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Genetic application in a facility location problem with random demand within queuing framework

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Abstract In many service and industrial applications of the facility location problem, the number of required facilities along with allocation of the customers to the facilities are the two major questions that need to be answered. In this paper, a facility location problem with stochastic customer demand and immobile servers is studied. Two objectives considered in this problem are: (1) minimizing the average customer waiting time and (2) minimizing the average facility idle-time percentage. We formulate this problem using queuing theory and solve the model by a genetic algorithm within the desirability function framework. Several examples are presented to demonstrate the applications of the proposed methodology.

Keywords Facility location · Queuing theory · Genetic algorithm · Desirability function

Introduction

Facility layout and location problems have been the subject of analysis since the seventeenth century (Francis et al. 1992). Even though these problems have received considerable attention over the years, it was not until the emergence of the interest in operations research and management science that the subject received renewed attention in a number of disciplines. Currently, there exists a strong interdisciplinary interest in facility layout and location problems. Mathematicians, operation researchers, architects, computer scientists, economists, engineers from several disciplines, management scientists, technical geographer, transportation system designers, regional scientists, and urban planners have discovered a commonality of interest in a concern for the layout and location of the facilities. Each brings different interpretations and different solutions to the problem.

One of the objectives of the facility layout and location problem is to find the locations of the facilities in a system such that the sum of system operating costs is minimized. For example, Li et al. (1999) developed a dynamic programming model to find the location of web proxies with minimum cost. The stochastic queue median (SQM) of Berman et al. (1985) considers a mobile server such as an emergency response unit, in which in response to each demand call (e.g., patients), the available sever (e.g., ambulance) travels to the demand location to provide services.

Another objective of the facility layout and location problem is to determine the minimum number of storage facilities among a discrete set of location sites such that the probability of each customer being covered is not less than a critical value. The literature within the subject of emergency services also includes many works that extend the probabilistic location set covering problem (PLSCP) (Revelle and Hogan 1989). For example, Marianov and Revelle (1994) developed the PLSCP, which models each geographic region as multi-server queuing system.

The flow-capturing model introduced by Hodgson (1990) is another closely related subject. Locating gas stations, convenience stores, and billboards are some applications of the flow-capturing model (Berman et al. 1995; Hodgson and Berman 1997), in which sometimes the server may be congested (Berman 1995). As an example, Shavandi

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