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A VARIANT OF DIFFERENTIAL EVOLUTION FOR DISCRETE OPTIMIZATION PROBLEMS REQUIRING MUTUALLY DISTINCT VARIABLES

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Abstract. *A large number of real world problems are formulated in terms of a set of discrete or integer variables for which an optimal set is obtained through appropriate optimization of a function. These problems are best represented using a set of discrete numbers over bounded or unbounded discrete spaces, in order to limit the search domain of the algorithm. In this work, Differential Evolution (DE) is used for the discrete problem, where the search space is augmented to improve the performance of the technique. Although in principal DE is used to find the optimal solution, the manner in which the space is stated and then searched is altered to improve the overall performance. Both unique and non-unique discrete sets of variables are investigated as control variables of the functions, and the algorithm for each is outlined accordingly. A number of established test functions are used to state the performance of the proposed DE discrete variable optimization technique, when compared to real space DE optimization.*
Keywords: Evolutionary algorithms, Global optimization, Differential evolution, Discrete optimization, Mutually distinct

1. **Introduction.** Optimization strategies, that can predict a set of variables to best perform a required task, are routinely used in many applications and fields. Optimization of variables to efficiently predict a discrete outcome is important in, for example, aircraft scheduling [1] and facility location problems [2]. Moreover, Differential Evolution (DE) [3] is a very robust method of optimization, and recently significant improvements to DE include, constraint optimization [4] and multi-objective [5] optimization. Improvements in efficiency and robustness are still needed in discrete optimization methods and algorithms to improve the overall estimation of a set of variables that can predict an optimal outcome. Here in, a new approach to discrete optimization is proposed based on DE. The adequacy of the proposed method is explored using a general perspective and test functions are used to establish and rank the performance of the proposed algorithm. An application problem is also provided to show that the method is applicable to real world problems.

The class of problems intended for this study are ones in which the function to be minimized uses input variables that are discrete and different. Moreover, the cost function itself returns a real value rather than an integer value.

The aim of this work is to investigate the manner in which functions can be minimized using a variant of Differential Evolution (DE) [6] for discrete variables. The problem in terms of unique discrete inputs d_i is simply stated as:

$$\min f(d_1, \ldots, d_L), \quad d_i \neq d_j \in [D_l, D_u], \quad i, j = 1, \ldots, L \tag{1}$$