Optimization of Performance Measures in Finite Queueing Systems

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Abstract

To maintain their business competitiveness, manufacturing, telecommunication, and service companies develop their facilities and systems having optimal service rates and numbers of servers to function efficiently and effectively. These systems are best modeled as closed finite queueing network models and state dependent queues. However, because of blocking in these finite queueing networks, the optimal service rates and number of servers allocation issue is a challenging nonlinear mixed integer optimization problem. To tackle this difficult mathematical problem, first, we propose a queue decomposition method together with a nonlinear sequential quadratic optimization algorithm. Extensive analyses and resolution of small topologies are performed and we show that the results are very encouraging and very close to those of simulation but requiring only a fraction of CPU times. Then, this methodology is applied to larger supply chain topologies including a car-body shop case study where most of the operations are performed by robots that load and weld stamped steel parts. We show that the model yields encouraging results. Finally, from these various experiments, we propose a set of recommendations and managerial insights relative to the importance of joint optimization of various performance measures in such systems.

Keywords
Material Handling, Closed Finite Networks, Optimization of Queueing Systems, Performance Measures, Nonlinear Mixed Integer Problem.

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