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Cost Optimization and Performance Modelling of Discrete-time Queues with its Real-life Applications

Abstract: Queueing theory is a branch of applied mathematics that studies and models the behavior of queues, or waiting lines. It provides a mathematical framework for analyzing and understanding how queues form and behave in various systems, such as telecommunications networks, computer systems, manufacturing processes, transportation systems, and service operations. Queueing theory provides insights into system performance, helps in capacity planning, and guides decisionmaking to optimize resource allocation and improve customer service levels in various operational environments. Queueing systems find widespread application in various domains where efficient resource utilization, service optimization, and performance analysis are critical. One key area of application is in telecommunications and networking, where queueing theory helps in modeling call centers, network routers, and data packet processing. By analyzing arrival rates, service times, and queue lengths, queueing models assist in optimizing network performance, reducing congestion, and improving quality of service. Using queueing theory, we can model and analyze various call centers scenarios to optimize the number of phone lines (servers) needed to meet a target service level (e.g., ensuring most calls are answered within a certain time threshold). Another important application is in manufacturing and supply chain management, where queueing theory aids in optimizing production processes, inventory management, and logistics. Discrete-time queueing systems model the behavior of queues where events such as arrivals and services occur at discrete time intervals. Entities arrive based on a specified probability distribution (like Poisson, geometric), with service times following various distributions (like exponential, geometric). These systems are particularly useful for simulating and studying real-world scenarios where processes unfold in discrete steps or intervals, such as in computer systems, telecommunications networks, or service operations. Discrete-time queueing models can be analyzed using mathematical techniques such as Markov chains, recursion equations, and simulation algorithms. Simulation methods allow for experimentation with different system parameters (e.g., arrival rate, service rate, number of servers) to predict and optimize system performance. Examples of discrete-time queueing systems include, a digital communication network where data packets arrive and are processed in discrete time slots, a computer system where tasks arrive and are executed in discrete time intervals, a manufacturing system where jobs arrive for processing at specific time intervals etc. In this, we throw light on few recent works done on Discrete-time queueing systems which provides valuable insights into system performance, resource allocation, and bottleneck identification, helping organizations optimize operational efficiency and service quality in various domains.

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Biography: Shweta Upadhyaya obtained her MPhil and PhD in Mathematics from the Dr. B.R. Ambedkar University, Agra. Currently she is an Assistant Professor-III in Amity University, Noida, U.P. Her research areas of interests include Probability theory, Stochastic modelling, Queueing Modelling and Optimization. She has published 43 research papers in international/national journals of repute and has participated and presented her research papers in many international/national conferences.

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