SYSTEM MODELING AND ANALYSIS: FOUNDATIONS OF SYSTEM PERFORMANCE EVALUATION

HISASHI KOBAYASHI, BRIAN L. MARK, PEARSON EDUCATION, INC., 2009, ISBN 10: 0-13-129355-9, ISBN 13: 978-0-13-129355-7, 782 PAGES

REVIEWER: ZDZISLAW PAPIR

The monograph begins with an Introduction chapter providing a general discussion of such ideas like modeling approaches (hierarchical, analytic, simulation, measurement and empirical models) and measures used in performance evaluation of telecommunication networks. To attract the readership the authors present several elaborated case studies — both classical as well more up to date — like cellular networks, data exchange protocols under window flow control, call blocking, multiplexer models, Web server systems, local area networks, and Internet traffic characterization. The section 'Performance Measures' should include more details and more figures on network performance requirements that are imposed by different applications.

The rest of the monograph has been split into four parts: Part I: Basic Queueing and Loss Models; Part II: Queueing and Loss Networks; Part III: Advanced Queueing Models; and Part IV: Simulation Modeling and Analysis. The section 'Bibliography,' being common for all the book, contains almost 600 positions. Note, however, that each chapter of the book, in addition to some examples to be solved, provides discussion issues accompanied by hints for further reading.

Part I: Basic Queueing and Loss Models is devoted to the queueing models well known from other network performance cookbooks. However, some interesting 'spices' can be identified easily. The main 'mail' includes birth-and-death processes and queueing models, Little's formula, both Erlang and Engset loss models, and two last sections presenting mainly M/G/1 models with different scheduling disciplines (IS, LCFS-PR, and PS).

What differentiates this text from many others is a discussion of discrete- and continuous time traffic models (including long-range dependence, continued in Chapter 12), generalizations of Little's theorem, some convenient formulas for efficient computation of Erlang's and Engset's formula, dimensioning curves, and the insensitivity property.

Part II: Queueing and Loss Networks consists of three chapters. Chapter 6, 'Queueing Networks,' presents both open and closed Jackson networks with exponential servers. Product form solutions are being generalized to multiple routing chains and finally to BCMP networks (open and closed chains mixed, different classes of customers, different aggregation levels of network state information). Chapter 7, 'Loss Networks and Generalized Loss Models.' deals with the concept of loss networks being a mesh of interconnected Erlang/Engset loss stations (allowing for different classes of customers) that is useful when modeling circuit-switched networks carrying multirate traffic. The last section of the chapter shows that it is possible to integrate loss and queueing networks into a single system while retaining a product form solution. A state space for networks of whichever type grows rapidly, so calculation of QoS parameters is possible with special algorithms. This idea is presented in Chapter 8, 'Computational Algorithms for Product-Form Networks.'

Part III: Advanced Queueing Models is a container for different and important queueing models which did not find their place in previous chapters. Chapter 9, 'Conservation Laws, Priority Queues, and Polling Models,' does not require any further presentation as its title is self-explanatory. Chapter 10, 'Phase-Type Process and Matrix-Geometric Method,' extends multistage processes (Cox distributions) to phase-type processes (PH) allowing customers to walk freely over all the process stages. The well known examples of such processes are the MMPP and the IPP. PH models of either interarrival or service times are not sufficient to solve a PH/PH/1 queue. Behavior of such queues is described by quasi-birth-death processes that can be solved by a matrix-geometric approach. Foundations for Chapter 11, 'Discrete-Time Queues,' are laid down by an observation that in many telecommunication systems both arrivals and departures can occur at discrete epochs of time. The geometric (Bernoulli) distribution is useful when trying to meet with such a restriction.

Chapter 12, 'Traffic Modeling,' involves must-read content devoted to traffic characterization for network performance analysis with special attention paid to second-order properties. The authors start with Markovian arrival processes that include several Markovian processes such as Poisson process, the MMPP, and the BMAP. Of course, the authors do treat concepts of long-range dependent and self-similar traffic which have gained much attention in recent years.

Now let's inspect the next two chapters, Chapter 13, 'Fluid Models' and Chapter 14, 'Approximation and Bounding Techniques.' The idea behind both of them is that often in the performance evaluation practice it is not recommended to use exact and complicated solutions in favor of simple, albeit approximate, solutions. Fluid models describe discrete counting arrival and departure processes as continuous variables. Their complexity, however, depends on whether they have to capture only first-order properties (average values, Chapter 13) or second-order properties (deviations from mean, Chapter 14).

