A Dual-Population and Multi-Stage based Constrained Multi-Objective Evolutionary Algorithm

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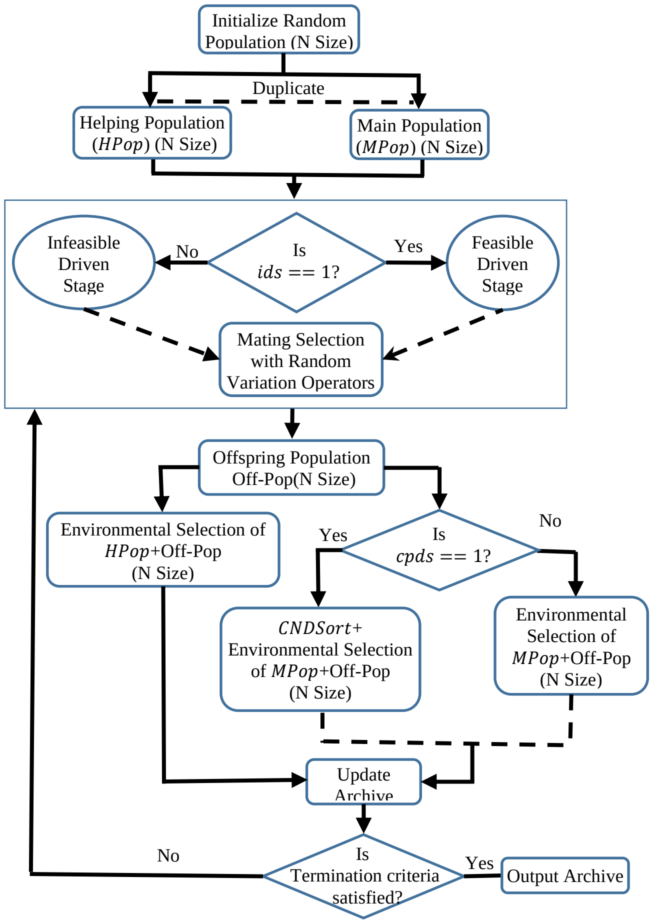

Figure 1. Flowchart of the proposed CMOEA-DPMS

A novel dual population-based multi-staged evolutionary algorithm, which is termed as CMOEA-DPMS. CMOEA-DPMS benefits from the advantages of both multi-stage and multi-population strategies. The general framework of the proposed CMOEA named CMOEA-DPMS, is described in Figure 1. CMOEA-DPMS employs two populations, one archive and divides the evolution in to two stages. One population will act as a Helping

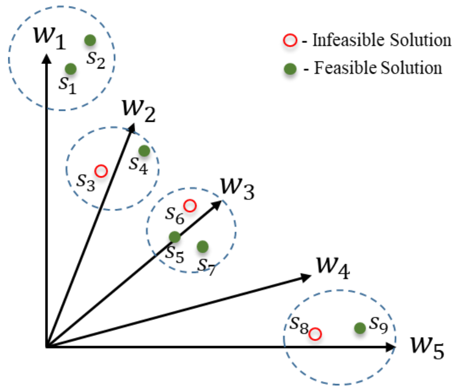

Figure 2. Illustration of $DCDSort$ in 2-objective space

Population ($HPop$) to explore the search space by ignoring constraints and the other population referred to as Main Population ($MPop$) tries to maintain well distributed infeasible/feasible solutions depending on the stage of evolution. However, preference would be given to feasible solutions over infeasible ones. However, the archive is employed to store well converged and uniformly distributed feasible solutions throughout the evolutionary process. The proposed algorithm will be in Infeasible Driven Stage (stage one) and explores the objective space by selecting parents from $HPop$ to generate offsprings. Once the exploration is done, CMOEA-DPMS switches to Feasible Driven Stage (stage two) and prefers to explore more feasible regions by selecting parents from $MPop$ to generate offsprings. The proposed $DCDSort$ is used as primary selection criteria for $MPop$. To preserve the diversity in the $MPop$, $DCDSort$ sometimes prefer infeasible solutions to explore the regions where feasible solutions are not found. Figure 2 illustrates the working mechanism of $DCDSort$ with an example. In Figure 2, five uniformly distributed weight vectors with nine solutions are considered. Nine solutions are associated according to their perpendicular distance to the weight vectors. We can observe from Figure 2 that, s_3 and s_4 are associated with w_2 where s_3 is infeasible solution and s_4 is feasible one. $DCDSort$ classify s_4 into first sub-front and s_3 into second using CNDSort. As in the first front, there exist only one solution, s_4 will be directly selected for next generation. Solutions $\{s_5, s_6, s_7\}$ are associated with w_3 where s_6 is infeasible and $\{s_6, s_7\}$ are feasible. Similarly, $DCDSort$ classify $\{s_6, s_7\}$ into first sub-front and s_6 into second sub-front. As there exist two solutions in the first sub-front, $DCDSort$ selects best solution based on the PBI value. As w_4 has no solutions associated with it, solution closest to w_4 will be selected irrespective to its feasibility.

During the evolutionary process, the adaptive switching between the different stages take place when there is no significant change in the $HPop$. The two populations co-evolve with their own environmental selections but employs a single offspring generation procedure i.e., the offsprings produced in both stages will be shared by both populations.