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Research Article

(N, n)-Preemptive-Priority M/G/1 Queues with Finite and Infinite Buffers

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In this paper, we analyze an M/G/1 priority queueing model with finite and infinite buffers under the (N, n)-preemptive priority discipline, under which preemption decisions are made based on the number of high-priority customers. This priority queueing model can be used for the performance analysis of communication systems accommodating delay- and loss-sensitive packets simultaneously. To analyze the proposed model, we extend the method of delay cycle analysis and develop a queue length version of it for finite-buffer queues. Throughout our analysis, we demonstrate that by the proposed method the analysis of the complex priority queueing model can be reduced to that of simple delay cycles, so two different preemption modes of the queueing model can be dealt with in a unified way. The numerical study reveals that adjusting the decision variables N and n allows us to fine-tune system performance for different classes of customers, and N operates as a primary control variable, regardless of the preemption mode and service-time distributions.

1. Introduction

In this paper, we consider an M/G/1 priority queueing model with a finite buffer for high-priority customers and an infinite buffer for low-priority customers. We call this an M/G/1/(K, ∞) priority queue. The priority queue operates under the (N, n)-preemptive priority discipline. This is a flexible priority discipline in which the decision whether to preempt a low-priority customer in service is made based on the number of high-priority customers in the system.

In general, priority queueing models are extensively used for the analysis of communication and computer systems [1–6]. Priority queueing models with finite and infinite buffers have been studied mainly for the analyses of communication systems used to service heterogeneous streams of traffic simultaneously [7–12]. In such a system, there is loss-sensitive traffic as well as delay-sensitive traffic arriving at the system. To accommodate heterogeneous service needs of these two types of traffic, the loss-sensitive traffic is offered space priority with an effectively infinite buffer, while the delay-sensitive traffic is given time priority with the privilege of getting serviced earlier than the loss-sensitive traffic. However, all the studies mentioned above are restricted to priority queueing models with finite and infinite buffers under the nonpreemptive priority discipline. Although the nonpreemptive priority discipline is more straightforward to implement than the preemptive priority discipline, there is a major drawback that the service quality for high-priority customers may degrade severely when the service time of a low-priority customer is long or varies significantly. For this reason, there have been recent studies on preemption-based scheduling methods for communication systems that accommodate both high-volume multimedia traffic and delay-sensitive traffic [2–6]. In this line of thought, [13] has recently analyzed an M/G/1/(K, ∞) priority queueing model under the preemptive-resume priority discipline as well as under the nonpreemptive one. To do this, [13] developed a delay cycle analysis of single-class finite-buffer M/G/1 queues and combined it with the traditional delay cycle analysis of infinite-buffer M/G/1 priority queues. [14] also has studied M/G/1/(K, ∞) priority queues under the preemptive-repeat-different priority discipline as well as under the preemptive-repeat-identical discipline.

M G 1 Priority Queues

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On Certain Priority Queues Sreekantan S. Nair,1970 *Information and Influence Propagation in Social Networks* Wei Chen,Carlos Castillo,Laks V.S. Lakshmanan,2022-05-31 Research on social networks has exploded over the last decade To a large extent this has been fueled by the spectacular growth of social media and online social networking sites which continue growing at a very fast pace as well as by the increasing availability of very large social network datasets for purposes of research A rich body of this research has been devoted to the analysis of the propagation of information influence innovations infections practices and customs through networks Can we build models to explain the way these propagations occur How can we validate our models against any available real datasets consisting of a social network and propagation traces that occurred in the past These are just some questions studied by researchers in this area Information propagation models find applications in viral marketing outbreak detection finding key blog posts to read in order to catch important stories finding leaders or trendsetters information feed ranking etc A number of algorithmic problems arising in these applications have been abstracted and studied extensively by researchers under the garb of influence maximization This book starts with a detailed description of well established diffusion models including the independent cascade model and the linear threshold model that have been successful at explaining propagation phenomena We describe their properties as well as numerous extensions to them introducing aspects such as competition budget and time criticality among many others We delve deep into the key problem of influence maximization which selects key individuals to activate in order to influence a large fraction of a network Influence maximization in classic diffusion models including both the independent cascade and the linear threshold models is computationally intractable more precisely P hard and we describe several approximation algorithms and scalable heuristics that have been proposed in the literature Finally we also deal with key issues that need to be tackled in order to turn this research into practice such as learning the strength with which individuals in a network influence each other as well as the practical aspects of this research including the availability of datasets and software tools for facilitating research We conclude with a discussion of various research problems that remain open both from a technical perspective and from the viewpoint of transferring the results of research into industry strength applications *Queueing Networks* Richard J. Boucherie,Nico M. van Dijk,2010-11-25 This handbook aims to highlight fundamental methodological and computational aspects of networks of queues to provide insights and to unify results that can be applied in a more general manner The handbook is organized into five parts Part 1 considers exact analytical results such as of product form type Topics include characterization of product forms by physical balance concepts and simple traffic flow equations classes of service and queue disciplines that allow a product form a unified description of product forms for discrete time queueing networks insights for insensitivity and aggregation and decomposition results that allow sub networks to be aggregated into single nodes to reduce computational burden Part 2 looks at monotonicity and comparison results such as for computational

simplification by either of two approaches stochastic monotonicity and ordering results based on the ordering of the process generators and comparison results and explicit error bounds based on an underlying Markov reward structure leading to ordering of expectations of performance measures Part 3 presents diffusion and fluid results It specifically looks at the fluid regime and the diffusion regime Both of these are illustrated through fluid limits for theanalysis of system stability diffusion approximations for multi server systems and a system fed by Gaussian traffic Part 4 illustrates computational and approximate results through the classical MVA mean value analysis and QNA queueing network analyzer for computing mean and variance of performance measures such as queue lengths and sojourn times numerical approximation of response time distributions and approximate decomposition results for large open queueing networks spanPart 5 enlightens selected applications as spanloss networks originating from circuit switched telecommunications applications capacity sharing originating from packet switching in data networks and a hospital application that is of growing present day interest spanThe book shows that spanthe intertwined progress of theory and practicespan will remain to be most intriguing and will continue to be the basis of further developments in queueing networks *Probability Theory Subject Indexes from Mathematical Reviews* American Mathematical Society,1987 Some Queueing [i.e. Queuing] Models for a Time-shared Facility Linus E. Schrage,1974 **Scientific and Technical Aerospace Reports** ,1981 *BASIC Technical Systems Simulation* Dragoljub Savić,A. Dusko Savic,1989 On writing BASIC simulation programs that solve realistic problems Covers the basics systems models and simulation random numbers technical systems transactions and queuing systems Annotation copyright Book News Inc Portland Or *Mathematical Reviews* ,2008 **Cognitive infocommunications** Anna Esposito,Gennaro Cordasco,Carl Vogel,Péter Baranyi,2023-06-21 **Defence Science Journal** ,1977 *Memoirs of the Defense Academy* Bōei Daigakkō (Japan),1965 **Government Reports Annual Index** ,1993 **Automation and Remote Control** ,1986 □□□□□□□□□□□□□□□□□□□□ □□□□□□□□□□□□□□□□□,1999 GLOBECOM Tokyo '87 ,1987 Engineering Cybernetics ,1983 *SIAM Journal on Computing* Society for Industrial and Applied Mathematics,1985 Contains research articles in the application of mathematics to the problems of computer science and the nonnumerical aspects of computing Digital Signal Processing Applications ,1999 *Networking in the Nineties* ,1991 Service Disciplines for Packet-switching Integrated-services Networks Hui Zhang,1993

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