Special Issue on Evolutionary Multiobjective Optimization - Editorial

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Editorial

Evolutionary Multiobjective Optimization (EMO) is a broad, active research field that studies the use of nature inspired stochastic search algorithms in solving optimization problems with two or more conflicting objective functions. The algorithms developed in this area, known under a variety of umbrella terms such as evolutionary algorithms, swarm optimization, or ant colony optimization are heuristic techniques that have the main benefit of being highly configurable to a wide range of problems and user demands. EMO topics range from theoretical considerations and algorithm design to challenging real-world applications, and are therefore of great interest to the Computers and Operations Research audience. At the 23rd International Conference on Multiple Criteria Decision Making (MCDM 2015) in Hamburg, Germany, we organized a special stream on the topic of EMO and invited researchers with or without presented abstracts to contribute to this special issue to showcase the latest scientific results on EMO.

Out of the 28 works originally submitted, we have carefully chosen seven peer-reviewed high-quality papers for this special issue. These present a small snapshot of the state of the art and the variety of the research in the EMO field. An emerging theme among several of the papers is the solution of multiobjective variants of well-known combinatorial optimization problems via the development of hybrid approaches, which combine a local search strategy with a population-based outer loop. The problems considered range from production planning via scheduling and the multiobjective linear assignment problem to the multiobjective traveling salesperson problem, which is considered in two contributions. A second theme is tackling problems involving dynamic or uncertain objectives, as seen in two of the papers. These are complemented by a work on mathematical and engineering test problems, as well as the proposal of a new method for efficient hypervolume calculation.

Paper by paper, the special issue comprises:

Evolutionary Robust Optimization in Production Planning - Interactions between Number of Objectives, Sample Size and Choice of Robustness Measure by Juan Esteban Diaz, Julia Handl, and Dong-Ling Xu investigates the influence of uncertainty on multiobjective and single-objective optimization strategies for a production planning problem of a real manufacturing system. Interactions between the choice of the strategy, the robustness criterion as well as the sample size are considered. The multiobjective approach turns out to be better than the single-objective one with regard to both performance and robustness, and the authors draw some conclusions for choosing the robustness measure appropriately as well.

A Multi-objective Evolutionary Algorithm Guided by Directed Search for Dynamic Scheduling by Du-Juan Wang, Feng Liu, and Yaochu Jin presents an optimization strategy for dynamic multiobjective scheduling problems. Featuring operational costs and the cost of derivation from a baseline schedule as objectives, the scheduling problem allows for continuous arrival of new jobs,

rejection of jobs, as well as controllable job processing times. The proposed hybrid approach consists of a population re-initialization mechanism and three types of offspring generation mechanisms all integrated in NSGA-II. It is found that the new strategy mostly converges faster compared to conventional NSGA-II after a dynamic event occurred, and that it receives better results with respect to the convergence of solutions.

A population-based algorithm for solving linear assignment problems with two objectives by Xavier Gandibleux, Hiroyuki Morita, Naoki Katoh presents a two phase approach for the linear assignment problem with two objectives. In the first step, an initial population is calculated with each solution being an optimal assignment for an appropriate weighted sum of the two objectives. In the second step, an evolutionary process is executed based on the initial population and involving crossover, path-relinking, and local search. The authors emphasize that their algorithm is easy to implement and does not need any parameter tuning. A comparison on 15 publicly available test instances is performed and it is found that the variant enabling all proposed operators performs best, beating previous results in the literature.

An Evolutionary Approach to Generalized Biobjective Traveling Salesperson Problem by Murat Köksalan and Diclehan Tezcaner Öztürk addresses a TSP problem that features multiple edges between nodes in contrast to the classical (multiobjective) TSP problem, where only one edge between nodes needs to be considered. As a result, not only the order of visiting the nodes but also the edge to use between node pairs needs to be determined. To tackle the problem, the authors propose a problem-specific evolutionary algorithm in which the evaluation function only approximates the underlying true multiobjective TSP to gain time in the evolution process. It is shown experimentally that the approach presented works well in approximating the true nondominated sets of different randomproblem instances with 16, 32, and 64 nodes.

Perturbed Decomposition Algorithm applied to the multi-objective Traveling Salesman Problem by Marek Cornu, Tristan Cazenave, Daniel Vanderpooten proposes a new multiobjective population-based meta-heuristic for the bi- and tri-objective symmetric traveling salesperson problem. Their perturbed decomposition algorithm comprises two phases. In the first one, the optimization problem is decomposed into a number of aggregated problems. Resulting solutions of the first phase thereby serve as starting points for a Pareto local search in the second phase. The new approach is tested against two methods considered to be state-of-the-art on random and Euclidean instances. In the bi-objective cases, the new approach generally outperforms the one it is tested against. In the three-objective cases, both alternative methods are outperformed by the new approach, in particular on the larger instances.

Towards Faster Convergence of Evolutionary Multi-Criterion Optimization Algorithms using Karush-Kuhn-Tucker Optimality Based Local Search by Mohamed Abouhawwasha, Haitham Seadab, and Kalyanmoy Deb introduces another hybrid approach to numerical multiobjective problems based on NSGA-III, the successor of the well-known NSGA-II algorithm. Within the proposed algorithm, the worst converged population member is identified by a Karush-

Kuhn-Tucker proximity measure. This solution is considered to undergo an achievements calarization based local search method. A comparison on 17 test functions including two engineering design problems featuring two-, three-, and ten-objective constrained and unconstrained problems is performed. The numerical experiments indicate that the newly proposed approach converges much faster than the conventional NSGA-III.

Box Decomposition Algorithm to Compute the Hypervolume Indicator by Renaud Lacour, Kathrin Klamroth, and Carlos M. Fonseca investigates theoretically the computational complexity of the hypervolume indicator, which is often used in (evolutionary) multiobjective optimization to measure the quality of Pareto front approximations. The authors propose a new type of algorithm based on the idea of partitioning the dominated objective space into axis-parallel hyperrectangles. The algorithm is analyzed for incremental and non-incremental scenarios (in which the set of points is growing over time or not). While having a lower runtime bound that is higher than the worst-case upper bounds for the best available algorithms, the newly proposed algorithm is competitive in numerical experiments on various types of problem instances. Another contribution of the paper is the theoretical proof of improved upper and lower runtime bounds for the well-known WFG algorithm for computing hypervolume.

Besides wishing you, as a reader, an enjoyable time with the papers, we would like to thank everybody who has contributed in one way or another to this special issue. Our sincerest thanks go, of course, to all authors and reviewers who made the most important effort of all to make this edition happen. Many thanks also go to the editors Francisco Saldanha da Gama and Stefan Nickel who supported our final decisions for and our original proposal of the special issue. Finally, we would like to warmly thank Santhosh Rao and Gowri Vasanthkumar from Elsevier for their technical support and their kindness when dealing with daily editorial issues.

Guest Editors of the Special Issue on EMO

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