Novel heuristics for solving bi-objective assignment problems based on efficient exploration of the criterion set

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Abstract

In this study we address the bi-objective assignment problem. Our solution approach is an adaptation of a general procedure proposed in the recent literature to solve continual multiobjective optimization problems. The integrality of the decision variables generates a discrete Pareto front, and its full disclosure cannot be straight forward reached by using a framework developed for continual problems. Within our approach, we combine the manner of defining and ordering the subsets of the Pareto front (from the continual approach) with a new way of choosing the hypothetical bounds to be targeted (customized to specific optimization problems). Each hypothetical bound is exclusively chosen from a certain subsest of the criterion space prepared for being disclosed. The TDM model [5]:

$$\max \left\{ \sum_{i=1}^{p} c_i f_i\left(x\right) + p_0 \lambda | x \in X, f_i\left(x\right) \geq \lambda y_i^0, i = \overline{1,p}, \lambda \geq 0 \right\},$$

introduced in the recent literature to solve multiple objective continual problems, is employed to optimize an aggregation of the objectives. The original way of choosing the hypothetical bound y^0 was related to a convex combination of certain already generated non-dominated vectors. We can improve the quality of the generated Pareto front by properly choosing the hypothetical bounds with respect to the characteristics of the discrete decision space. We have already applied a similar framework to solve multiple objective knapsack problems (that are known to be the most approachable combinatorial problems) and mixed-integer linear problems. We refer the reader to [2] and [3] for more details.

We carried out experiments on several instances of bi-objective assignment problems recalled from the literature. Preliminary results show that our approach performs well, being able to derive relevant non-dominated points of the Pareto front. Within experiments we used Octave programming language and its GLPK solver employed for solving all single objective linear optimizations.

For large scale instances we developed heuristics that employs the Hungarian method to solve single objective aggregated assignment problems, and then

improved the solution via TDM model and PESA framework. Within our experiments we used IGD metric [1]:

$$IGD(A, P^*) = \frac{\sum_{v \in P^*} d(v, A)}{|P^*|},$$

as diversity indicator of the quality of generated Pareto front. So far, we carried out experiments on instances recalled from [4] and having two objective functions. We solved small size instances exactly, while we statistically analyzed large size instances. The large scale instances had 200 or 300 operators/jobs.

Keywords: Bi-objective assignment problem, Anytime algorithm, Heuristics

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