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Hybridizing sine cosine algorithm with multi-orthogonal search strategy for engineering design problems

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Abstract

This paper presents a new algorithm based on hybridizing the sine cosine algorithm (SCA) with a multi-orthogonal search strategy (MOSS), named multi-orthogonal sine cosine algorithm (MOSCA), for solving engineering design problems. The proposed MOSCA integrates the advantages of the SCA and MOSS to eliminate SCA's disadvantages, like unbalanced exploitation and the trapping in local optima. The proposed MOSCA works in two stages, firstly, the SCA phase starts the search process to enhance exploration capability. Secondly, the MOSS phase starts its search from SCA found so far to boost the exploitation tendencies. In this regard, MOSS phase can assist SCA phase to search based on deeper exploration/exploitation patterns as an alternative. Therefore, the MOSCA can be more robust, statistically sound, and quickly convergent. The performance of the MOSCA algorithm is investigated by applying it on eighteen benchmark problems and four engineering design problems. The experimental results indicate that MOSCA is a promising algorithm and outperforms the other algorithms in most cases.

Keywords: Sine cosine algorithm; Orthogonal array; Engineering design problems.

1. Introduction

Engineering design problems (EDPs) have been a very significant and challenging area in the field of engineering for obtaining more accurate and efficient shape of the designs. These EDPs are generally formulated as nonlinear constrained optimization problems (NCOPs). Frequently, NCOPs are difficult to solve due to the presence of complex nature of constraints (mixing continuity-discontinuity, discontinuity, and non-convex regions, etc.). Also, the feasible region for the candidate problem may be limited to a thin subset of the search region due to the presence of the complexity in the constraints.

For solving such types of problems, there are two groups, namely, mathematical programming and metaheuristic methods. Mathematical programming methods is also named gradient-based methods such as the steepest descent method, linear programming, integer programming, Newton and quasi Newton methods, and dynamic programming have been applied for solving