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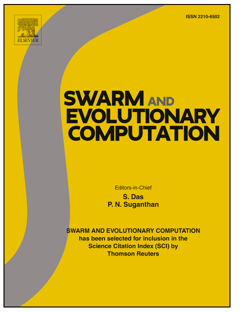


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# Multiobjective evolutionary algorithms based on target region preferences

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**Abstract**

Incorporating decision makers' preferences is of great significance in multiobjective optimization. Target region-based multiobjective evolutionary algorithms (TMOEAs), aiming at a well-distributed subset of Pareto optimal solutions within the user-provided region(s), are extensively investigated in this paper. An empirical comparison is performed among three TMOEA instantiations: T-NSGA-II, T-SMS-EMOA and T-R2-EMOA. Experimental results show that T-SMS-EMOA has the best overall performance regarding the hypervolume indicator within the target region, while T-NSGA-II is the fastest algorithm. We also compare TMOEAs with other state-of-the-art preference-based approaches, i.e., DF-SMS-EMOA, RVEA, AS-EMOA and R-NSGA-II to show the advantages of TMOEAs. A case study in the mission planning of earth observation satellite is carried out to verify the capabilities of TMOEAs in the real-world application. Experimental results indicate that preferences can improve the searching ability of MOEAs, and TMOEAs can successfully find nondominated solutions preferred by the decision maker.

*Keywords:* Target Region, Preferences, Multiobjective Evolutionary Algorithms (MOEA), Satellite Mission Planning

## 1. Introduction

Many real-world applications deal with *multiobjective optimization problems* (MOPs), in which several objectives are to be optimized simultaneously. Because of the conflicting nature of the objectives, a single solution that reaches the optimum for every objective does not exist. Instead, a set of trade-off solutions termed *Pareto optimal solutions* constitute the solution set, which is called *Pareto set* (PS). The corresponding image in the objective space is referred to as *Pareto front* (PF).

*Metaheuristics* are a broad family of non-deterministic optimization methods that may provide a sufficiently good solution to complex optimization problems [1]. Multiobjective Metaheuristics (MOMHs) have demonstrated a great success in solving MOPs, among which multiobjective evolutionary algorithms (MOEAs) are by far very popular and widely used. Other alternatives include particle swarm optimization (PSO), artificial immune system (AIS), ant colony optimization (ACO), etc.

Since the ultimate goal of multi-objective optimization is to assist the *decision maker* (DM) in finding the most preferred solution, the integration of preferences becomes indispensable. Preference-based MOMHs (PMOMHs) have attracted widespread attention in both academic reasearches [2–4] and engineering applications [5–7]. With preference information before (*a-priori*) or during (*interactive*) the optimization process, PMOMHs obtain a subset of Pareto optimal solutions that are of interest to the DM without obtaining the whole PS, thus alleviating the selection burden of the DM.

The preferences can be articulated through reference point [8, 9], Desirability functions [10, 11], aspiration set [12], weight functions [13, 14], trade-off constraints [15, 16], weight vectors [17, 18], pairwise comparison [19, 20], outranking relations [21, 22] and so on. A user-defined region in the objective space in the shape of a rectangle or a circle (which is termed *target region*) is an intuitive and flexible way to express preferences. It is more direct and intuitive than the trade-off constraints or weight vectors, by which the DM has no idea which part of the

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