Data Networks By Bertsekas And Gallager Solution


Multiset Detection and High-Performance Data Network Design contains comprehensive coverage of network design, performance, and availability. Tony Kenyon provides the tools to solve medium- to large-scale data network design problems from the ground up. He lays out a practical and systematic approach that integrates network planning, research, design, and deployment, using state-of-the-art techniques in performance analysis, cost analysis, simulation, and topology modeling. The proliferation and complexity of data networks today is challenging our ability to design and manage them effectively. A new generation of Internet, e-commerce, and multimedia applications has changed traditional assumptions on traffic dynamics, and demands tight quality of service and security guarantees. These issues, combined with the economics of moving large traffic volumes across international backbones, mean that the demands placed on network designers, planners, and managers are now greater than ever before. High-Performance Data Network Design is a "must have" for anyone seriously involved in designing data networks. Together with the companion volume, Data Networks: Routing, Security, and Performance Optimization, this book gives readers the guidance they need to plan, implement, and optimize their enterprise infrastructure. Includes real insight into the entire design process. Includes basic principles, practical advice, and examples of design for industry-strength enterprise data networks. Integrates topics often overlooked—backbone optimization, bottleneck analysis, simulation tools, and network costing.

Resource Allocation and Cross-layer Control in Wireless Networks. This book covers the design and optimization of computer networks applying a rigorous optimization methodology, applicable to any network technology. It is organized into two parts. In Part 1 the reader will learn how to model network problems appearing in computer networks as optimization programs, and use optimization theory to give insights on them. Four problem types are addressed systematically—traffic routing, capacity dimensioning, congestion control, and topology design. Part 2 targets the design of algorithms that solve network problems like the ones modeled in Part 1. Two main approaches are addressed—gradient-like algorithms inspiring distributed network protocols that dynamically adapt to the network, or cross-layer schemes that coordinate the cooperation among protocols; and those focusing on the design of heuristic algorithms for long-term static network design and planning problems. Following a hands-on approach, the reader will have access to a large set of examples in real-life technologies like IP, wireless and optical networks. Implementations of models and algorithms will be available in the open-source Net2Plan tool from which the user will be able to see how the lessons learned take real form in algorithms, and reuse or execute them to obtain numerical solutions. An accompanying link to the author’s own Net2plan software enables readers to produce numerical solutions to a multitude of real-life problems in computer networks (www.net2plan.com).

Quality of Service Control in High-speed Networks. This highly acclaimed work, first published by Prentice Hall in 1989, is a comprehensive and theoretically sound treatment of parallel and distributed numerical methods. It focuses on algorithms that are naturally suited for massive parallelization, and it explores the fundamental convergence, rate of convergence, communication, and synchronization issues associated with such algorithms. This is an extensive book, which aside from its focus on parallel and distributed algorithms, contains a wealth of material on a broad variety of computation and optimization topics. It is an excellent supplement to several of our other books, including Convex Optimization Algorithms (Athena Scientific, 2015), Nonlinear Programming (Athena Scientific, 1999), Dynamic Programming and Optimal Control (Athena Scientific, 2012), Neuro-Dynamic Programming (Athena Scientific, 1996), and Network Optimization (Athena Scientific, 1998). The on-line edition of the book contains a 95-page solutions manual.

Convex Optimization Theory AD HOC NETWORKS: Technologies and Protocols is a concise in-depth treatment of various constituent components of ad hoc network protocols. It reviews issues related to medium access control, scalable routing, group communications, use of directional/smart antennas, network security, and power management among other topics. The authors examine various technologies that may aid ad hoc networking including the presence of an ability to tune transmission power levels or the deployment of sophisticated smart
antennae. Contributors to this volume include experts that have been active in ad hoc network research and have published in the premier conferences and journals in this subject area. AD HOC NETWORKS: Protocols and Technologies will be immensely useful as a reference work to engineers and researchers as well as to advanced level students in the areas of wireless networks, and computer networks.

Wireless Communications 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. Part 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.

