Opposition-Based Multi-Objective Whale Optimization Algorithm with Multi-Leader Guiding

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Abstract

Over the years, heuristic algorithms have been widely studied, especially in multi-objective optimization problems (MOPs). The multi-objective whale optimization algorithm based on multi-leader guiding (MOWOAMLG) is proposed in this paper, which is the multi-objective version of whale optimization algorithm (WOA). The proposed algorithm adopts several improvements to enhance optimization performance. First, multiple leadership solutions guide the population to search the sparse space to achieve more homogeneous exploration in per iteration, and the leadership solutions are selected on the Pareto front by grid mechanism and the principle of maximum crowding distance. Second, the differential evolution (DE) is employed to generate the offspring for the leadership solutions, while WOA is employed for the ordinary solutions. In addition, a novel opposition-based learning (OBL) strategy is developed to improve the distribution of the initial population. To show the significance of the proposed algorithm, it is tested on the 20 bi-objective and tri-objective unconstrained benchmark problems of varying nature and complexities. The result of numerical experiments shows that the proposed algorithm has competitive advantages in convergence and distribution while compared with other 10 classic or state-of-the-arts algorithms. The convergence curve of IGD indicates that MOWOAMLG is able to obtain good Pareto front in cost of fewer optimization iterations. Moreover, it is tested on load distribution of hot rolling, and the result proves its good performance in real-world applications. Thus, all of the aforementioned results have indicated that MOWOAMLG is comparatively effective and efficient to solve MOPs.

Full Text

This preprint is available for download as a PDF.

