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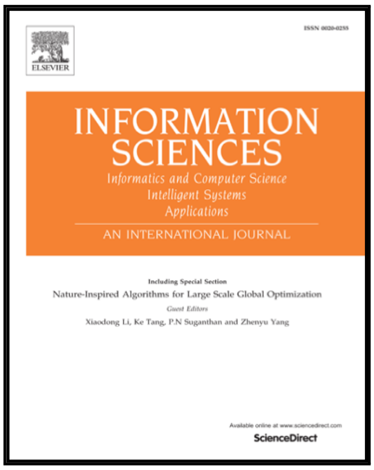

Reference Point based Archived Many Objective Simulated Annealing

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Reference Point based Archived Many Objective Simulated Annealing

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Abstract

Recent research in optimization theory focuses on developing algorithms for the many objective optimization problems. These problems require careful attention to efficiently handle the increasing number of objectives and also to address the various challenges associated with these types of problems. The present study introduces a new unconstrained many-objective optimization algorithm called reference point based many objective simulated annealing algorithm (RSA). The algorithm is an amalgamation of several new modules including a reference point based clustering technique to control the size of the archive which stores the solutions, a novel mutation strategy termed as mutation-switching and a new acceptance probability function. Unlike the existing simulated annealing based multiobjective optimization techniques, the current work explores the use of archive-to-archive transition rather than point-to-point transition. The performance of RSA is validated and compared with many other state-of-the-art algorithms on a number of unconstrained benchmark problems of DTLZ and WFG test suites with up to 15 objectives. The experimental results show that RSA outperforms AMOSA, NSGA-III, MOEA/D-PBI and θ-DEA in terms of two well-known performance metrics, namely inverse generational distance (IGD) and hyper-volume (HV), for a majority of the test cases considered . It has also been shown that RSA usually requires fewer number of function evaluations compared to other algorithms for equal or better performance and might thus be more useful for MaOO problems which are expensive in terms of computational time. To illustrate some real-life applications of RSA, in a part of the paper, we have developed a multiobjective clustering technique utilizing RSA as the underlying optimization mechanism which is then used for segmenting satellite images.Obtained results prove the efficacy of RSA in solving the segmentation task.

Keywords: Many-objective optimization, Clustering, Pareto optimality, Simulated Annealing, Mutation switching, Acceptance Probability, Reference Points.

1. Introduction

Multiobjective optimization (MOO) deals with the optimization of more than one objective function simultaneously [11, 9]. The objectives of a MOO problem are usually conflicting. The subset of MOO problems optimizing four or more objectives is called Many-Objective Optimization (MaOO) problems [49], [26], [25] . MaOO forms an important domain of research on optimization problems where MOO algorithms face severe scalability issues. Several practical applications where MaOO algorithms have been used are control systems [17, 20], automotive engine calibration [27], software engineering [33, 36], industrial scheduling [40, 46], land use management [8], etc.

AMOSA (archived multiobjective simulated annealing) [7] which is a MOO algorithm based on simulated annealing was shown to outperform existing evolutionary MOO techniques like NSGA-II [13] and PAES [24] when applied to optimize a large number of objectives. However it suffers from producing a non-uniform Pareto front for certain kinds of functions, especially functions like DTLZ4 which has a biased

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