Network Optimization: Continuous and Discrete Models

AD HOC NETWORKS This classic textbook aims to provide a fundamental understanding of the principles that underlie the design of data networks; which form the backbone of the modern internet. It was developed through classroom use at MIT in the 1980s, and continues to be used as a textbook in MIT classes. The present edition also contains detailed high-quality solutions to all the end-of-chapter exercises. Among its major features the book: 1) Describes the principles of layered architectures. 2) Explains the principles of data link control, with many examples and insights into distributed algorithms and protocols. 3) Provides an intuitive coverage of queueing, and its applications in delay and performance analysis of networks. 4) Covers the theory of multiaccess communications and local data networks. 5) Discusses in-depth theoretical and practical aspects of routing and topological design. 6) Covers the theory of flow control, emphasizing issues of congestion and delay in integrated high-speed networks.

Public Data Networks Appropriate for a first course on computer networking, this textbook describes the architecture and function of the application, transport, network, and link layers of the internet protocol stack, then examines audio and video networking applications, the underpinnings of encryption and network security, and the key issues of network management. Th

Fundamentals of Digital Communication

Data Networks,2/e Error correcting coding is often analyzed in terms of its application to the separate levels within the data network in isolation from each other. In this fresh approach, the author's consider the data network as a superchannel (a multi-layered entity) which allows error correcting coding to be evaluated as it is applied to a number of network layers as a whole. By exposing the problems of applying error correcting coding in data networks, and by discussing coding theory and its applications, this original technique shows how to correct errors in the network through joint coding at different network layers. Discusses the problem of reconciling coding applied to different layers using a superchannel approach. Includes thorough coverage of all the key codes: linear block codes, Hamming, BCH and Reed-Solomon codes, LDPC codes decoding, as well as convolutional, turbo and iterative coding. Considers new areas of application of error correcting codes such as transport coding, code-based cryptosystems and coding for image compression. Demonstrates how to use error correcting coding to control such important data characteristics as mean message delay. Provides theoretical explanations backed up by numerous real-world examples and practical recommendations. Features a companion website containing additional research results including new constructions of LDPC codes, joint error-control coding and synchronization. Reed-Muller codes and their list decoding. By progressing from theory through to practical problem solving, this resource contains invaluable advice for researchers, postgraduate students, engineers and computer scientists interested in data communications and applications of coding theory.

Reinforcement Learning and Optimal Control

Error Correcting Coding and Security for Data Networks
Optimization of Computer Networks  This book considers large and challenging multistage decision problems, which can be solved in principle by dynamic programming (DP), but their exact solution is computationally intractable. We discuss solution methods that rely on approximations to produce suboptimal policies with adequate performance. These methods are collectively known by several essentially equivalent names: reinforcement learning, approximate dynamic programming, neuro-dynamic programming. They have been at the forefront of research for the last 25 years, and they underlie, among others, the recent impressive successes of self-learning in the context of games such as chess and Go. Our subject has benefited greatly from the interplay of ideas from optimal control and from artificial intelligence, as it relates to reinforcement learning and simulation-based neural network methods. One of the aims of the book is to explore the common boundary between these two fields and to form a bridge that is accessible by workers with background in either field. Another aim is to organize coherently the broad mosaic of methods that have proved successful in practice while having a solid theoretical and/or logical foundation. This may help researchers and practitioners to find their way through the maze of competing ideas that constitute the current state of the art. This book relates to several of our other books: Neuro-Dynamic Programming (Athena Scientific, 1996), Dynamic Programming and Optimal Control (4th edition, Athena Scientific, 2017), Abstract Dynamic Programming (2nd edition, Athena Scientific, 2018), and Nonlinear Programming (Athena Scientific, 2016). However, the mathematical style of this book is somewhat different. While we provide a rigorous, albeit short, mathematical account of the theory of finite and infinite horizon dynamic programming, and some fundamental approximation methods, we rely more on intuitive explanations and less on proof-based insights. Moreover, our mathematical requirements are quite modest: calculus, a minimal use of matrix-vector algebra, and elementary probability (mathematically complicated arguments involving laws of large numbers and stochastic convergence are bypassed in favor of intuitive explanations). The book illustrates the methodology with many examples and illustrations, and uses a gradual expository approach, which proceeds along four directions: (a) From exact DP to approximate DP: We first discuss exact DP algorithms, explain why they may be difficult to implement, and then use them as the basis for approximations. (b) From finite horizon to infinite horizon problems: We first discuss finite horizon exact and approximate DP methodologies, which are intuitive and mathematically simple, and then progress to infinite horizon problems. (c) From deterministic to stochastic models: We often discuss separately deterministic and stochastic problems, since deterministic problems are simpler and offer special advantages for some of our methods. (d) From model-based to model-free implementations: We first discuss model-based implementations, and then we identify schemes that can be appropriately modified to work with a simulator. The book is related and supplemented by the companion research monograph Rollout, Policy Iteration, and Distributed Reinforcement Learning (Athena Scientific, 2020), which focuses more closely on several topics related to rollout, approximate policy iteration, multagent problems, discrete and Bayesian optimization, and distributed computation, which are either discussed in less detail or not covered at all in the present book. The author's website contains class notes, and a series of videolecures and slides from a 2021 course at ASU, which address a selection of topics from both books.