Figures

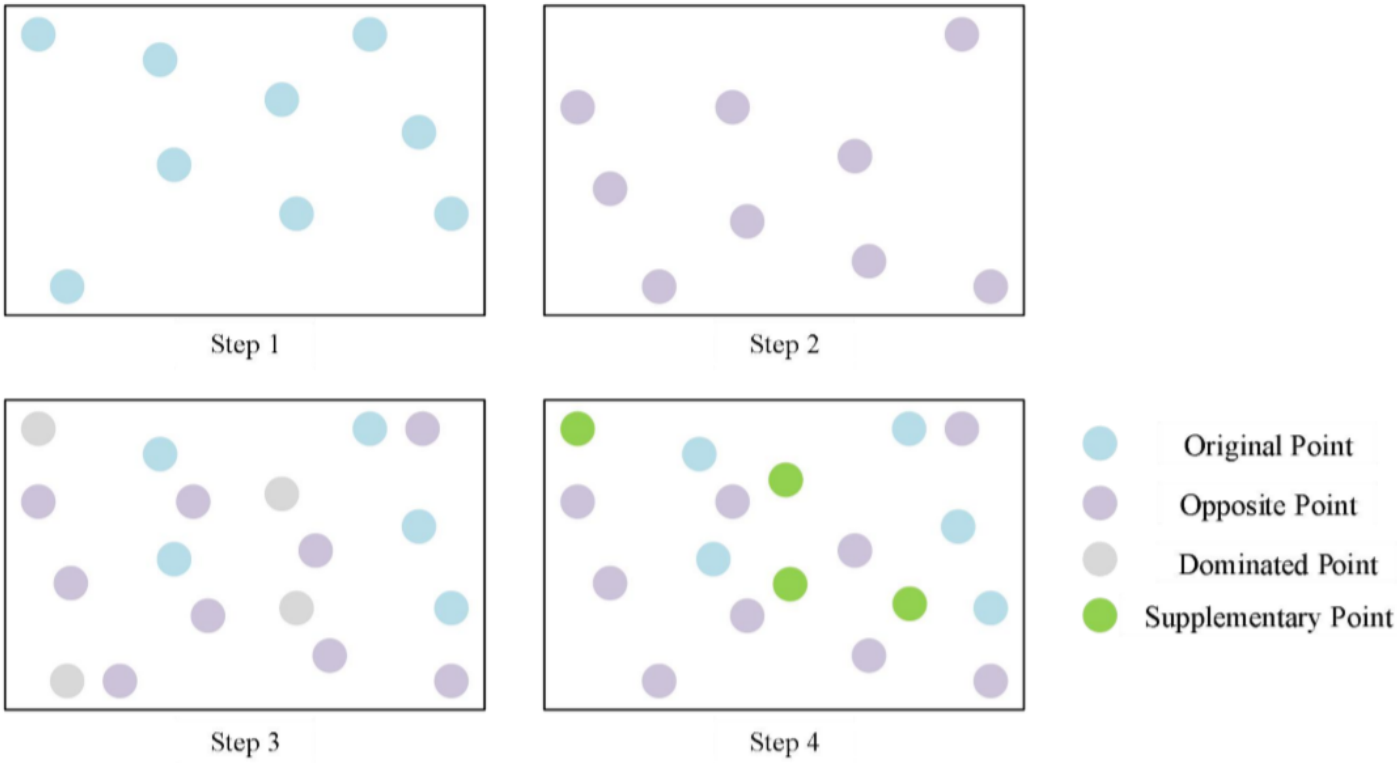

Figure 1

A simple example to show the proposed OBL

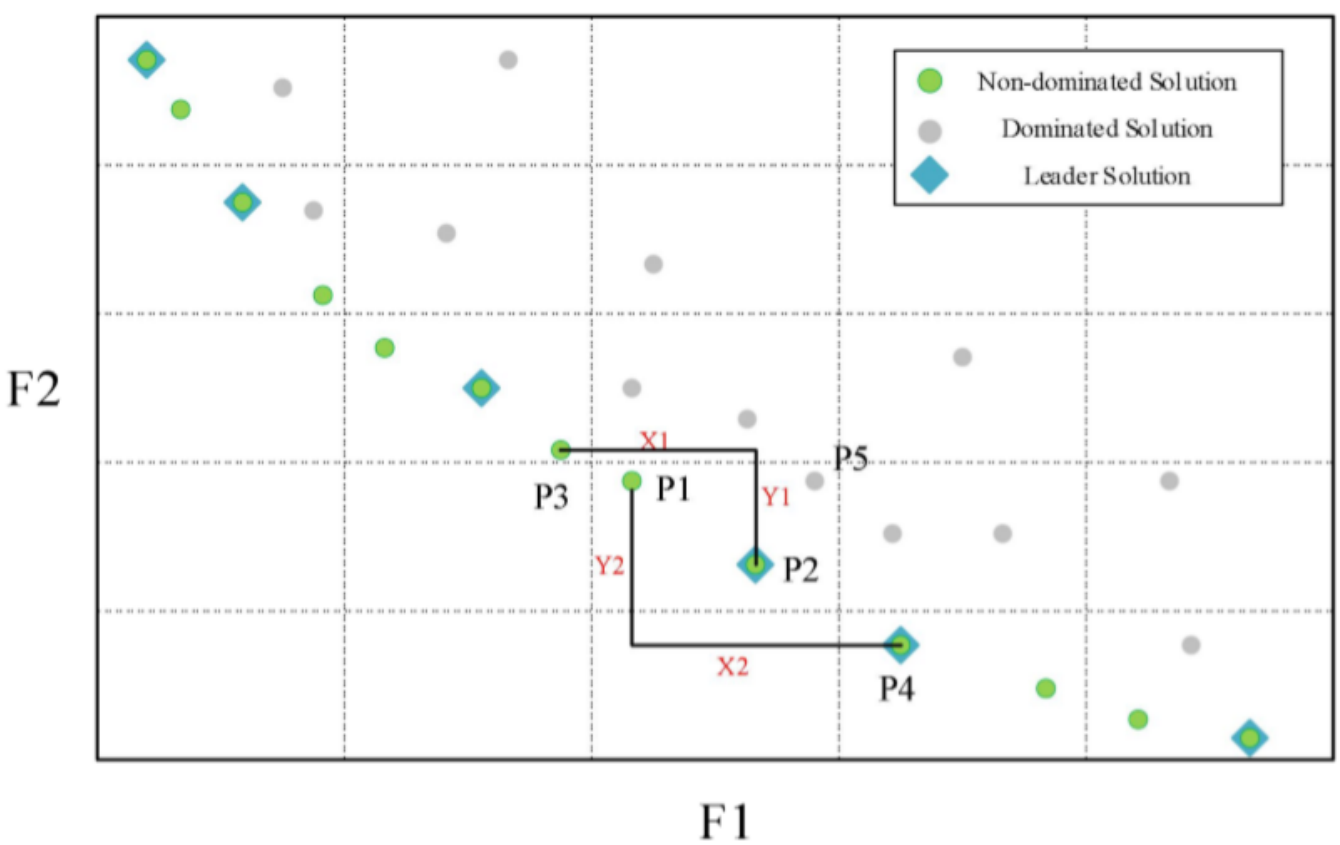

Figure 2

