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Survey Paper

A Benchmark-Suite of real-World constrained multi-objective optimization problems and some baseline results

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A R T I C L E I N F O

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A B S T R A C T

Generally, Synthetic Benchmark Problems (SBPs) are utilized to assess the performance of metaheuristics. However, these SBPs may include various unrealistic properties. As a consequence, performance assessment may lead to underestimation or overestimation. To address this issue, few benchmark suites containing real-world problems have been proposed for all kinds of metaheuristics except for Constrained Multi-objective Metaheuristics (CMOMs). To fill this gap, we develop a benchmark suite of Real-world Constrained Multi-objective Optimization Problems (RWCMOPs) for performance assessment of CMOMs. This benchmark suite includes 50 problems collected from various streams of research. We also present the baseline results of this benchmark suite by using state-of-the-art algorithms. Besides, for comparative analysis, a ranking scheme is also proposed.

1. Introduction

During the past decades, Constrained Multi-objective Optimization Problems (CMOPs) has gained a lot of attention since the majority of optimization problems of real-world applications contain constraints. Generally, a CMOP has multiple conflicting objectives with one or more constraints that demand to optimize these objectives while satisfying the constraints simultaneously. In CMOPs, Evolutionary Algorithms (EAs) and other metaheuristics have to provide proper tradeoffs among the conflicting objectives while satisfying all constraints, which is a great challenge to them [1,2].

Without losing generality, a CMOP can be defined mathematically:

$$\text{Minimize } f_1(\bar{x}), f_2(\bar{x}), \dots, f_M(\bar{x}), \tag{1}$$

$$\text{Subject to } g_i(\bar{x}) \le 0, i \in \{1, 2, \dots, ng\}$$

$$h_j(x) = 0, j \in \{ng+1, ng+2, \dots, ng+nh\}$$

$$L_k \le x_k \le U_k, k \in \{1, \dots., D\}$$

where f_i represents the i-th objective function, M is the total number of the conflicting objective functions, $\bar{x} = (x_1, x_2, \dots .x_D)^T$ is a solution vector of length D, L_k and U_k are the lower and upper bound of the search-space at k-th dimension, ng and nh are the total number of the inequality and equality constraints, respectively. Here, solution $\bar{x}$ can be of two types: feasible and infeasible solution. The feasible solutions satisfy all $(ng + nh)$ constraints of the given problem and blackthe set of all possible feasible solutions within the bound of the search-space creates a subspace in the search-space, called a feasible region. black-However, blackthe solution that does not lie in the feasible region is called an infeasible solution. Similarly, a set of all possible infeasible solutions formed an infeasible subspace in the search-space.

The constraint violation of blackthe solution $\bar{x}_i$ over a j-th constraint can be calculated by the following equation:

$$v_j = \begin{cases} max\left(0, g_j(\bar{x}_i)\right), & j \le ng \\ max\left(0, |h_j(\bar{x}_i)| - \epsilon\right), & ng < j \le (ng+nh) \end{cases}, \tag{2}$$

where v_j is the value of constraint violation for $\bar{x}_i$ on j-th constraint and ϵ is a very small value (10^{-4}) for relaxing the equality constraints. On the basis of this definition, a solution can be called as a feasible solution if that solution has zero constraint violation at each constraint or the

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