Mobile Computing  The research papers in this volume describe recent, original developments in techniques, tools and applications in the area of communication system performance. Involved in the project are researchers from the world's leading universities, research institutes and companies.

Solutions Manual to Data Networks Based on an extremely popular short course conducted by the authors for several Fortune 500 companies, this volume is designed to help professionals develop a deeper understanding of data networks and evolving integrated networks, and to explore today's various analysis and design tools. KEY TOPICS: It begins with an overview of the principles behind data networks, then develops an understanding of the modeling issues and mathematical analysis needed to compare the effectiveness of different networks. An ideal reference for Communication, Network, and Research and Development Engineers.

Communication Networks  The rapid development of wireless digital communication technology has created capabilities that software systems are only beginning to exploit. The falling cost of both communication and of mobile computing devices (laptop computers, hand-held computers, etc.) is making wireless computing affordable not only to business users but also to consumers. Mobile computing is not a "scaled-down" version of the established and well-studied field of distributed computing. The nature of wireless communication media and the mobility of computers combine to create fundamentally new problems in networking, operating systems, and information systems. Further more, many of the applications envisioned for mobile computing place novel demands on software systems. Although mobile computing is still in its infancy, some basic concepts have been identified and several seminal experimental systems developed. This book includes a set of contributed papers that describe these concepts and systems. Other papers describe applications that are currently being deployed and tested. The first chapter offers an introduction to the field of mobile computing, a survey of technical issues, and a summary of the papers that comprise subsequent chapters. We have chosen to reprint several key papers that appeared previously in conference proceedings. Many of the papers in this book are being published here for the first time. Of these new papers, some are expanded versions of papers first presented at the NSF-sponsored Mobidata Workshop on Mobile and Wireless Information Systems, held at Rutgers University on Oct 31 and Nov 1, 1994.

Introduction to Probability

Convex Analysis and Optimization Computer Networks, Architecture and Applications covers many aspects of
research in modern communications networks for computing purposes.

Energy and Spectrum Efficient Wireless Network Design This book is written by leading scholars in Network Science, Nonlinear Science and Infrastructure Systems, expressly to develop common theoretical underpinnings for better solutions to modern infrastructural problems. The book is dedicated to the formulation of infrastructural tools that will better solve problems from transportation networks to telecommunications, Internet, supply chains and more.

Data Networks Network optimization is important in the modeling of problems and processes from such fields as engineering, computer science, operations research, transportation, telecommunication, decision support systems, manufacturing, and airline scheduling. Recent advances in data structures, computer technology, and algorithm development have made it possible to solve classes of network optimization problems that until recently were intractable. The refereed papers in this volume reflect the interdisciplinary efforts of a large group of scientists from academia and industry to model and solve complicated large-scale network optimization problems.

The communication of information is a crucial point in the development of our future way of life. We are living more and more in an information society. Perhaps the more obvious applications are those devoted to distributed cooperative multimedia systems. In both industry and academia, people are involved in such projects. HPN'95 is an international forum where both communities can find a place for dialogues and interchanges. The conference is targeted to the new mechanisms, protocols, services and architectures derived from the need of emerging applications, as well as from the requirements of new communication environments. This workshop belongs to the series started in 1987 in Aachen (Germany), followed by Liege (Belgium) in 1988, Berlin (Germany) in 1991, Liege (Belgium) again in 1992 and Grenoble (France) in 1994. HPN'95 is the sixth event of the series sponsored by IFIP WG 6.4 and will be held at the Arxiduc Lluis Salvador building on the campus of the University of the Balearic Islands in Palma de Mallorca (Spain) from September 13 to 15.