The multi-leader selection mechanism

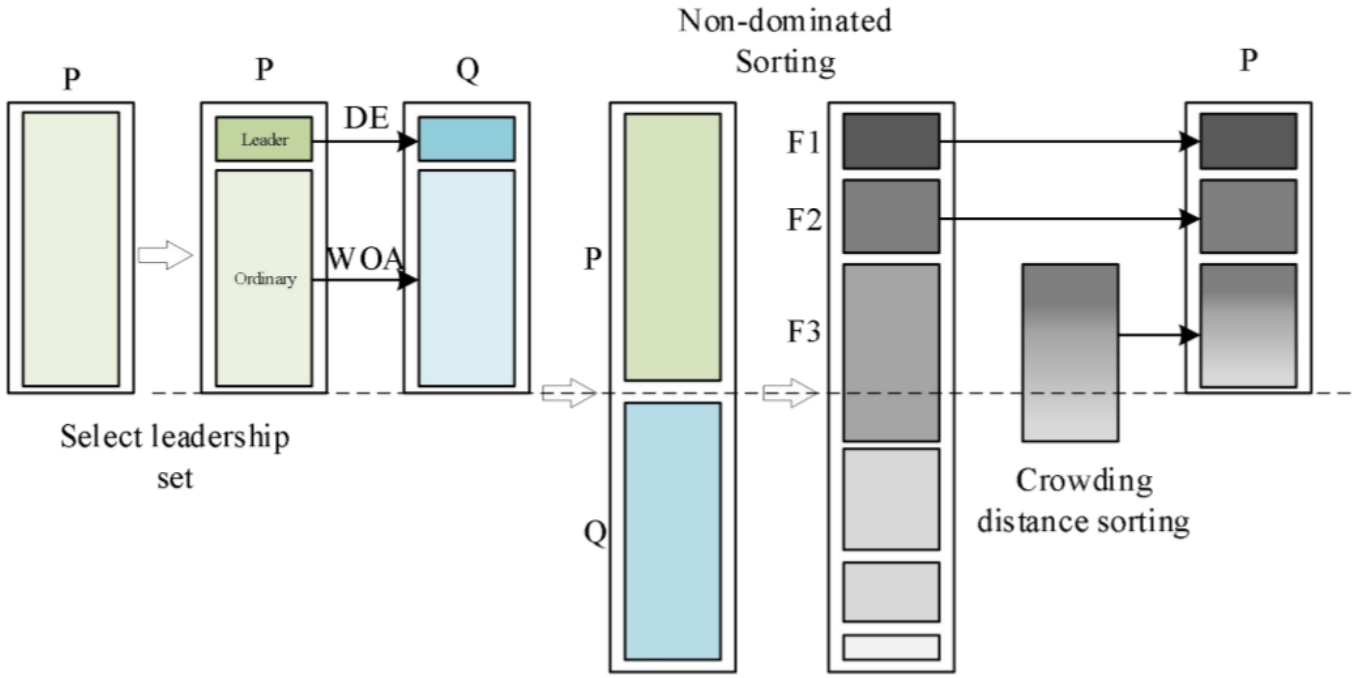

Figure 3

The main cycle procedure

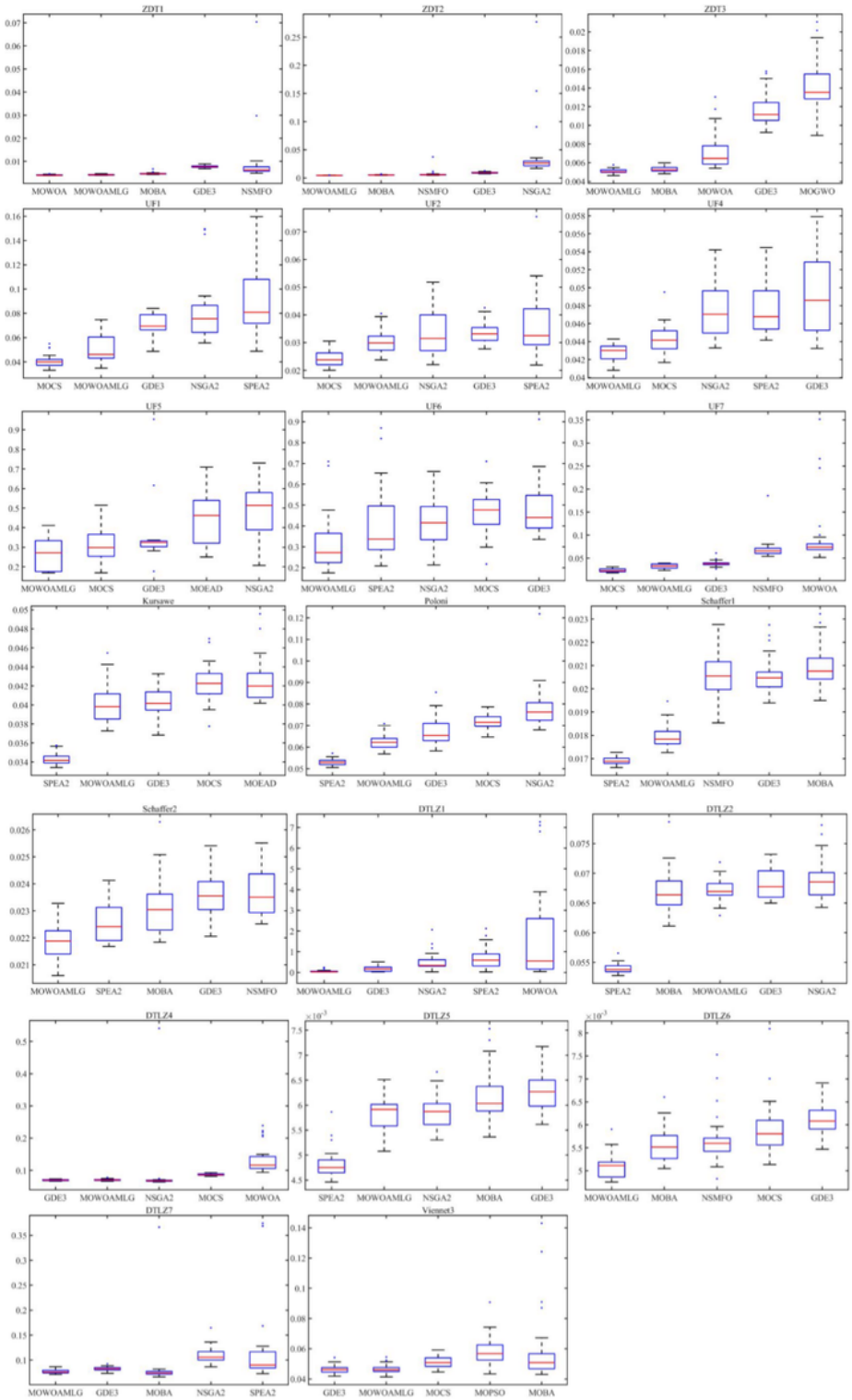

Figure 4

