

John S. Baras - George Theodorakopoulos

Path Problems in Networks



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Konstantinos Poularakis, Leandros Tassiulas, T.V. Lakshman

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Path Problems in Networks John S. Baras, George Theodorakopoulos, 2009-10-15 The algebraic path problem is a generalization of the shortest path problem in graphs Various instances of this abstract problem have appeared in the literature and similar solutions have been independently discovered and rediscovered. The repeated appearance of a problem is evidence of its relevance This book aims to help current and future researchers add this powerful tool to their arsenal so that they can easily identify and use it in their own work Path problems in networks can be conceptually divided into two parts A distillation of the extensive theory behind the algebraic path problem and an exposition of a broad range of applications First of all the shortest path problem is presented so as to fix terminology and concepts existence and uniqueness of solutions robustness to parameter changes and centralized and distributed computation algorithms Then these concepts are generalized to the algebraic context of semirings Methods for creating new semirings useful for modeling new problems are provided A large part of the book is then devoted to numerous applications of the algebraic path problem ranging from mobile network routing to BGP routing to social networks These applications show what kind of problems can be modeled as algebraic path problems they also serve as examples on how to go about modeling new problems This monograph will be useful to network researchers engineers and graduate students It can be used either as an introduction to the topic or as a quick reference to the theoretical facts algorithms and application examples The theoretical background assumed for the reader is that of a graduate or advanced undergraduate student in computer science or engineering Some familiarity with algebra and algorithms is helpful but not necessary Algebra in particular is used as a convenient and concise language to describe problems that are essentially combinatorial Table of Contents Classical Shortest Path The Algebraic Path Problem Properties and Computation of Solutions Applications Related Areas List of Semirings and Applications

Path Problems in Networks John Baras, George Theodorakopoulos, 2022-06-01 The algebraic path problem is a generalization of the shortest path problem in graphs Various instances of this abstract problem have appeared in the literature and similar solutions have been independently discovered and rediscovered The repeated appearance of a problem is evidence of its relevance This book aims to help current and future researchers add this powerful tool to their arsenal so that they can easily identify and use it in their own work Path problems in networks can be conceptually divided into two parts A distillation of the extensive theory behind the algebraic path problem and an exposition of a broad range of applications First of all the shortest path problem is presented so as to fix terminology and concepts existence and uniqueness of solutions robustness to parameter changes and centralized and distributed computation algorithms Then these concepts are generalized to the algebraic context of semirings Methods for creating new semirings useful for modeling new problems are provided A large part of the book is then devoted to numerous applications of the algebraic path problem ranging from mobile network routing to BGP routing to social networks These applications show what kind of problems can

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Scheduling and Congestion Control for Wireless and Processing Networks Libin Jiang, Jean Walrand, 2022-06-01 In this book we consider the problem of achieving the maximum throughput and utility in a class of networks with resource sharing constraints This is a classical problem of great importance In the context of wireless networks we first propose a fully distributed scheduling algorithm that achieves the maximum throughput Inspired by CSMA Carrier Sense Multiple Access which is widely deployed in today s wireless networks our algorithm is simple asynchronous and easy to implement Second using a novel maximal entropy technique we combine the CSMA scheduling algorithm with congestion control to approach the maximum utility Also we further show that CSMA scheduling is a modular MAC layer algorithm that can work with other protocols in the transport layer and network layer Third for wireless networks where packet collisions are unavoidable we establish a general analytical model and extend the above algorithms to that case Stochastic Processing Networks SPNs model manufacturing communication and service systems In manufacturing networks for example tasks require parts and resources to produce other parts SPNs are more general than queueing networks and pose novel challenges to throughput optimum scheduling We proposes a deficit maximum weight DMW algorithm to achieve throughput optimality and maximize the net utility of the production in SPNs Table of Contents Introduction Overview Scheduling in Wireless Networks Utility Maximization in Wireless Networks Distributed CSMA Scheduling with Collisions Stochastic Processing networks

Performance Modeling of Communication Networks with Markov Chains Jeonghoon Mo,2022-05-31 This book is an introduction to Markov chain modeling with applications to communication networks It begins with a general introduction to performance modeling in Chapter 1 where we introduce different performance models We then introduce basic ideas of Markov chain modeling Markov property discrete time Markov chain DTMC and continuous time Markov chain CTMC We also discuss how to find the steady state distributions from these Markov chains and how they can be used to compute the system performance metric The solution methodologies include a balance equation technique limiting probability technique and the uniformization We try to minimize the theoretical aspects of the Markov chain so that the book is easily accessible to readers without deep mathematical backgrounds We then introduce how to develop a Markov chain model with simple applications a forwarding system a cellular system blocking slotted ALOHA Wi Fi model and multichannel based LAN model

