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A hybrid shuffled complex evolution approach with pattern search for unconstrained optimization

Viviana Cocco Mariani [a,*], Leandro dos Santos Coelho [b]

[a] *Department of Mechanical Engineering, Pontifical Catholic University of Parana, Imaculada Conceição, 1155, Zip code 80215-910, Curitiba, PR, Brazil*

[b] *Industrial and Systems Engineering Graduate Program, Pontifical Catholic University of Parana, Imaculada Conceição, 1155, Zip code 80215-910, Curitiba, PR, Brazil*

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Abstract

The difficulties associated with using classical mathematical programming methods on complex optimization problems have contributed to the development of alternative and efficient numerical approaches. Recently, to overcome the limitations of classical optimization methods, researchers have proposed a wide variety of meta-heuristics for searching near-optimum solutions to problems. Among the existing meta-heuristic algorithms, a relatively new optimization paradigm is the Shuffled Complex Evolution at the University of Arizona (SCE-UA) which is a global optimization strategy that combines concepts of the competition evolution theory, downhill simplex procedure of Nelder–Mead, controlled random search and complex shuffling. In an attempt to reduce processing time and improve the quality of solutions, particularly to avoid being trapped in local optima, in this paper is proposed a hybrid SCE-UA approach. The proposed hybrid algorithm is the combination of SCE-UA (without Nelder–Mead downhill simplex procedure) and a pattern search approach, called SCE-PS, for unconstrained optimization. Pattern search methods are derivative-free, meaning that they do not use explicit or approximate derivatives. Moreover, pattern search algorithms are direct search methods well suitable for the global optimization of highly nonlinear, multiparameter, and multimodal objective functions. The proposed SCE-PS method is tested with six benchmark optimization problems. Simulation results show that the proposed SCE-PS improves the searching performance when compared with the classical SCE-UA and a genetic algorithm with floating-point representation for all the tested problems. As evidenced by the performance indices based on the mean performance of objective function in 30 runs and mean of computational time, the SCE-PS algorithm has demonstrated to be effective and efficient at locating best-practice optimal solutions for unconstrained optimization.

Keywords: Shuffled complex evolution algorithm; Pattern search; Genetic algorithm; Unconstrained optimization

1. Introduction

Optimization problems are of importance for the industrial as well as the scientific world in many applications. There are many optimization problems that present attributes, such as high nonlinearity and multimodality, the solution of this kind of problems is usually a complex task. Moreover, in many instances, complex optimization problems present noise

* Corresponding author. Tel.: +55 41 3271 1326; fax: +55 41 3271 1490.
E-mail addresses: viviana.mariani@pucpr.br (V.C. Mariani), leandro.coelho@pucpr.br (L.d.S. Coelho).

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