The boxplot of IGD metric

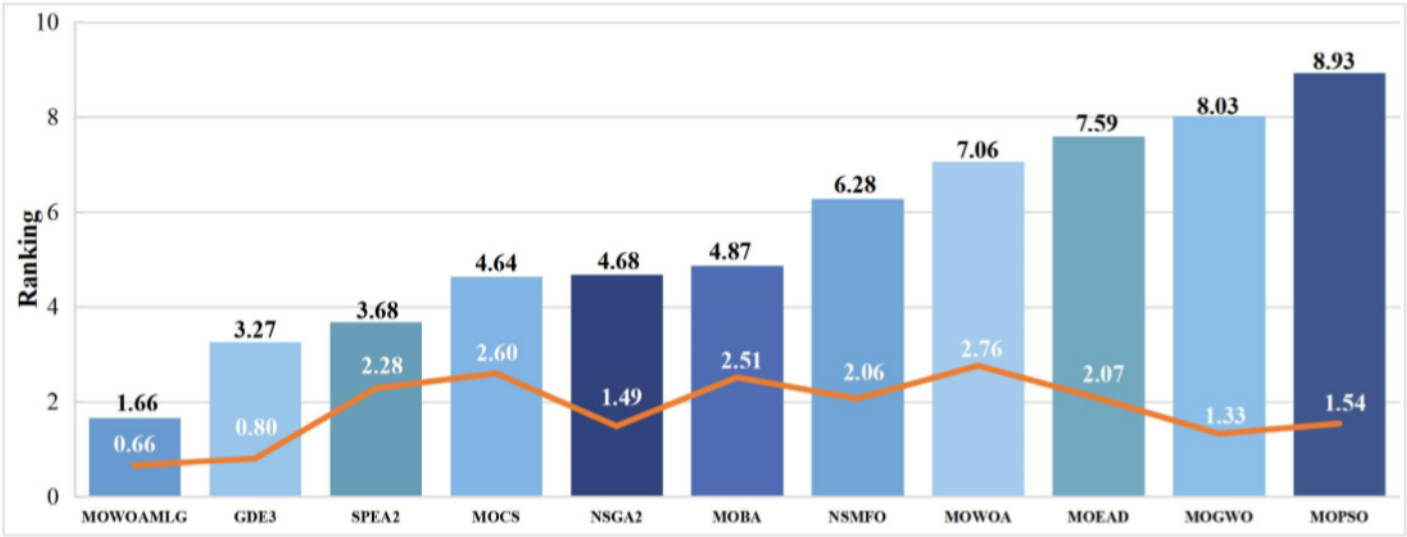

Figure 5

The ranking of IGD metric (bar represents mean, line represents standard deviation)