Chapter 15, 'Time-Dependent Solutions of Queues,' shows how the probability generating function and the spectral expansion method together with the Laplace transform can help us in searching for a nonstationary behavior of the continuous-time Markov chain model (the birth-and-death process). The last chapter, however, presents a time-dependent solution of a fluid flow model.

If the models presented up to here are not sufficient to satisfactorily answer our performance problems, then we must look for a last resort in simulation techniques, which the authors treat in Part IV: Simulation Modeling and Analysis. The matters related are extensive, so in Chapter 16, 'Formulation and Implementation of Simulation Models,' the authors focus on some selected issues such as the comparison of a self-driven and a trace-driven simulation, sample implementation of simulators, and generating random variables. Chapter 17, 'Simulation Experiments and Statistical Data Analysis,' is devoted to the last three phases of each solid simulation experiment, namely, design of an experiment, validation of a model, and analysis of simulation data. The two last sections of the chapter discuss selected techniques for improving simulation efficiency and accelerating when rare events are considered to play a crucial role.

I am convinced that this monograph will grip the reader as it touches a broad spectrum of queueing models, presents them in an ascending manner and, last but not least, provides valuable discussion points and directions for further reading.

NETWORK SCIENCE: THEORY AND APPLICATIONS

TED G. LEWIS, JOHN WILEY & SONS, INC., HOBOKEN, NJ, 2009, ISBN 978-0-470-33188-0, HARDCOVER, 512 PAGES

REVIEWER: PIOTR CHOLDA

Researchers interested in the theoretical evaluation of different network architectures and behavioral phenomena will gain from reading this book. Network science can be understood as

(Continued on page 16)

(Continued from page 14)

a mathematics- (mainly graph-) based description of existing interactions. As such, it is obviously of interest for Internet and computer science people.

Except for the Preface, reference list, index, and the author's biography, it consists of thirteen chapters, that are divided according to the book title into two parts, the first one (including six first chapters) being of rather general, introductory character, and the second one presenting advanced theory with its possible applications. Hence, the opening Chapter 1 gives mainly basic data on the history of network science research, along with a definition of its subject. As the main fundamental modeling knowledge relevant for the topic is related to the graph theory, Chapter 2 presents basic notions and achievements of this branch of mathematics. Some interesting topologies (e.g., random, regular graphs, scale-free or small-world topologies) are given therein, as well as listings of graph representation classes in Java software. The next three chapters focus on the main graph structures most frequently used to describe existing networks, characterizing them in detail and surveying their features and relevant algorithms (e.g., for finding a diameter, the shortest path, etc.). Regular, random, and scale-free networks and their variants are covered in detail. Again, Java classes are presented as examples of different procedure realization. The application part starts with a chapter on emergence, then Chapter 8 deals with epidemics models. Next, dynamic properties of networks are covered in Chapter 9, i.e., synchrony, chaos, and stability to give a few buzzwords. Chapter 10 elaborates on influence networks that are of an utmost interest for social scientists. Chapter 11 overviews the usage of the network science for modeling of risk and resilience, exemplified mainly by security issues, but also applicable to fault-tolerance. Chapter 12 is interesting for economy specialists as it presents netgain property modeling. The last chapter gives different applications of network science in biology.

I think the application related chapters content is strongly influenced by the author's interests and research experience. Thus, we will not find many examples addressing Internet or peer-to-peer structure therein. This might be perceived as a drawback, but on the other hand it is nowhere said that the book is aimed at networking readers. Nevertheless, I recommend this book to them, although they will not be able to find easy receipts for their problems. Where I see a gain for them is in the broad group of relevant topics covered deeply, and a fluent and clear writing. The presentation is kept quite formal due to its overwhelming mathematical content, but many examples make the presented definitions and theorems more understandable. Moreover, the abovementioned inclusion of software code makes the presented concepts more approachable for engineers, and additionally provides easy to modify material to be used just after reading the book. Except for readers mentioned at the beginning of this review, the work can also be recommended to computer science or networking undergraduates, Ph.D. students, or just laymen that need to get acquainted with such a complex body of knowledge. Apparently having them in mind, the author prepared a set of exercises at the end of almost all the chapters.

POWER LINE COMMUNICATIONS IN PRACTICE

XAVIER CARCELLE, ARTECH HOUSE, 2009, ISBN-13: 978-1-59693-335-4, HARDCOVER, 343 PAGES

REVIEWER: LUKASZ ZBYDNIEWSKI

Power line communications (PLC) is an interesting technology that makes use of electric power delivery systems for telecommunication purposes. The book *Power Line Communication in Practice,* written by X. Carcelle, provides a comprehensive look at the theory and practice of the high-speed PLC transmission.

