate stochastic processes Up-to-date topical coverage such as single- and multiserver queues with and without delays, along with the necessary fundamental coverage of probability and difference equations Discussions on queueing models such as single- and multiserver Markovian queues with balking, reneging, delay, feedback, splitting, and blocking, as well as their role in the treatment of networks of queues with and without delay and network*

reliability Delayed and Network Queues is an excellent textbook for upper-undergraduate and graduate-level courses in applied mathematics, queueing theory, queueing systems, probability, and stochastic processes. The book is also an ideal reference for academics and practitioners in mathematical sciences, biomathematics, operations research, management, engineering, physics, business, economics, health industry, and industrial engineering. Aliakbar Montazer Haghighi, PhD, is Professor and Head of the Department of Mathematics at Prairie View A&M University, USA, as well as founding Editor-in-Chief of Applications and Applied Mathematics: An International Journal (AAM). His research interests include probability, statistics, stochastic processes, and queueing theory. Among his research publications and books, Dr. Haghighi is the coauthor of Difference and Differential Equations with Applications in Queueing Theory (Wiley, 2013). Dimitar P. Mishev, PhD, is Professor in the Department of Mathematics at Prairie View A&M University, USA. His research interests include differential and difference equations and queueing theory. The author of numerous research papers and three books, Dr. Mishev is the coauthor of Difference and Differential Equations with Applications in Queueing Theory (Wiley, 2013).

Introduction to Discrete Event Systems

Springer Nature *This unique textbook comprehensively introduces the field of discrete event systems, offering a breadth of coverage that makes the material accessible to readers of varied backgrounds. The book emphasizes a unified modeling framework that transcends specific application areas, linking the following topics in a coherent manner: language and automata theory, supervisory control, Petri net theory, Markov chains and queueing theory, discrete-event simulation, and concurrent estimation techniques. Topics and features: detailed treatment of automata and language theory in the context of discrete event systems, including application to state estimation and diagnosis comprehensive coverage of centralized and decentralized supervisory control of partially-observed systems timed models, including timed automata and hybrid automata stochastic models for discrete event systems and controlled Markov chains discrete event simulation an introduction to stochastic hybrid systems sensitivity analysis and optimization of discrete event and hybrid systems new in the third edition: opacity properties, enhanced coverage of supervisory control, overview of latest software tools This proven textbook is essential to advanced-level students and researchers in a variety of disciplines where the study of discrete event systems is relevant: control, communications, computer engineering, computer science, manufacturing engineering, transportation networks, operations research, and industrial engineering. Christos G. Cassandras is Distinguished Professor of Engineering, Professor of Systems Engineering, and Professor of Electrical and Computer Engineering at Boston University. Stéphane Lafortune is Professor of Electrical Engineering and Computer Science at the University of Michigan, Ann Arbor.*

An Introduction to Queueing Networks

Stochastic Networks

Cambridge University Press *Communication networks underpin our modern world, and provide fascinating and challenging examples of large-scale stochastic systems. Randomness arises in communication systems at many levels: for example, the initiation and termination times of calls in a telephone network, or the statistical structure of the arrival streams of packets at routers in the Internet. How can routing, flow control and connection acceptance algorithms be designed to work well in uncertain and random environments? This compact introduction illustrates how stochastic models can be used to shed light on important issues in the design and control of communication networks. It will appeal to readers with a mathematical background wishing to understand this important area of application, and to those with an engineering background who want to grasp the underlying mathematical theory. Each chapter ends with exercises and suggestions for further reading.*