High Performance Data Network Design Resource Allocation and Cross Layer Control in Wireless Networks presents abstract models that capture the cross layer interaction from the physical to transport layer in wireless network architectures including cellular, ad-hoc and sensor networks as well as hybrid wireless-wireline. The emphasis in the presentation is on describing the models and the algorithms with application examples that illustrate the range of possible applications. Representative cases are analyzed in full detail to illustrate the applicability of the analysis techniques, while in other cases the results are described without proofs and references to the literature are provided.

Parallel and Distributed Computation: Numerical Methods research monograph providing a synthesis of old research on the foundations of dynamic programming, with the modern theory of approximate dynamic programming and new research on semicontractive models. It aims at a unified and economical development of the core theory and algorithms of total cost sequential decision problems, based on the strong connections of the subject with fixed point theory. The analysis focuses on the abstract mapping that underlies dynamic programming and defines the mathematical character of the associated problem. The discussion centers on two fundamental properties that this mapping may have: monotonicity and (weighted sup-norm) contraction. It turns out that the nature of the analytical and algorithmic DP theory is determined primarily by the presence or absence of these two properties, and the rest of the problem's structure is largely inconsequential. New research is focused on two areas: 1) The ramifications of these properties in the context of algorithms for approximate dynamic programming, and 2) The new class of semicontractive models, exemplified by stochastic shortest path problems, where some but not all policies are contractive. The 2nd edition aims primarily to amplify the presentation of the semicontractive models of Chapter 3 and Chapter 4 of the first (2013) edition, and to supplement it with a broad spectrum of research results that I obtained and published in journals and reports since the first edition was written (see below). As a result, the size of this material more than doubled, and the size of the book increased by nearly 40%. The book is an excellent supplement to several of our books: Dynamic Programming and Optimal Control (Athena Scientific, 2017), and Neuro-Dynamic Programming (Athena Scientific, 1996).

Data Networks

Linear Network Optimization

Data Networks

This book describes, analyzes, and recommends traffic engineering (TE) and quality of service (QoS) optimization methods for integrated voice/data dynamic routing networks. These functions control a network's response to traffic demands and other stimuli, such as link failures or node failures. TE and QoS optimization is concerned with measurement, modeling, characterization, and control of network traffic, and the application of techniques to achieve specific performance objectives. The scope of the analysis and recommendations include dimensioning, call/flow and connection routing, QoS resource management, routing table management, dynamic transport routing, and operational requirements. Case studies are included which provide the reader with a concrete way into the technical details and highlight why and how to use the techniques
Abstract Dynamic Programming

Public Data Networks provide a comprehensive survey of PDNs, covering all major countries. PDNs allow efficient and cost-effective telecommunication between a terminal and computer, or between computers, regardless of who owns the data terminal. The authors discuss the current state of, and forthcoming developments in, data communications using public telecommunication facilities. Apart from the classical telecommunication networks (telegraph and telephone), public data networks provide the majority of data communication services worldwide. The range of data services and user facilities has gradually expanded, the quality of services improved, and new services have appeared (e.g., datafax, teletex, videotex, message handling and teleconferencing). The authors concentrate on PDN principles, taking account of the latest CCITT recommendations and ISO standards. Appendices and references provide detailed information for those working on PDNs at research, design an implementation level. Network digitalization and integration of networks and services have aided progress towards the integrated services digital network (ISDN). The ISDN uses advanced transmission and switching techniques to enhance the telecommunication services provided to its users. An ISDN has much in common with the PDN as far as architecture, methods of network management and functions are concerned, but there are distinct differences in the methods of access and signalling. The authors have extensive experience in data communication networking. Dr. Kubin is vice-chairman of Study Group IX of the International Telegraph and Telephone Consultative Committee (CCITT); Dr. Puzman is the Czechoslovak representative at Technical Commission 6 (TC-6) of the International Federation for Information Processing (IFIP). Public Data Networks is essential reading for researchers and designers of PDNs, in universities and industry, and provides important reference material for telecommunications and computer science students.