The book is divided into two parts dealing with theoretical as well as practical aspects of this technology. Four chapters of the first part and eight chapters belonging to the second part are preceded by a very good introduction to PLC in which a brief history and standardization effort made by various standardizations bodies are presented.

Part I, entitled PLC Theory, presents a theoretical overview of PLC technology, concentrating mainly on the family of the HomePlug specifications. Four consecutive chapters describe, respectively, the architecture of the system; its functionality; security aspects; and finally, the frame formats. The overall architecture of PLC networks is presented from the perspective of the electrical network and shared medium. The reader is acquainted with physical and data link layers covering such aspects of PLC transmission as attenuations, coupling of devices, frequency response, and interface sensitivity. The PLC architecture is described also as public and private networks presented through the analogy to a network bus. Chapter 3 concentrates on the main four PLC functionalities: network mode; PLC frame management mode; medium access technique; and quality of service. Special attention is paid to the MAC layer, presenting well known protocols from wired and wireless technologies that have been adapted to the specific PLC environment. Chapter 4 deals with the security issue, presenting first a short introduction to the main terminology and mechanisms connected with cryptography such as symmetric and asymmetric key encryption. The remaining part of this chapter specifies security issues related to PLC networks. In particular, improvement to the IEEE 802.1x authentication architecture is discussed. Finally, in Chapter 5 the author describes physical layer frames for HomePlug 1.0 and new HomePlug AV standards. A comparison between HomePlug 1.0 and 802.11b is also presented.

Part II, entitled PLC in Practice, concentrates on possible practical applications using devices existing on the market. Chapter 6 presents various applications of PLC technology. One can find here many propositions of utilization, starting from multimedia, though local networks, finishing with very specific applications such as industrial, public, or automotive. Detailed discussion about each application is performed specifying its requirements with connection to parameters offered by HomePlug's family devices. Chapters 7, 8, and 9, respectively, describe equipment available on the market, its optimal installation issue, and configuration of various devices for popular operating systems. In the three next chapters, some examples of the installation and configuration of devices are discussed in the cases of in-home, industrial, and public environments, which usually have different network requirements. In each case, the author provided a comparison of different technologies from the perspective of offered services. Examples of configurations are discussed, including also a case study implementation of PLC in a hotel. An overview of providing Internet access using a PLC technology for small, medium, and large networks is also introduced. The last chapter deals with coexistence between different network technologies.

The book is a very good starting point for everyone who wants to familiarize themselves with the theoretical aspects of a PLC transmission, and who wants to use PLC devices existing on the market. Before this book, there were no good sources of information for potential customers who are interested in utilization of PLC in their applications. I strongly recommend this book, which gives a high quality insight into this still evolving and developing technology.

ADAPTIVE FILTERING: ALGORITHMS AND PRACTICAL IMPLEMENTATION, THIRD EDITION

BY PAULO S.R. DINIZ, SPRINGER, NEW YORK 2008, XXIV, 656 PAGES, HARDCOVER, ISBN: 978-0-387-31274-3

REVIEWER: TOKUNBO OGUNFUNMI

The book titled "Adaptive Filtering: Algorithms and Practical Implementation," Third Edition, by Paulo S.R. Diniz replaces two previous editions. This new edition has improved significantly upon those two editions.

At Santa Clara University, we offer a two-course sequence on Adaptive Signal Processing. The first course covers algorithms such as Least Mean Square (LMS), Recursive Least Squares (RLS), and algorithms for IIR structure of adaptive filters. The second covers primarily Linear Prediction, Basis for Fast Algorithms, Various Fast Algorithms (e.g., based on Tranversal, Lattice, QR, Inverse QR), Kalman filters, Constant Modulus Algorithm (CMA), and Nonlinear Adaptive Filtering. The book by Diniz covers most of these course topics. It presented most of the algorithms in a unified format. It added new coverage of topics such as IIR adaptive filters, CMA blind adaptive filters, data-selective adaptive filtering algorithms, adaptive lattice-based RLS filters, and sub-band adaptive filters.

Another good feature of the book is the use of MATLAB to perform simulations in order to explain important ideas and example applications of the algorithms. The book is also very practical. To attest to its suitability as a teaching text, the author has given a number of carefully developed examples which are useful to explain nuances of Wiener filters, LMS, RLS, and other algorithms to students. In addition, there are many examples throughout the book and many end-of-chapter problems. There are four appendices on Complex Differentiation, Quantization effects in LMS and RLS algorithms and on Kalman filters. These add some value to the book.

