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Multi-period hub set covering problems with flexible radius: A modified genetic solution

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ABSTRACT

Traditionally, in hub covering problems, it is assumed that the covering radius is an exogenous parameter which cannot be controlled by the decision maker. In many real-world cases, with a negligible increase in covering radius, considerable savings in hub establishment costs are possible. On the contrary, changes in problem parameters during the planning horizon cause the results of theoretical models to be impractical in real-world situations. This article proposes a mixed integer model for a multi-period single-allocation hub set covering problem in which the covering radius is a decision variable. The proposed model is validated through a real world case study. Also, due to the NP-Hardness of the problem a modified genetic algorithm (GA) is proposed for solving that. The proposed GA benefits from a dynamic stopping criteria and immigration operator. The performance of the proposed GA is compared with the original GA and imperialist competitive algorithm (ICA). Computational results corroborated efficiency of the proposed algorithm in achieving high-quality solutions in a reasonable time.

1. Introduction and literature review

The concept of hub nodes arises when there are many origin-destination (O/D) pairs in a transportation network to benefit from the economies of scale. Hubs are nodes in which the flow from various origins is gathered, and after reorganization, it is dispatched to the destinations. Hub location problems, initially introduced by O'Kelly [1], have many applications in cargo delivery systems, airline networks and telecommunication systems. O'Kelly proposed a quadratic model for hub median problem which was aimed at minimizing total flow costs [2]. Subsequent researches by Campbell [3], Ernst et al. [4], and O'Kelly et al. [5] proposed some linearized versions for the problem. Hub location problems are generally classified into three categories: hub center, hub median and hub covering problems. This article investigates on hub-covering problem. Readers can refer to the review papers by Alumur et al. [6], Farahani et al. [7], and Campbell and O'Kelly [8] for the other categories of hub location problem. Initially, Campbell proposed mathematical formulations for single and multiple-allocation versions of hub set covering problem (HSCP) and hub maximal covering problem (HMCP) [9]. He also proposed that an O/D pair *i, j*, might be covered by hubs *k, l* in three ways:

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