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Abstract: In general cases, to find the exact upper bound on the minimal total cost of the transportation problem with varying demands and supplies is an NP-hard problem. In literature, there are only two approaches with several shortcomings to solve the problem. In this paper, the problem is formulated as a bi-level programming model, and proven to be solvable in a polynomial time if the sum of the lower bounds for all the supplies is no less than the sum of the upper bounds for all the demands; and a heuristic algorithm named TPVDS-A based on genetic algorithm is developed as an efficient and robust solution method of the model. Computational experiments on benchmark and new randomly generated instances show that the TPVDS-A algorithm outperforms the two existing approaches.

Keywords: Genetic algorithms; Transportation problem; Transportation problem with varying demands and supplies; Bounds on the minimal total cost; Upper bound on the minimal total cost

1. Introduction

Transportation problem (TP) is a well-known problem which can be formulated and solved as a linear programming problem. Kantorovich [17] contributed to TP in 1939 and later on Hitchcock [13] developed the transportation model. Afterwards, a number of scholars have studied this problem from various perspectives and obtained some valuable results, e.g., Dantzig [10], Charnes and Cooper [7], Arsham and Khan [3], Arsham [4], Adlakha and Kowalski [1], Dahiya and Verma [9], Sonia and Puri [29], Vancroonenburg et al. [30], Sabbagh et al. [25], Sharma et al. [27], Walter et al. [31], Hwang and Kang [15]. Mostly, in literature, the supply and demand values are exactly known when solving TP.

Less attention has been paid to developing transportation models with variable parameter values. For example, Das et al. [11] proposed an approach to solve the multi-objective TP with coefficients of terms in the objective function and parameter values at the sources and the destinations given in an interval. Safi and Razmjoo [26] focused on the TP where a fixed charge was added to transportation cost, and parameter values were given in intervals. For this problem, Safi and Razmjoo [26] proposed two solution procedures. It is notable that both Das et al. [11] and Safi and Razmjoo [26] did not make any attempt to find the exact lower and upper bounds on the minimal total cost of the TP with varing parameter values in intervals. Liu [20] constructed two mathematical models to find the exact lower and upper bounds on the minimal total cost of the TPVDS (transportation problem with varying demands and supplies) . On one hand, to find the exact lower bound on the minimal total cost of the TPVDS has been well solved, because it can be reduced to a linear