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UNI-MODAL AND MULTI-MODAL OPTIMIZATION USING MODIFIED HARMONY SEARCH METHODS

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Abstract. *The Harmony Search (HS) method is an emerging meta-heuristic optimization algorithm. In this paper, we propose two modified HS methods to deal with the uni-modal and multi-modal optimization problems. The first modified HS method is based on the fusion of the HS and Differential Evolution (DE) technique, namely, HS-DE. The DE is employed here to optimize the members of the HS memory. The second modified HS method utilizes a novel HS memory management approach, and it targets at handling the multi-modal problems. Several nonlinear functions are used to demonstrate and verify the effectiveness of our two new HS methods.*
Keywords: Harmony search, Differential evolution, Uni-modal optimization, Multi-modal optimization, Hybrid optimization methods

1. **Introduction.** Firstly proposed by Geem *et al.* in 2001 [1], the HS method is inspired by the underlying principles of the musicians' improvisation of the harmony. During the recent years, it has been successfully applied in the areas of function optimization [2], mechanical structure design [3], and pipe network optimization [4]. Unfortunately, empirical study has shown that the original HS method sometimes suffers from a slow search speed [2], and it is not suitable for handling the multi-modal problems. To overcome these drawbacks, we propose two modified HS methods in this paper. The first modified HS method is a hybridization of the HS and Differential Evolution (DE): HS-DE, which can accelerate the convergence procedure of the regular HS method. The DE technique is a simple but universal numerical optimizer [5]. The individuals in the DE are updated by an amount of the difference between two randomly chosen ones. The DE has the distinguishing advantages of computation simplicity as well as convergence efficiency. The second modified HS method is based on the employment of an effective diversity maintenance policy for the members of the HS memory. Extensive computer simulations have shown that our two modified HS methods can outperform the original HS in attacking the uni-modal and multi-modal problems.

The rest of this paper is organized as follows. We briefly introduce the essential principles of both the HS and DE methods in Sections 2 and 3, respectively. In Section 3, by merging the HS and DE together, we propose a new hybrid optimization method: HS-DE, in which the fitness of the HS memory members can be improved by the DE. The second modified HS method is presented and discussed in Section 4. Simulation examples of nonlinear functions optimization are demonstrated in Section 5. Finally, in Section 6, we conclude our paper with some remarks and conclusions.