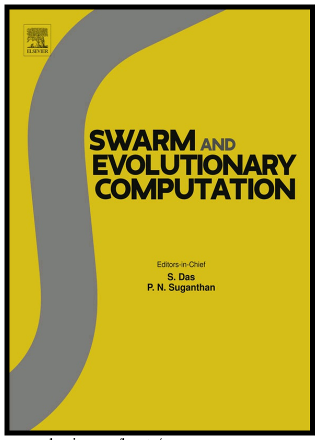

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LONSA: A Labeling-Oriented Non-dominated Sorting Algorithm for Evolutionary Many-Objective Optimization

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Abstract

Multiobjective algorithms are powerful in tackling complex optmization problems mathematically represented by two or more conflicting objective functions and their constraints. Sorting a set of current solutions across non-dominated fronts is the key step for the searching process to finally identify which ones are the best solutions. To perform that step, a high computational effort is demanded, especially if the size of the solution set is huge or the mathematical model corresponds to a many-objective problem. In order to overcome this, a new labeling-oriented algorithm is proposed in this paper to speed up the solution-to-front assignment by avoiding usual dominance tests. Along with this algorithm, called Labeling-Oriented Non-dominated Sorting Algorithm (LONSA), the associated methodology is carefully detailed to clearly explain how the classification of the solution set is successfully achieved. This work presents a comparison between LONSA and other well-known algorithms usually found in the literature. The simulation results have shown a better performance of the proposed algorithm against nine chosen strategies in terms of computational time as well as number of comparisons.

Keywords: Multiobjective Optimization, Non-Dominance, Many-Objective, Solution Labeling.

1. Introduction

Over the last decade, an increasing number of real-world multidimensional optimization problems have been addressed by researchers with the aid of several multiobjective evolutionary algorithms (MOEAs) [1–3] enabled by data processing power of today's computers. According to the literature, those classes of optimization problems, known as many-objective problems (MOPs) [4–6] in short, have been dealt by many MOEAs [7–10] designed to be resilient in the task of filtering optima among solutions scattered throughout a highly challenging n-dimensional search space. Most of those MOEAs were based on Pareto-dominance concept such as MOGA [1], NSGA-II [7], NSGA-III [4, 5], SPEA2 [8], PAES [11], and MODEA [12]. All of them are able of achieving the same result, considering a set of solutions as input and the non-dominated fronts as output. However, each algorithm has its own computational cost to bound the non-dominated fronts. According to Zhou et al. [2], the multipurpose framework based on Pareto dominance [3] was applied to the NSGA-II [7] as well as other existing MOEAs with different levels of adaption of the underlying principle. Nevertheless, the computing time of those algorithms have been the bottleneck which is severely degraded by the efficency of how sorting is performed on the solutions distributed across a finite number of fronts. This burden is responsible for the major quota of the time spent during the whole optimization process, straightly influenced by the model complexity features (number of objectives, number and type of the decision variables) and algorithm parameters (population size, number of generations). Therefore, a sorting procedure applied on identifying such fronts which has low-computational cost and is free of redundant operations regardless the landscape of the search space is worthy and it is still an open challenge. Recently, additional strategies based on niching, archiving, tree structures, or lists were proposed in the literature to overcome or mitigate that lim-

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