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AN EFFICIENT METHOD FOR LINEAR BILEVEL PROGRAMMING PROBLEMS BASED ON THE ORTHOGONAL GENETIC ALGORITHM

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Abstract. *This paper presents an efficient method for solving linear bilevel programming problems (LBLPPs). First the LBLPP is transformed into a single level complementary slackness problem by applying Karush-Kuhn-Tucker (KKT) conditions. In order to cope with the complementarity constraints, a binary encoding technology is adopted for KKT multipliers. Thus, a genetic algorithm called the orthogonal genetic algorithm is presented to efficiently solve the complementary slackness problem. By using the binary encoding technology for KKT multipliers, the complementary slackness problem is simplified to successive linear programming (LP) problems. By solving the LP problem, the fitness value of the corresponding chromosome is evaluated. When the LP problem is solvable, a feasible solution of the original LBLPP which is at a vertex of the polytope can be found. Numerical experiments on some test problems from the literature show that the proposed algorithm can find global optimal solutions with less computation burden.*
Keywords: Linear bilevel programming problem, Karush-Kuhn-Tucker conditions, Genetic algorithm, Orthogonal experimental design, Global optimal solution

1. **Introduction.** Bilevel programming problem (BLPP) arises when a decentralized noncooperative decision system involving a leader and a follower is modelled. In this system the leader makes the decision first, and the follower then makes its decision based on the leader's [1]. Due to the hierarchical structure, BLPP belongs to a class of non-convex and nondifferentiable global optimization problems. Linear bilevel programming problem (LBLPP) is a special case in which all the constraints and the objective functions of both programming problems are linear. This kind of problem has a wide field of applications such as government policy, urban transportation, economic systems, network design and finance [9]. Thanks to its numerous and diverse applications, LBLPP has received increasing attention in the literature (see [1-6,9,10] and the references therein).

LBLPP is intrinsically hard to solve. In fact, it has been proved to be a NP-hard problem. LBLPP has the favorable property that the solution occurs at an extreme point of the feasible set that can be exploited by enumeration technique. However, it could provide a global optimal solution for only a relatively small problem. The popular approach for LBLPP is to transform the original two-level problem into a single level one by replacing the lower-level optimization problem with its Karush-Kuhn-Tucker (KKT) optimality conditions. Based on this reformulation, some algorithms have been developed, for example, branch-and-bound method [1,4,8], genetic algorithm [2], and neural network approach [9]. Genetic algorithm (GA) has been found to be popular tool in solving a wide