The examples cover CTMC DTMC birth death process and non birth death process We then introduce more difficult examples in Chapter 4 which are related to wireless LAN networks the Bianchi model and Multi Channel MAC model with fixed duration These models are more advanced than those introduced in Chapter 3 because they require more advanced concepts such as renewal reward theorem and the queueing network model We introduce these concepts in the appendix as needed so that readers can follow them without difficulty We hope that this textbook will be helpful to students researchers and network practitioners who want to understand and use mathematical modeling techniques Table of Contents Performance Modeling Markov Chain Models

Network Connectivity Chen Chen, Hanghang Tong, 2022-01-26 Networks naturally appear in many high impact domains ranging from social network analysis to disease dissemination studies to infrastructure system design Within network studies network connectivity plays an important role in a myriad of applications. The diversity of application areas has spurred numerous connectivity measures each designed for some specific tasks Depending on the complexity of connectivity measures the computational cost of calculating the connectivity score can vary significantly Moreover the complexity of the connectivity would predominantly affect the hardness of connectivity optimization which is a fundamental problem for network connectivity studies This book presents a thorough study in network connectivity including its concepts computation and optimization Specifically a unified connectivity measure model will be introduced to unveil the commonality among existing connectivity measures For the connectivity computation aspect the authors introduce the connectivity tracking problems and present several effective connectivity inference frameworks under different network settings Taking the connectivity optimization perspective the book analyzes the problem theoretically and introduces an approximation framework to effectively optimize the network connectivity Lastly the book discusses the new research frontiers and directions to explore for network connectivity studies This book is an accessible introduction to the study of connectivity in complex networks It is essential reading for advanced undergraduates Ph D students as well as researchers and practitioners who are interested in graph mining data mining and machine learning **Modeling and Optimization in** Software-Defined Networks Konstantinos Poularakis, Leandros Tassiulas, T.V. Lakshman, 2022-06-01 This book provides a quick reference and insights into modeling and optimization of software defined networks SDNs It covers various algorithms and approaches that have been developed for optimizations related to the control plane the considerable research related to data plane optimization and topics that have significant potential for research and advances to the state of the art in SDN Over the past ten years network programmability has transitioned from research concepts to more mainstream technology through the advent of technologies amenable to programmability such as service chaining virtual network functions and programmability of the data plane However the rapid development in SDN technologies has been the key driver behind its evolution The logically centralized abstraction of network states enabled by SDN facilitates programmability and use of

sophisticated optimization and control algorithms for enhancing network performance policy management and security Furthermore the centralized aggregation of network telemetry facilitates use of data driven machine learning based methods To fully unleash the power of this new SDN paradigm though various architectural design deployment and operations questions need to be addressed Associated with these are various modeling resource allocation and optimization opportunities The book covers these opportunities and associated challenges which represent a call to arms for the SDN community to develop new modeling and optimization methods that will complement or improve on the current norms

Wireless Network Pricing Jianwei Huang, Lin Gao, 2022-06-01 Today s wireless communications and networking practices are tightly coupled with economic considerations to the extent that it is almost impossible to make a sound technology choice without understanding the corresponding economic implications. This book aims at providing a foundational introduction on how microeconomics and pricing theory in particular can help us to understand and build better wireless networks The book can be used as lecture notes for a course in the field of network economics or a reference book for wireless engineers and applied economists to understand how pricing mechanisms influence the fast growing modern wireless industry This book first covers the basics of wireless communication technologies and microeconomics before going in depth about several pricing models and their wireless applications. The pricing models include social optimal pricing monopoly pricing price differentiation oligopoly pricing and network externalities supported by introductory discussions of convex optimization and game theory The wireless applications include wireless video streaming service provider competitions cellular usage based pricing network partial price differentiation wireless spectrum leasing distributed power control and cellular technology upgrade More information related to the book including references slides and videos can be found at ncel ie cuhk edu hk Sharing Network Resources Abhey Parekh, Jean Walrand, 2022-06-01 Resource content wireless network pricing Allocation lies at the heart of network control In the early days of the Internet the scarcest resource was bandwidth but as the network has evolved to become an essential utility in the lives of billions the nature of the resource allocation problem has changed This book attempts to describe the facets of resource allocation that are most relevant to modern networks It is targeted at graduate students and researchers who have an introductory background in networking and who desire to internalize core concepts before designing new protocols and applications We start from the fundamental question what problem does network resource allocation solve This leads us in Chapter 1 to examine what it means to satisfy a set of user applications that have different requirements of the network and to problems in Social Choice Theory We find that while capturing these preferences in terms of utility is clean and rigorous there are significant limitations to this choice Chapter 2 focuses on sharing divisible resources such as links and spectrum Both of these resources are somewhat atypical a link is most accurately modeled as a gueue in our context but this leads to the analytical intractability of gueueing theory and spectrum allocation methods involve dealing with interference a poorly understood phenomenon Chapters 3 and 4 are

