

Preface

This book started as a combination of two of my ideas

- A revision to the first book, which I now call the first edition; *Queueing Theory for Telecommunications: Discrete Time Modelling of a Single Node System*, including rearrangement of material and corrections of errors that were found, and
- Some new and significant additions that make the book more complete. The additions are;
 1. A new chapter on Special single node queueing models, which include; LCFS, SIRO, Pair formation, and Finite source queue
 2. A new chapter on Queues with Time Varying Parameters
 3. A new chapter on Tandem Queues and Queueing Networks
 4. A new chapter on Optimization and Control of Discrete Time Queues
 5. A new subsection on Review of Probability for Discrete Random Variables and Matrices
 6. A new subsection on Censored Markov Chains
 7. A new subsection on Special Types of QBDs
 8. A new subsection on PH/PH/1 System with Start-up Times
 9. A new subsection on Queues with Very Large Buffers
 10. A new subsection on Geo/G/ ∞ Systems
 11. An Appendix for z -transforms and Kronecker product
 12. Finally, the Introduction is fully expanded.

In the end, it has become a completely new book or a new edition; hence a new title to reflect the contents of the new edition. In the process of making some new additions to the material I have come to further realize that modelling a queueing system using discrete time approach is so practical, very realistic, very important in many systems such as telecommunications, and on top of all very exciting. There is always something interesting and subtle about each model in discrete time, especially the “book-keeping” aspect regarding order of event occurrences. For example when arrivals and service are the only two main events taking place

in a discrete-time queue we know that it is important to first decide how we order the events since theoretically they can occur at the same time. So, when the two events occur at the same time do we recognize arrivals before service completions or vice versa? This presents two choices, known in the literature as *Late Arrivals* and *Early Arrivals*. One can practically develop a model for each one of them, even though it is not necessary. However, when we add some other events, for example the occurrence of vacations in vacation types of queues, then we have six possible combinations. Try and figure out the six! You can see that it becomes complex, a bit challenging but actually realistic. Would one then need to develop six different models? The answer is NO. A model should try and capture which of the sequences is actually used in the system considered. In this book we only select one sequence each time and present the associated model. For a different sequence one can use the same procedure developed in this book.

Most data are collected in discrete time, so to speak. In the end implementing queueing models for real life problems are carried out through numerical computations, which are based on digital operations. Even if continuous time models are created we can see that at the two supporting ends of the model, i.e. data collection and implementation on computers, are both based on discrete process. Continuous time models are nevertheless still very important especially when we want to understand the behaviours of a system, usually those that can be modelled nicely (possibly in closed form) to assist in revealing subtle behaviours that sometimes computational approaches can not bring out. Although this can also be achieved through discrete-time modelling of queueing systems, continuous time modelling seem to be more successful than discrete time in many of such cases. Hence this book is entitled “Applied Discrete Time Queues”. It is written for those who are looking for models they can apply to solving practical queueing problems or need some ideas regarding how to develop such models.

The list of objectives expected to be achieved in writing this book include providing:

1. basic material for modelling commonly occurring discrete-time queueing models.
2. sufficient theoretical background to allow building the models and understanding the tools needed to build them.
3. numerical tools needed to compute the measures used to assess queueing systems
4. ideas that lead to further questions to researchers who wish to pursue this area of work.

The same philosophy that the first book was based on still applies in this new book; trying to show how to set up most queueing models using the concept of discrete time Markov chains (DTMC) and then guiding the reader to the tools in the literature that can be used for the analysis. As such a new chapter on numerical computations for DTMC has been created to avoid mixing the theory and computations of DTMC into the same chapter. Since the book is based on matrix analysis a new chapter on matrix representation of distributions has also been introduced.

Any corrections to errors found in the book will be posted to the following website: <http://home.cc.umanitoba.ca/~alfa/adtq/index.html>.

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