Adaptive Guided Evolutionary Multi-Objective Optimization

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In Multi-objective Optimization many solutions have to be evaluated in order to provide the decision maker with a diverse Pareto-front. In Simulation-based Optimization the number of optimization function evaluations is very limited. If preference information is available however, the available function evaluations can be used more effectively by guiding the optimization towards interesting, preferred regions. One such algorithm for guided search is the Reference-point guided NSGA-II. It takes reference points provided by the decision maker and guides the optimization towards areas of the Pareto-front close to the reference points. We propose several extensions of R-NSGA-II. In the beginning of the optimization runtime the population is spread-out in the objective space while towards the end of the runtime most solutions are close to reference points. The purpose of a large population is to avoid local optima and to explore the search space which is less important when the algorithm has converged to the reference points. Therefore, we reduce the population size towards the end of the runtime. R-NSGA-II controls the objective space diversity through the epsilon parameter. We reduce the diversity in the population as it approaches the reference points. In a previous study we showed that R-NSGA-II keeps a high diversity until late in the optimization run which is caused by the Pareto-fitness. This slows down the progress towards the reference points. We constrain the Pareto-fitness to force a faster convergence. For the same reason an approach is presented that delays the use of the Pareto-fitness: Initially, the fitness is based only on reference point distance and diversity. Later, when the population has converged towards the Pareto-front, Pareto-fitness is considered as primary-, and distance as secondary fitness. We combine the proposed approaches and evaluate them on benchmark functions and in a case study of an industrial production line for car manufacturing.

Keywords: Adaptive Strategies, Evolutionary Multi-Objective Optimization, guided search, Reference Point, Simulation-Based Optimization.