Introduction to Queueing Systems with Telecommunication Applications

Springer Science & Business Media *The book is composed of two main parts: mathematical background and queueing systems with applications. The mathematical background is a self containing introduction to the stochastic processes of the later studies queueing systems. It starts with a quick introduction to probability theory and stochastic processes and continues with chapters on Markov chains and regenerative processes. More recent advances of queueing systems are based on phase type distributions, Markov arrival processes and quasy birth death processes, which are introduced in the last chapter of the first part. The second part is devoted to queueing models and their applications. After the introduction of the basic Markovian (from $M/M/1$ to $M/M/1/N$) and non-Markovian ($M/G/1$, $G/M/1$) queueing systems, a chapter presents the analysis of queues with phase type distributions, Markov arrival processes (from $PH/M/1$ to $MAP/PH/1/K$). The next chapter presents the classical queueing network results and the rest of this part is devoted to the application examples. There are queueing models for bandwidth charing with different traffic classes, slotted multiplexers, ATM switches, media access protocols like Aloha and IEEE 802.11b, priority systems and retrial systems. An appendix supplements the technical content with Laplace and z transformation rules, Bessel functions and a list of notations. The book contains examples and*

exercises throughout and could be used for graduate students in engineering, mathematics and sciences.

Queueing Networks with Discrete Time Scale

Explicit Expressions for the Steady State Behavior of Discrete Time Stochastic Networks

Springer 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.

From Markov Jump Processes to Spatial Queues

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 queueing 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 queueing theory, this opens up the natural extension of classical queueing 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 queueing 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 queueing 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 queueing theory on the graduate or post-graduate level.

Scheduling and Control of Queueing Networks

Cambridge University Press A graduate text on theory and methods using applied probability techniques for scheduling service, manufacturing, and information networks.

Stability of Queueing Networks

École d'Été de Probabilités de Saint-Flour XXXVI-2006

Springer Queueing networks constitute a large family of stochastic models, involving jobs that enter a network, compete for service, and eventually leave the network upon completion of service. Since the early 1990s, substantial attention has been devoted to the question of when such networks are stable. This volume presents a summary of such work. Emphasis is placed on the use of fluid models in showing stability, and on examples of queueing networks that are unstable even when the arrival rate is less than the service rate. The material of this volume is based on a series of nine lectures given at the Saint-Flour Probability Summer School 2006.

Lectures were also given by Alice Guionnet and Steffen Lauritzen.

Performance Modeling and Design of Computer Systems

Queueing Theory in Action

Cambridge University Press *Written with computer scientists and engineers in mind, this book brings queueing theory decisively back to computer science.*

An Introduction to Communication Network Analysis

John Wiley & Sons *This book is a quantitative text, which focuses on the real issues behind serious modeling and analysis of communications networks. The author covers all the necessary mathematics and theory in order for students to understand the tools that optimize computer networks today. Covers both classical (e.g. queueing theory) and modern (e.g. pricing) aspects of networking Integrates material on communication networks with material on modeling/analyzing and designing such networks Includes a Solution Manual*

Multidimensional Queueing Models in Telecommunication Networks

Springer *The increasing complexity of telecommunication networks requires us to develop adequate mathematical models. We must find their characteristics, optimize them subject to chosen criteria, and develop the corresponding control algorithms. Multidimensional queueing models are used to design and optimize modern and next-generation networks (NGN). The central problem of the related mathematical theory is to apply multidimensional and large-size queueing models to improve efficiency. In this book new methods are successively developed and applied to solve related problems. The book is recommended for researchers engaged with the mathematical theory of telecommunications traffic.*

The Fundamental Role of Teletraffic in the Evolution of

Telecommunications Networks

Proceedings of the 14th International Teletraffic Congress - ITC 14, Antibes Juan-les-Pins, France, 6-10 June, 1994

