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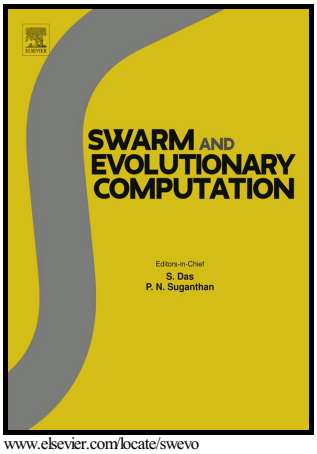

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Abstract

Decomposition based multiobjective evolutionary algorithms approximate the Pareto front of a multiobjective optimization problem by optimizing a set of subproblems in a collaborative manner. Often, each subproblem is associated with a direction vector and a reference point. The settings of these parameters have a very critical impact on convergence and diversity of the algorithm. Some work has been done to study how to set and adjust direction vectors to enhance algorithm performance for particular problems. In contrast, little effort has been made to study how to use reference points for controlling diversity in decomposition based algorithms. In this paper, we first study the impact of the reference point setting on selection in decomposition based algorithms. To balance the diversity and convergence, a new variant of the multiobjective evolutionary algorithm based on decomposition with both the ideal point and the nadir point is then proposed. This new variant also employs an improved global replacement strategy for performance enhancement. Comparison of our proposed algorithm with some other state-of-the-art algorithms is conducted on a set of multiobjective test problems. Experimental results show that our proposed algorithm is promising.

Index Terms

Multiobjective optimization, decomposition, reference points, test instance

I. Introduction

Recently decomposition based multiobjective evolutionary algorithms (MOEA/D) have received much attention [1]–[5]. These algorithms decompose a multiobjective optimization problem (MOP) into a number of simple subproblems and optimize them in a collaborative manner. How to decompose a MOP is a major issue in the design of a MOEA/D algorithm.

In principle, any decomposition approach can be used for decomposing a MOP. Although some decomposition approaches generate a set of multiobjective subproblems [6], most approaches are single-objective decomposition which this paper focuses on. These approaches divide a MOP into a number of single-objective optimization subproblems. The objective function in each subproblem is defined by aggregating all the objectives in the MOP in question into a scalar objective by some parameters such as a direction vector and reference points [3], [7]–[9]. The optimal solutions of these subproblems will be sought by MOEA/D. Hopefully, all the obtained (nearly) optimal solutions collectively approximate the Pareto front of the MOP. The distribution of the obtained solutions, which is critical to the approximation quality, can often be determined by the used aggregation method, the setting of direction vectors and reference points. Some efforts have been made to study how to dynamically adjust aggregation functions [10], [11] and direction vectors [12]–[14] for obtaining solutions with a desirable distribution on the Pareto front. However, little work has been done on the effect of referent points in aggregation functions on the distribution of the final optimal solutions.

The setting of reference points in aggregation functions plays a key role in the performance of MOEA/D. Actually, different types of reference points could have different impacts on the search behaviors of MOEA/D. Most MOEA/D variants adopt the ideal point as its reference point. The use of the ideal point would be effective when the population's diversity is easy to maintain as argued in [15]. In contrast, a utopian point is helpful for approximating the PF boundary. In [16], a set of reference points uniformly distributed along the convex hull of PF are employed in MOEA/D for ensuring good diversity. Moreover, some attempts on the use of the nadir point in MOEA/D can be found in [17], [18]. In [18], the reference point changes from the ideal point to the nadir point if fewer solutions are obtained in the boundary regions than in the middle region of the PF after several generations. Very recently, both the utopian point and a generalized nadir point were suggested to be used simultaneously as the reference points in [19].

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