introductions to two allocation workhorses auctions and matching In these chapters we allow the users to game the system i e to be strategic but don't allow them to collude In Chapter 5 we relax this restriction and focus on collaboration Finally in Chapter 6 we discuss the theoretical yet fundamental issue of stability Here our contribution is mostly on making a mathematically abstruse subdiscipline more accessible without losing too much generality A Primer on Physical-Layer Network Coding Soung Chang Liew, Lu Lu, Shengli Zhang, 2022-05-31 The concept of physical layer network coding PNC was proposed in 2006 for application in wireless networks Since then it has developed into a subfield of communications and networking with a wide following This book is a primer on PNC It is the outcome of a set of lecture notes for a course for beginning graduate students at The Chinese University of Hong Kong The target audience is expected to have some prior background knowledge in communication theory and wireless communications but not working knowledge at the research level Indeed a goal of this book course is to allow the reader to gain a deeper appreciation of the various nuances of wireless communications and networking by focusing on problems arising from the study of PNC Specifically we introduce the tools and techniques needed to solve problems in PNC and many of these tools and techniques are drawn from the more general disciplines of signal processing communications and networking PNC is used as a pivot to learn about the fundamentals of signal processing techniques and wireless communications in general We feel that such a problem centric approach will give the reader a more in depth understanding of these disciplines and allow him her to see first hand how the techniques of these disciplines can be applied to solve real research problems As a primer this book does not cover many advanced materials related to PNC PNC is an active research field and many new results will no doubt be forthcoming in the near future We believe that this book will provide a good contextual framework for the interpretation of these advanced results should the reader decide to probe further into the field of PNC An Introduction to Models of Online Peer-to-Peer Social **Networking** George Kesidis, 2022-06-01 This book concerns peer to peer applications and mechanisms operating on the Internet particularly those that are not fully automated and involve significant human interaction. So the realm of interest is the intersection of distributed systems and online social networking Generally simple models are described to clarify the ideas Beginning with short overviews of caching graph theory and game theory we cover the basic ideas of structured and unstructured search We then describe a simple framework for reputations and for iterated referrals and consensus This framework is applied to a problem of sybil identity management The fundamental result for iterated Byzantine consensus for a relatively important issue is also given Finally a straight forward epidemic model is used to describe the propagation of malware on line and for BitTorrent style file sharing This short book can be used as a preliminary orientation to this subject matter References are given for the interested student to papers with good survey and tutorial content and to those with more advanced treatments of specific topics For an instructor this book is suitable for a one semester seminar course Alternatively it could be the framework for a semester s worth of lectures where the instructor would supplement each

chapter with additional lectures on related or more advanced subject matter A basic background is required in the areas of computer networking probability theory stochastic processes and queueing Table of Contents Networking overview Graphs Games Search in structured networks Search in unstructured networks Transactions reputations and referrals False Referrals Peer to peer file sharing Consensus in dynamical belief systems Byzantine consensus Epidemics

Path Problems In Networks George Theodorakopoulos: Bestsellers in 2023 The year 2023 has witnessed a noteworthy surge in literary brilliance, with numerous compelling novels captivating the hearts of readers worldwide. Lets delve into the realm of top-selling books, exploring the captivating narratives that have enthralled audiences this year. The Must-Read: Colleen Hoovers "It Ends with Us" This touching tale of love, loss, and resilience has captivated readers with its raw and emotional exploration of domestic abuse. Hoover expertly weaves a story of hope and healing, reminding us that even in the darkest of times, the human spirit can prevail. Uncover the Best: Taylor Jenkins Reids "The Seven Husbands of Evelyn Hugo" This captivating historical fiction novel unravels the life of Evelyn Hugo, a Hollywood icon who defies expectations and societal norms to pursue her dreams. Reids captivating storytelling and compelling characters transport readers to a bygone era, immersing them in a world of glamour, ambition, and self-discovery. Discover the Magic: Delia Owens "Where the Crawdads Sing" This mesmerizing coming-of-age story follows Kya Clark, a young woman who grows up alone in the marshes of North Carolina. Owens weaves a tale of resilience, survival, and the transformative power of nature, captivating readers with its evocative prose and mesmerizing setting. These bestselling novels represent just a fraction of the literary treasures that have emerged in 2023. Whether you seek tales of romance, adventure, or personal growth, the world of literature offers an abundance of compelling stories waiting to be discovered. The novel begins with Richard Papen, a bright but troubled young man, arriving at Hampden College. Richard is immediately drawn to the group of students who call themselves the Classics Club. The club is led by Henry Winter, a brilliant and charismatic young man. Henry is obsessed with Greek mythology and philosophy, and he quickly draws Richard into his world. The other members of the Classics Club are equally as fascinating. Bunny Corcoran is a wealthy and spoiled young man who is always looking for a good time. Charles Tavis is a guiet and reserved young man who is deeply in love with Henry. Camilla Macaulay is a beautiful and intelligent young woman who is drawn to the power and danger of the Classics Club. The students are all deeply in love with Morrow, and they are willing to do anything to please him. Morrow is a complex and mysterious figure, and he seems to be manipulating the students for his own purposes. As the students become more involved with Morrow, they begin to commit increasingly dangerous acts. The Secret History is a masterful and gripping novel that will keep you speculating until the very end. The novel is a cautionary tale about the dangers of obsession and the power of evil.

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