Elsevier *The International Teletraffic Congress (ITC) is a recognized international organization taking part in the work of the International Telecommunications Union. The congress traditionally deals with the development of teletraffic theory and its applications to the design, planning and operation of telecommunication systems, networks and services. The contents of ITC 14 illustrate the important role of teletraffic in the current period of rapid evolution of telecommunication networks. A large number of papers address the teletraffic issues behind developments in broadband communications and ATM technology. The extension of possibilities for user mobility and personal communications together with the generalization of common channel signalling and the provision of new intelligent network services are further extremely significant developments whose teletraffic implications are explored in a number of contributions. ITC 14 also addresses traditional teletraffic subjects, proposing enhancements to traffic engineering practices for existing circuit and packet switched telecommunication networks and making valuable original contributions to the fundamental mathematical tools on which teletraffic theory is based. The contents of these Proceedings accurately reflect the extremely wide scope of the ITC, extending from basic mathematical theory to day-to-day traffic engineering practices, and constitute the state of the art in 1994 of one of the fundamental telecommunications sciences.*

Fundamentals of Queueing Theory

John Wiley & Sons *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.

Fundamentals of Queueing Systems

Statistical Methods for Analyzing Queueing Models

Springer Science & Business Media *Waiting in lines is a staple of everyday human life. Without really noticing, we are doing it when we go to buy a ticket at a movie theater, stop at a bank to make an account withdrawal, or proceed to checkout a purchase from one of our favorite department stores. Oftentimes, waiting lines are due to overcrowded, overfilling, or congestion; any time there is more customer demand for a service than can be provided, a waiting line forms. Queueing systems is a term used to describe the methods and techniques most ideal for measuring the probability and statistics of a wide variety of waiting line models. This book provides an introduction to basic queueing systems, such as $M/M/1$ and its variants, as well as newer concepts like systems with priorities, networks of queues, and general service policies. Numerical examples are presented to guide readers into thinking about practical real-world applications, and students and researchers will be able to apply the methods learned to designing queueing systems that extend beyond the classroom. Very little has been published in the area of queueing systems, and this volume will appeal to graduate-level students, researchers, and practitioners in the areas of management science, applied mathematics, engineering, computer science, and statistics.*

Network Traffic Engineering Models and Applications

John Wiley & Sons *A COMPREHENSIVE GUIDE TO THE CONCEPTS AND APPLICATIONS OF QUEUING THEORY AND TRAFFIC THEORY* Network Traffic Engineering: Stochastic Models and Applications provides an advanced level queuing theory guide for students with a strong mathematical background who are interested in analytic modeling and performance assessment of service system networks, with a focus on communication networks. The text begins with the basics of queuing theory before moving on to more advanced levels. Examples and applications are a key part of the material. The topics covered in the book are derived from cutting-edge research, project development, teaching activity, and discussions on the subject. They include applications of queuing and traffic theory in: Cellular networks Wi-Fi networks Ad-hoc and vehicular networks Congestion control in 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 and PhD students of engineering and science in the field of Information and Communication Technologies, including computer, telecommunications, and electrical engineering, computer science, data science, Network Traffic Engineering offers a supremely practical approach, grounded on a solid theoretical foundation, to a rapidly developing field of study and industry.

Performance Evaluation: Origins and Directions

Springer Science & Business Media This monograph-like state-of-the-art survey presents the history, the key ideas, the success stories, and future challenges of performance evaluation and demonstrates the impact of performance evaluation on a variety of different areas through case studies in a coherent and comprehensive way. Leading researchers in the field have contributed 19 cross-reviewed topical chapters competently covering the whole range of performance evaluation, from theoretical and methodological issues to applications in numerous other fields. Additionally, the book contains one contribution on the role of performance evaluation in industry and personal accounts of four pioneering researchers describing the genesis of breakthrough results. The book will become a valuable source of reference and indispensable reading for anybody active or interested in performance evaluation.