The book offers brief introductions to Kalman filters and nonlinear adaptive filters. I believe it is a right mix of background behind the algorithms and depth of exposition of algorithms. The number of pages devoted to the topics in each chapter is neither too low nor too high. Its coverage of the other areas is not exhaustive but enough and suitable as a teaching text.

Chapter 1 provides a general introduction and relates the topic to optimization theory using a general framework of an objective function. The objective function must satisfy the non-negativity and optimality criteria to be consistent. Various algorithms are illustrated using variants of the objective function.

Chapter 2 deals with fundamentals of adaptive filtering covering signal representation, random signals, ergodicity, correlation matrix properties, and Wiener filters. The generalized constrained Wiener filter and the generalized sidelobe canceller are used to introduce the concept of constrained adaptive filtering and the use of Lagrange multipliers technique. The Mean Square Error surface was illustrated for the Wiener filter. The Newton's algorithm and Steepest Descent algorithm are introduced and studied well in this chapter.

The classical LMS algorithm was introduced and studied extensively in Chapter 3. The author separates the real LMS and complex LMS derivations for simplicity. Properties of the LMS algorithm, including gradient behavior, convergence behavior of the coefficient vector, coefficient-error-vector covariance matrix, behavior of the error signal, minimum Mean-Square Error, excess Mean-Square Error and misadjustment are presented quite well.

Another example of the distinguishing features of the book is the treatment of quantized and signed LMS algorithms. Chapter 4 deals with such LMS-based algorithms and others like the LMS-Newton Algorithm, the normalized LMS algorithm, the transform-domain LMS algorithm, and the real and complex Affine Projection Algorithms. These algorithms are analyzed for misadjustment, transient analysis and behavior in non-stationary environments.

The RLS algorithm is covered in Chapter 5 where the author adds some sections describing the relation between least squares and Wiener solutions and the influence of the deterministic autocorrelation initialization on the algorithm. Again, the real and complex versions of the algorithm were presented separately. The algorithm is analyzed for misadjustment, transient analysis and behavior in non-stationary environments

Chapter 6 is devoted to the relatively new area of data-selective adaptive filtering. Variations of normalized the LMS, Affine Projection and bi-normalized LMS algorithms based on Set-Membership principle are presented here.

Chapter 7 deals with the topic of adaptive lattice-based RLS algorithms. This is the first of the three chapters devoted to fast adaptive algorithms. The other two chapters are on fast Transversal filters and QR-RLS adaptive filters. One of the things I like about this chapter is the discussion of both the Lattice RLS algorithm based on a priori errors and that based on posteriori errors. Other useful topics are the error-feedback Lattice RLS algorithm and quantization effects of the algorithm.

Chapter 8 discusses the Fast Transversal RLS algorithm. The performance of this algorithm was later improved by stabilization to reduce the effect of the growth of numerical errors.

QR-RLS adaptive filters are discussed in Chapter 9. However, this discussion is incomplete because it does not mention the Inverse QR methods that have been developed in the literature as well.

In Chapter 10 the author presents a well-written introduction to the topic of IIR Adaptive Filters. The output-error and equation error methods are discussed and differentiated. The algorithms used for adapting the coefficients of an IIR adaptive filter presented here include the RLS, Gauss-Newton, and other gradient-based algorithms. Alternative structures such as cascade form, lattice structure, parallel form, and frequency-domain parallel structures for IIR adaptive filters are covered. The coverage of the Stieglitz-McBride method completes the treatment of IIR filters in this chapter.

Chapter 11 is focused on nonlinear adaptive filters. The LMS and RLS adaptive algorithms for Volterra filters are presented. Coverage of adaptive bilinear filters, the multilayer perceptron algorithm, and the radial basis function algorithm rounds up this chapter. One weakness of the book is superficial coverage of the topic of nonlinear adaptive filters.

Chapter 12 covers the topic of subband adaptive filters. It is a well-written chapter. It begins with multi-rate systems and filter banks, then moves on to subband adaptive filters, cross-filter elimination, sub-band adaptive filters, and finally frequency-domain adaptive filtering.

CMA Adaptive filtering and blind adaptive filter algorithmic concepts are covered in the last chapter. Topics covered include the CMA algorithm, Godard algorithm, Sato algorithm, affine projection constant modulus algorithm, blind single-input multiple-output (SIMO) equalizers, and SIMO-CMA equalizers.

However, it is difficult to strike a good balance in coverage and do a good job of it, especially in a rapidly expanding subject area such as adaptive signal processing. I believe the author has successfully done that. Overall, the book is excellent for teaching the subject of adaptive signal processing and enhances the landscape of textbooks on the subject.