Mixed-Discrete Fuzzy Multiobjective Optimization of Structures using a Hybrid Genetic Algorithm

Singiresu S. Rao and Ying Xiong
Department of Mechanical and Aerospace Engineering
University of Miami, Coral Gables, FL 33124-0624, USA

Many structural design optimization problems require considering some of the design variables as integer or discrete values. Structural optimization problems involving uncertain and imprecise data can be solved using fuzzy approaches. Many real-life design problems involve multiple and conflicting objectives. Although much attention has been focused on the development and applications of fuzzy optimization, multiobjective programming and mixed-discrete optimization methods separately, fuzzy multiobjective optimization problems in mixed-discrete design space were not addressed in the literature. This paper presents a new method in which the fuzzy lambda-formulation and game theory techniques are combined with a mixed-discrete hybrid genetic algorithm for solving mixed-discrete fuzzy multiobjective programming problems. A hybrid genetic algorithm is developed and used to determine the optimal feasible region containing the global optimum point, and the hybrid negative sub-gradient method, combined with discrete one-dimension search, is subsequently used to replace the GA to find the final optimum solution. The lambda-formulation corresponds to the maximization of the satisfaction level of the objective and constraint function values achieved in the presence of fuzzy data. The game theory approach maximizes a measure of the deviations of the multiple objective functions from their respective optimum values. Three example problems, dealing with the optimal designs of a two-bar truss, a conical convective spine and a twenty-five bar truss, demonstrate that the method can be flexibly and effectively applied to various kinds of engineering design problems.