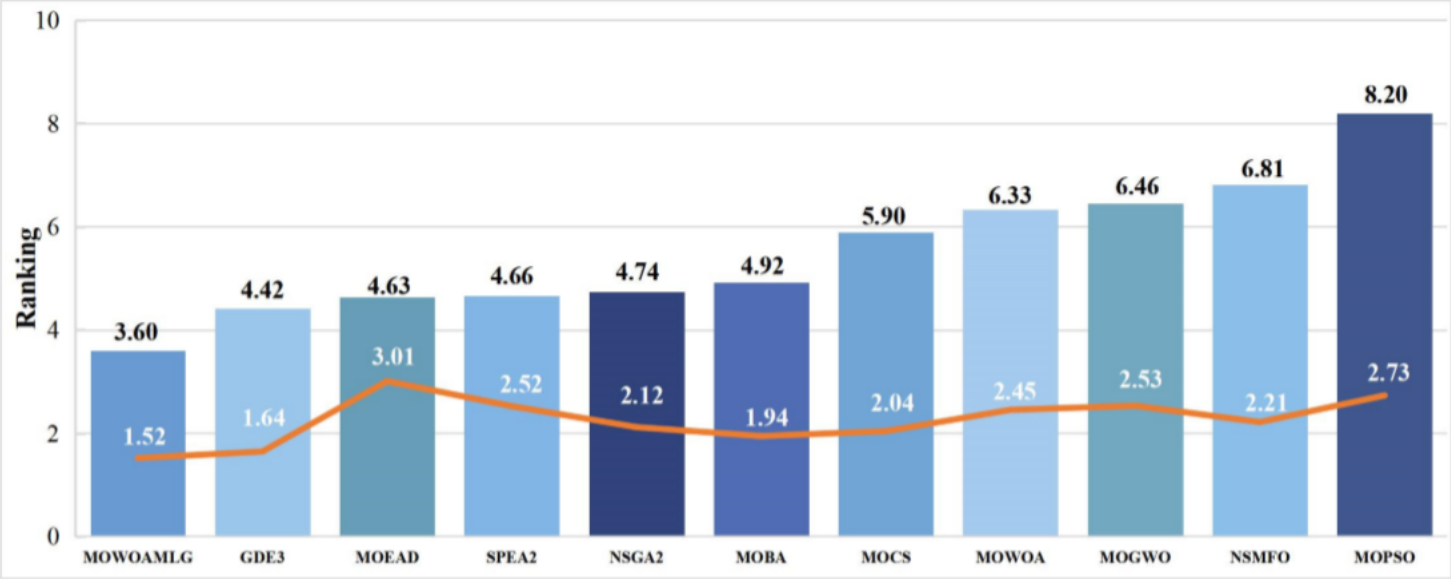

Figure 6

The ranking of GD metric

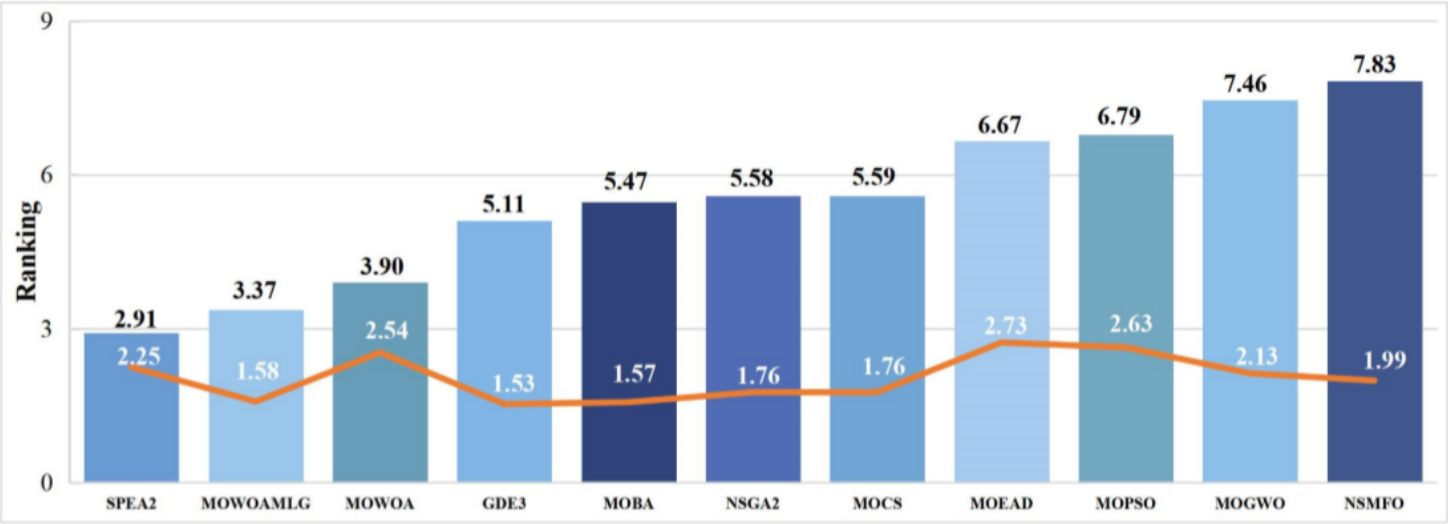

Figure 7

The ranking of SP metric

