CONTROLLED QUEUEING SYSTEMS

Submitted for publication to
CRC Press
Boca Raton, FL USA

V. RYKOV
Applied Math Dept., Oil and Gas State Academy
Leninsky prosp. 65, 117917 Moscow Russia

M. YU. KITAEV
2nd Krasnoselskaja str. 2, app. 209
Moscow Russia

The purpose of this book is to collect together the newest results on the theory of Markov decision processes needed for queueing models and to demonstrate their applications to main types of control in queueing systems. These types are:

- control of arrivals;
- control of service mechanisms;
- control of service discipline.

This book, to the best of our knowledge, is the first one which is completely devoted to the subject pointed out in its title. We realize that an attempt to be encyclopedic would defeat the purpose of the book because of the overwhelming amount of material. Therefore, within each of these classes we have chosen representatives where the general ideas were expressed in the most clear form.

The emphasis is placed on conditions providing "good" structural properties of optimal strategies such as monotonicity, threshold and hysteretic character, and priority. These properties allow us to restrict the range of search of the optimal strategy and sometimes to explicitly construct it.

We hope that this book will turn out to be useful to applied mathematicians interested in queueing systems, specialists in system analysis and performance evaluation, and for graduate and postgraduate students of corresponding orientations.

Each chapter is followed by exercises which form an essential logical part of the book. In most exercises, the reader is offered to complete technical fragments of proofs. Other exercises, grouped in series, are intended to lead the reader step by step to justification of some facts given in the text as auxiliary. This strategy allowed us to reduce proofs and emphasize guiding ideas.

In bibliographical remarks as a rule, we only refer to those sources which were directly used in the text. It was not our intention to give an overall picture of the literature on one topic or another. The reader, interested in the history of the subject or in topics not treated in the book, may consult recent surveys which are cited in the book.
## Contents

1. Semi-Regenerative Decision Models
   1.2. Description of basic decision model
      1.2.1. Histories and strategies
      1.2.2. Cost functionals
      1.2.3. Markov properties
   1.3. Rigorous definitions and assumptions
   1.4. Examples of controlled queues
   1.5. Optimization problems
   1.6. Renewal kernels of the decision model
   1.7. Special classes of strategies
   1.8. Sufficiency of Markov strategies
   1.9. Remarks and exercises

2. Dynamic Programming
   2.1. Introduction
   2.2. Discounting in continuous time
   2.3. Dynamic programming equation
   2.4. Bellman functions
   2.5. Finite horizon problem
   2.6. Infinite-horizon discounted-cost problem
   2.7. Random-horizon problem
   2.8. Remarks and exercises

3. Average Cost Criterion
   3.1. Introduction
   3.2. Preliminaries: weak topology, limit passages
   3.3. Preliminaries: taboo-probabilities, limit theorems for Markov renewal processes
   3.4. Notation, recurrence-communication assumptions, examples
   3.5. Existence of optimal policies
   3.6. Existence of optimal strategies. General criterion
   3.7. Existence of optimal strategies. Sufficient condition
   3.8. Optimality equation
   3.9. Constrained average-cost problem
   3.10. Average-cost optimality as limiting case of discounted-cost optimality
   3.11. Remarks and exercises

4. Continuously Controlled Jump Markov Processes
   4.1. Introduction
   4.2. Facts about measurability of stochastic processes
   4.3. Marked point processes and random measures
   4.4. The predictable sigma-algebra
   4.5. Dual predictable projection of random measures
   4.6. Definition of controlled jump Markov processes
   4.7. An M/M/1 queue with controllable input and service rate
   4.8. Dynamic programming
   4.9. Optimization problems
   4.10. Remarks and exercises
Submit your manuscripts at
http://www.hindawi.com