Dynamic Resampling for Guided Evolutionary Multi-Objective Optimization of Stochastic Systems

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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 R-NSGA-II algorithm. It takes reference points provided by the decision maker and guides the optimization towards areas of the Pareto-front close to the reference points. In Simulation-based Optimization the modeled systems are often stochastic and a reliable quality assessment of system configurations by resampling requires many simulation runs. Therefore optimization practitioners make use of dynamic resampling algorithms that distribute the available function evaluations intelligently on the solutions to be evaluated. Criteria for sampling allocation can be a.o. objective value variability, closeness to the Pareto-front indicated by elapsed time, or the dominance relations between different solutions based on distances between objective vectors and their variability. In our work we combine R-NSGA-II with several resampling algorithms based on the above mentioned criteria. Due to the preference information R-NSGA-II has fitness information based on distance to reference points at its disposal. We propose a resampling strategy that allocates more samples to solutions close to a reference point. Previously, we proposed extensions of R-NSGA-II that adapt algorithm parameters like population size, population diversity, or the strength of the Pareto-dominance relation continuously to optimization problem characteristics. We show how resampling algorithms can be integrated with those extensions. The applicability of the proposed algorithms is shown in a case study of an industrial production line for car manufacturing.

Keywords: Evolutionary Multi-Objective Optimization, guided search, Reference Point, Resampling, Simulation-Based Optimization, Stochastic Systems.