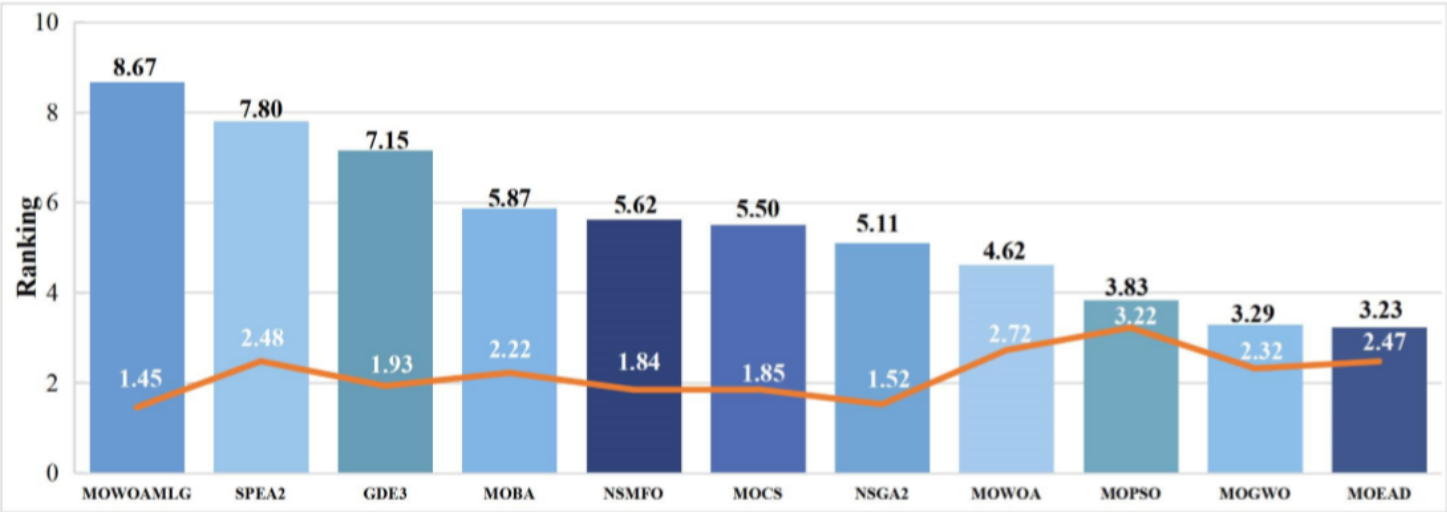

Figure 8

The ranking of CPF metric

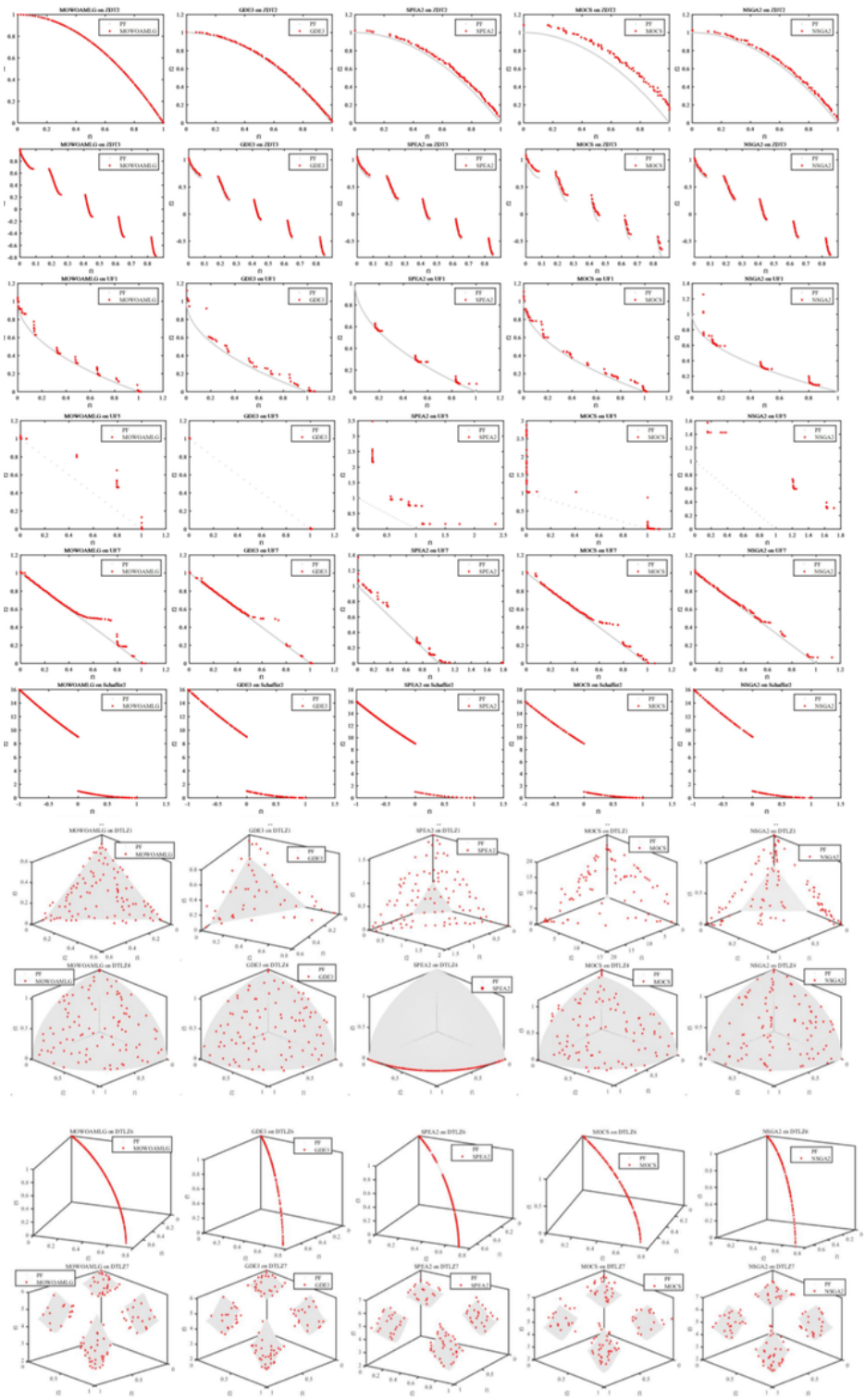

Figure 9

The comparison of the obtained Pareto optimal front