Queueing Theory in Manufacturing

Systems Analysis and Design

Springer Science & Business Media *The objective of the book is to acquaint the reader with the use of queueing theory in the analysis of manufacturing systems.*

Introduction to Network Emulation

CRC Press *Emulation is a hybrid experimentation technique intended to bridge the gap between simulation and real-world testing. The key idea of emulation is to reproduce in real time and in a controlled manner the essential functionality of a system, so that it can interact with other real systems that can thus be evaluated. This book describes the technique of network emulation and compares it with the other experimental approaches: the scholarly analytical modeling, the popular network simulation, and the demanding real-world testing. To emphasize the practical aspects related to emulation, this book presents a large number of examples of network emulators on the market, as well as provides an in-depth analysis of a case study, the wireless network emulation testbed called QOMB.*

Analysis of Queues

Methods and Applications

CRC Press *Written with students and professors in mind, Analysis of Queues: Methods and Applications combines coverage of classical queueing theory with recent advances in studying stochastic networks. Exploring a broad range of applications, the book contains plenty of solved problems, exercises, case studies, paradoxes, and numerical examples. In addition to the standard single-station and single class discrete queues, the book discusses models for multi-class queues and queueing networks as well as methods based on fluid scaling, stochastic fluid flows, continuous parameter Markov processes, and quasi-birth-and-death processes, to name a few. It describes a variety of applications including computer-communication networks, information systems, production operations, transportation, and service systems such as healthcare, call centers and restaurants.*

A Tutorial on Queuing and Trunking with Applications to Communications

Morgan & Claypool Publishers *The motivation for developing this synthesis lecture was to provide a tutorial on queuing and trunking, with extensions to networks of queues, suitable for supplementing courses in communications, stochastic processes, and networking. An essential component of this lecture is MATLAB-based*

demonstrations and exercises, which can be easily modified to enable the student to observe and evaluate the impact of changing parameters, arrival and departure statistics, queuing disciplines, the number of servers, and other important aspects of the underlying system model. Much of the work in this lecture is based on Poisson statistics, since Poisson models are useful due to the fact that Poisson models are analytically tractable and provide a useful approximation for many applications. We recognize that the validity of Poisson statistics is questionable for a number of networking applications and therefore we briefly discuss self-similar models and the Hurst parameter, long-term dependent models, the Pareto distribution, and other related topics. Appropriate references are given for continued study on these topics. The initial chapters of this book consider individual queues in isolation. The systems studied consist of an arrival process, a single queue with a particular queuing discipline, and one or more servers. While this allows us to study the basic concepts of queuing and trunking, modern data networks consist of many queues that interact in complex ways. While many of these interactions defy analysis, the final chapter introduces a model of a network of queues in which, after being served in one queue, customers may join another queue. The key result for this model is known as Jackson's Theorem. Finally, we state the BCMP Theorem, which can be viewed as a further extension of Jackson's Theorem and present Kleinrock's formula, which can be viewed as the network version of Little's Theorem. Table of Contents: Introduction / Poisson, Erlang, and Pareto Distributions / A Brief Introduction to Queueing Theory / Blocking and Delay / Networks of Queues

Optimal Design of Queueing Systems

CRC Press The First Comprehensive Book on the Subject Focusing on the underlying structure of a system, Optimal Design of Queueing Systems explores how to set the parameters of a queueing system, such as arrival and service rates, before putting it into operation. It considers various objectives, comparing individually optimal (Nash equilibrium), socially optimal, class optimal, and facility optimal flow allocations. After an introduction to basic design models, the book covers the optimal arrival rate model for a single-facility, single-class queue as well as dynamic algorithms for finding individually or socially optimal arrival rates and prices. It then examines several special cases of multiclass queues, presents models in which the service rate is a decision variable, and extends models and techniques to multifacility queueing systems. Focusing on networks of queues, the final chapters emphasize the qualitative properties of optimal solutions. Written by a long-time, recognized researcher on models for the optimal design and control of queues and networks of queues, this book frames the issues in the general setting of a queueing system. It shows how design models can control flow to achieve a variety of objectives.

Introduction to Queueing Theory

The book is not intended to be characterized as either 'theoretical' or 'applied'. The emphasis of the book is on understanding the interplay of mathematical and heuristic reasoning that underlies queueing theory and its applications, with the following two objectives: 1) To give the student sufficient understanding of the theory so that he will be able to apply it in the practice of operations research, and 2) To give the student the background required to read the literature and embark on research.