Beginners with no prior experience will make their first ANP decision. Experts, and those in between the two extremes, will acquire valuable tools and techniques to improve the validity of their ANP decisions. Attendees should come prepared with an interesting decision, big or small, that has at least 3 alternatives and 2 clusters, i.e. groupings, of criteria, with multiple criteria in each cluster to build a decision model during the tutorial. The fundamentals of the ANP will be addressed, just in time, as we build our individual decision model. The ANP Best Practices will serve as our checklist to make sure that we address the critical components of an ANP decision. A review of ANP studies, that were published in the Social Science Citation Index (SSCI) over a one-year period, revealed that over half of the published ANP models had errors or omissions that were serious enough to bring the validity of the published model into question. These findings contributed to the development of the ANP Best Practices. The most common or critical omissions will be covered in greater detail at the specific times that they should be addressed when we are building our decision models. Tools and techniques will be provided to help decision makers: to check for the convergence of the Supermatrix, to identify and adapt a disjoint Supermatrix, to recognize and accurately capture the desired level of dependency in the Supermatrix, to test and improve the Coherency of the Supermatrix, and to conduct and report meaningful sensitivity analysis. By the end of this tutorial, beginners will have “experienced” an ANP model from beginning to end; and experts will have more tools and techniques to improve the validity of their decisions.

Please bring your own laptop to this special session

MON-3-E

Contributed Session: Recent Advances in Multiobjective Optimization

Monday 13:50-15:30 - Room: Hagia Sophia

Chair: Petra Weidner

1. Robustness Indicators for Multi-Objective Integer Linear Programming

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Decision uncertainty is a robustness concept in continuous single and multi-objective optimization, which takes into account the inaccuracy of the implementation of a solution (also called implementation error). Due to technical limitations a solutions might not be feasible for implementation. Implementing a solution in the neighborhood of the computed optimal solution can lead to a smaller or larger loss in solution quality. To limit this loss one can, for example, optimize the worst solution in the neighborhood (minmax). Eichfelder et al. (2017) investigate decision uncertainty for continuous multiobjective problems using set-valued optimization problems as robust counterpart. We transfer this concept to multi-objective combinatorial optimization problems. In the discrete context decision uncertainty is due to the fact that certain items (edge, element, ...) of a Pareto optimal solution might turn out to be unavailable in the implementation phase. Instead of reoptimizing the problem one is interested in repairing a solution by substituting the flawed item. Thus, the originally selected Pareto optimal solution is substituted by a neighboring solution. The neighborhood structure is thereby defined by a combinatorial adjacency structure of the problem. We propose robustness indicators, which are based on those neighborhoods. They are mainly of two types, cardinality indicators and quality indicators. In a first case study we evaluate the robustness indicators on randomly generated instances of the cardinality constrained knapsack problems. Furthermore, by using these indicators as a quality measure for the representation problem we construct representative subsets of the non-dominated set that are robust against decision uncertainty.

2. A New Algorithm for Optimization over the Efficient Set

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Optimization over the efficient set of a multi-objective optimization problem is among the difficult problems in global optimization because of its nonconvexity, even in the linear case. In this paper, we propose a numerical method to tackle this problem when the objective functions and the feasible set of the multi-objective optimization problem are convex. This algorithm penalizes progressively iterates that are not efficient and uses a sequence of convex nonlinear subproblems that can be solved efficiently. The proposed algorithm is shown to perform well on a set of standard problems from the literature, as it allows to obtain optimal solutions in all cases.

3. A Differential Evolution Reference Point Method for Set-based Robustness by Means of the Averaged Hausdorff Distance

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In this work, we propose a method to find efficient solutions in the context of set-based robust multi-objective optimization. In this setting, a solution in decision space maps to a set, which represents the worst possible outcomes given the set of uncertainties. Thus, the task is to find the set of best-worst solutions. This set is highly attractive when the decision maker has an aversion towards risk and would like to perform the decision making from a worst-case approach. Moreover, when the decision maker has an aspiration vector, then we can use reference point methods where the objective is to find the solution whose image minimizes the distance to the aspiration vector. For set-based robustness, that is finding the solution whose set of worst cases is the 'closest' to the aspiration vector. The proposed method has three key components. First, since the image of the solutions is a set, we use the averaged Hausdorff distance to measure the distance from the image of a given solution to the aspiration vector. This formulation reduces the problem to a single-objective optimization problem. The averaged Hausdorff distance has been used by the evolutionary multi-objective community to compare the solutions found by different algorithms, and it has also been used as a selection mechanism for evolutionary algorithms. Next, for every solution in decision space, it is required to find the set of worst-cases. For this purpose, we use the weighted Tchebycheff method to find a good representation of the set. Finally, to find the solution that minimizes the averaged Hausdorff distance, we use a global search method that enables to avoid local optima. Namely, we use the differential evolution algorithm (DE/rand/1/bin) as the search engine. DE has been extensively used when tackling single-optimization problems in continuous spaces with good results. We test the method on an academic test function based on the bi-objective Lamé super-spheres with linear, convex and concave fronts. The results show that the method is capable of finding good solutions from the problem at hand given different aspiration vectors.

4. Scalarization Depending on the Purpose of Multiple Objectives in Optimization

**Petra Weidner, HAWK HHG, Germany, petra.weidner@hawk.de*

When looking for the best solution in practical applications, multiple objectives can come into existence by different reasons. They can express values of attributes, various scenarios in decision making under uncertainty or evaluations of multiple decision makers. This should be taken into consideration for the choice of a scalarizing problem. This aspect is discussed in the presentation. Moreover, it is shown that the