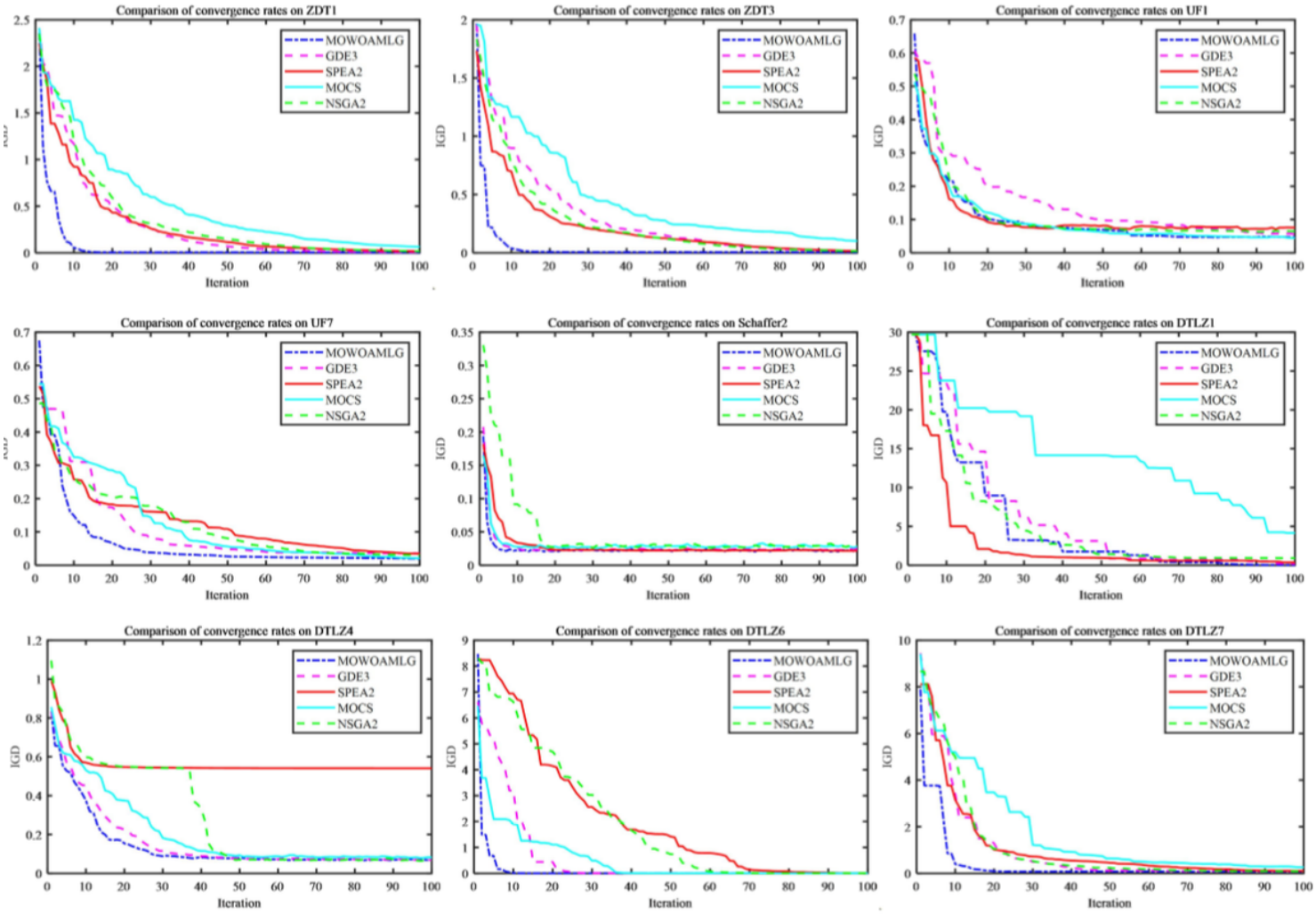

Figure 10

The comparison of convergence speed

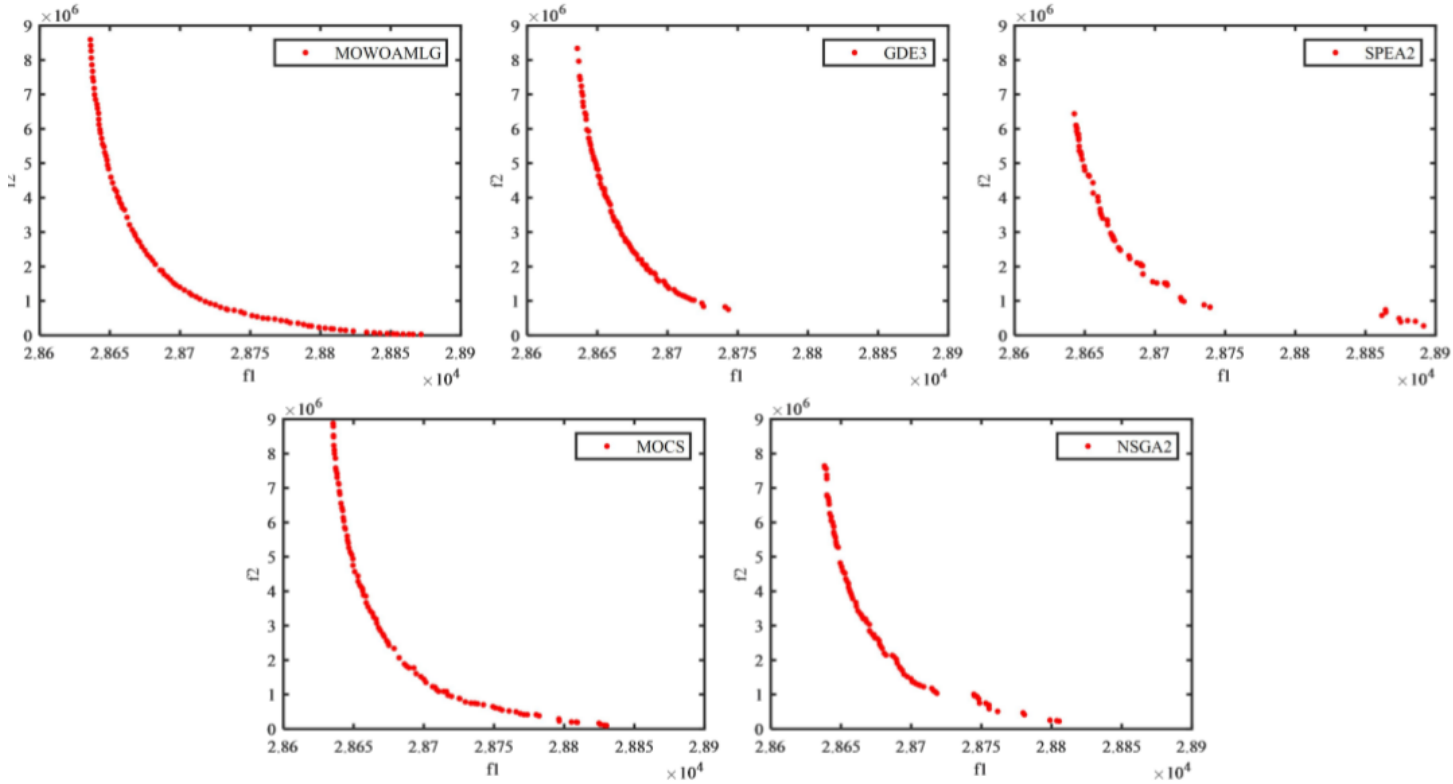

Figure 11

