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Book Selection

Edited by J Crocker

Queueing Networks: Customers, Signals and Product Form Solutions

X Chao, M Miyazawa and M Pinedo

John Wiley, July 1999. xii + 445 pp. £65.00.
ISBN: 0-471-98309-8

Queueing network models are used in industry and elsewhere to investigate the properties of computer, communication, manufacturing and logistic systems. However, the ability of such models to represent faithfully the essential characteristics of real systems is still quite limited, and so basic research in this field is an important ongoing activity. This book describes developments over the last ten years in an important branch of queueing network research, in which the authors have made significant contributions. This research, and the book itself, are largely theoretical in nature.

How does this book differ from other books on queueing networks? The answer lies in the sub-title: *Customers, Signals and Product Form Solutions.* A *signal* is an entity which, upon arrival at a queue, may change the state of the queue and may trigger an immediate departure, ie a signal can cause instantaneous movements within the network. A scenario which the authors use to illustrate this concept, and to which they return several times in the book, is the (quaintly American) 'bathroom problem'. In a park, there is a men's room and a ladies' room, referred to as node 1 and node 2, respectively. Individual men arrive at node 1 and individual women arrive at node 2 as conventional customers. In addition, couples consisting of a man and a woman also arrive, and each couple is modelled using a *positive signal.* Each signal adds one customer to node 1, immediately departs for node 2 as a positive signal, adds one customer there, and then leaves the network. In this way, the arriving couple 'splits' into two separate customers in the two queues. We can also remark, in passing, that the bathroom problem exemplifies a general principle of OR modelling—that the complexity of a mathematical model can be of a quite different order from that of the human or social process being modelled!

In addition, *negative signals* are also possible; the arrival of such a signal at a queue decreases the number of customers in the queue by one and then causes an immediate departure. Another feature that can be modelled using signals is *cause-dependent feedback.* Consider a quality control station in a flexible manufacturing system, in which each job has its own route through the system and the final stage is a quality control station. Suppose that a job being checked at this station has to be scrapped, and the cause is such that several other jobs in the system having a similar history also need to be scrapped. This situation cannot be handled by conventional queueing networks, but it can be modelled using *signals with feedback* which can remove all the offending jobs from the network.

Throughout the book, the authors concentrate primarily on networks which possess a *product-form* stationary distribution. This property is also important in conventional queueing networks. In such networks, the joint distribution of all the nodes in the network is the product of the marginal distributions of the individual nodes. The product-form property, when it is applicable, simplifies the analysis considerably. Another important concept discussed in the book is that of *quasi-reversibility*, which is the main approach used in the book for proving the existence of product-form stationary distributions. However, quasi-reversibility is not a necessary condition for a product-form solution. The authors give a general procedure to check whether a network has a product-form solution and to compute the solution when it exists.

It is difficult, in a brief review, to do justice to the breadth of material covered in this book. There are twelve lengthy chapters and each is packed with detailed mathematical analysis. The chapter headings are: 1 Introduction; 2 Fundamentals; 3 Quasi-reversibility; 4 Networks of Quasi-reversible Queues; 5 Networks with Exponential Service

Times; 6 Multiple Customer Classes and Arbitrary Service Times; 7 Networks with Batch Services and Negative Signals; 8 Batch Arrivals, Batch Services and Concurrent Movements; 9 State-dependent and History-dependent Transitions; 10 Local Balance Revisited; 11 Characterisation of Product Form and Stability Issues; and 12 Discrete Time Queues. There are also three short appendices covering some basic mathematical topics.

Although the material is of an advanced, theoretical nature, the authors have done a good job in making it accessible to the motivated reader. Complete proofs are given for all the major theorems discussed, and each chapter has a few simple examples, usually non-numerical in nature, to illustrate the ideas and suggest possible application areas. Many of the theorems involving signals can also be seen to be generalisations of corresponding results for conventional queueing networks. Each chapter rounds off with some notes on the references and some exercises for the reader. The address of an associated web site is given in the Preface; this has a short list of typographical errors and, when the site is complete, hints to the exercises and related material for instructors have been promised. My only minor criticism of the book is that the authors have not provided a glossary of mathematical symbols, which I would have found helpful.

Who should read this book? It is definitely not for the casual reader. The authors state that the book is suitable for Masters and PhD students in Engineering. Operations Research, and Probability and Statistics. It is clearly an essential reference source for students and researchers who wish to undertake projects or research in the area of queueing networks. However, if the reader wishes to study only conventional queueing network models, not involving signals, there are other books that would probably be more suitable (eg Walrand[1]). The authors state that students should have followed a prior course in stochastic processes. I would like to suggest that a prior course in basic queueing theory, preferably including an introduction to conventional queueing networks, would also be desirable for many students.

The research described in this book is likely to have a major impact on the future development of queueing-network methodology. It should stimulate further research in a number of areas including, one hopes, the development of efficient numerical algorithms and computer packages for the practical implementation of the methods described in this book.

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Reference

1 Walrand J (1988). *An Introduction to Queueing Networks*, Prentice-Hall: Englewood Cliffs, NJ.

Adaptive Search and the Management of Logistics Systems: Base Models for Learning Agents

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Kluwer Academic Publishers, 1999. xi+219 pp. £86.25.
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This book provides some solution approaches to the problem of planning and control in some activities of logistic. It is geared toward the use of evolutionary adaptive systems and hence the introduction of adaptive agents. The book concentrates mainly on exposing some evolutionary models applied to one particular part of logistics, namely job shop scheduling with a little flavour of physical distribution. In other words, the title is a bit misleading for those readers who see logistics as a marriage of several activities starting from the purchasing of material to the delivery of the final products.

This book is divided into two parts. In part I (Chapters 1–5), the basis of evolutionary adaptive systems is given and an architectural model for adaptive agents is put forward. Fundamental ideas of computational intelligence (CI) and adaptive systems are presented in the first two introductory chapters. The next two chapters concentrate on genetic algorithms (GA), as one of the mainstreams of evolutionary algorithms (EA), and its adaptive behaviour as well as its performance against other local search methods such as search algorithms (SA) and Tabu search (TS). Chapter 5 introduces adaptive agents which are defined to be *reactive, goal-oriented, permanent entity, communicative, and adaptive.* GA is presented as an agent satisfying those requirements. Examples of a few classes of knapsack are given to illustrate the usefulness of such an approach. In part II (Chapters 6–9), applications of these EAs are used. In Chapter 6, these methods are applied to certain combinatorial based problems with their appropriate encoding–decoding systems and their learning operators. Adaptive scheduling including local search algorithms are given in Chapter 7. Real world scheduling emphasising the need of examining several scenarios and the need for having flexibility of rescheduling is demonstrated in Chapter 8. This is the chapter which I liked best, as dynamic scheduling has now become more and more required due to competition and high level in customer service. The book finishes with a simplified case study from industry and an example of an on-line scheduling. Several examples are provided to demonstrate the usefulness of the models through figures and tables. There are, however, several typos and I hope these do not distract the readers.

This book is useful in the sense that it puts forward an important strategic view on how to address a continuously changing environment. This is done by introducing robust algorithms that have the capability to process data very