High Performance Networking

First detailed graduate-level textbook on multiuser detection, one of the most important areas in modern communications technology.

Data Communication Systems and Their Performance


Data Networks

A modern mathematical approach to the design of communication networks for graduate students, blending control, optimization, and stochastic network theories alongside a broad range of performance analysis tools. Practical applications are illustrated by making connections to network algorithms and protocols. End-of-chapter problems covering a range of difficulties support student learning.

Study Companion

This is a concise presentation of the concepts underlying the design of digital communication systems, without the detail that can overwhelm students. Many examples, from the basic to the cutting-edge, show how the theory is used in the design of modern systems and the relevance of this theory will motivate students. The theory is supported by practical algorithms so that the student can perform computations and simulations. Leading edge topics in coding and wireless communication make this an ideal text for students taking just one course on the subject. Fundamentals of Digital Communications has coverage of turbo and LDPC codes in sufficient detail and clarity to enable hands-on implementation and performance evaluation, as well as 'just enough' information theory to enable computation of performance benchmarks to compare them against. Other unique features include space-time communication and geometric insights into noncoherent communication and equalization.

Nonlinear Programming

Here are the refereed proceedings of the 5th International IFIP-TC6 Networking Conference, NETWORKING 2006. The 88 revised full papers and 31 poster papers are organized in topical sections on caching and content management, mobile ad-hoc networks, mobility/handoff, monitoring/measurements, multicast, multimedia, optical networks, peer-to-peer, resource management and QoS, routing, topology and location awareness, traffic engineering, transport protocols, wireless networks, and wireless sensor networks.

Network Games

Traditional network optimization focuses on a single control objective in a network populated by obedient users and limited dispersion of information. However, most of today's networks are large-scale with lack of access to centralized information, consist of users with diverse requirements, and are subject to dynamic changes. These factors naturally motivate a new distributed control paradigm, where the network infrastructure is kept simple and the network control functions are delegated to individual agents which make their decisions independently ("selfishly"). The interaction of multiple independent decision-makers necessitates the use of game
Data Networks A uniquely pedagogical, insightful, and rigorous treatment of the analytical/geometrical foundations of optimization. The book provides a comprehensive development of convexity theory, and its rich applications in optimization, including duality, minimax/saddle point theory, Lagrange multipliers, and Lagrangian relaxation/nondifferentiable optimization. It is an excellent supplement to several of our books: Convex Optimization Theory (Athena Scientific, 2009), Convex Optimization Algorithms (Athena Scientific, 2015), Nonlinear Programming (Athena Scientific, 2016), Network Optimization (Athena Scientific, 1998), and Introduction to Linear Optimization (Athena Scientific, 1997). Aside from a thorough account of convex analysis and optimization, the book aims to restructure the theory of the subject, by introducing several novel unifying lines of analysis, including: 1) A unified development of minimax theory and constrained optimization duality as special cases of duality between two simple geometrical problems. 2) A unified development of conditions for existence of solutions of convex optimization problems, conditions for the minimax equality to hold, and conditions for the absence of a duality gap in constrained optimization. 3) A unification of the major constraint qualifications allowing the use of Lagrange multipliers for nonconvex constrained optimization, using the notion of constraint pseudonormality and an enhanced form of the Fritz John necessary optimality conditions. Among its features the book: a) Develops rigorously and comprehensively the theory of convex sets and functions, in the classical tradition of Fenchel and Rockafellar b) Provides a geometric, highly visual treatment of convex and nonconvex optimization problems, including existence of solutions, optimality conditions, Lagrange multipliers, and duality c) Includes an insightful and comprehensive presentation of minimax theory and zero sum games, and its connection with duality d) Describes dual optimization, the associated computational methods, including the novel incremental subgradient methods, and applications in linear, quadratic, and integer programming e) Contains many examples, illustrations, and exercises with complete solutions (about 200 pages) posted at the publisher’s web site http://www.athenasc.com/convexity.html

Network Science, Nonlinear Science and Infrastructure Systems Provides the fundamental principles and practical tools needed to design next-generation wireless networks that are both energy- and spectrum-efficient.