The comparison of the obtained Pareto optimal front on load distribution

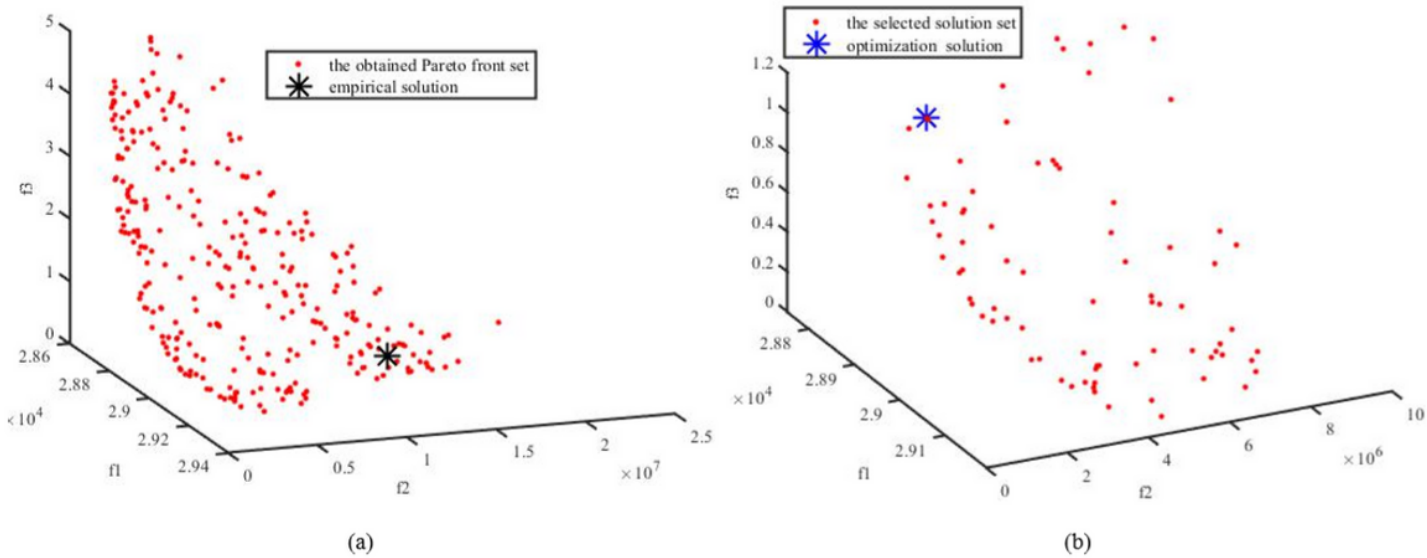

Figure 12

The obtained Pareto optimal front on load distribution