Using a parallel tabu search to approximate uniform design

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Abstract. In Multi-objective Optimization (MO), diversity assessment
is one of the most important concern in order to produce an approxi-
mated set of solutions evenly distributed over the Pareto front. To deal
with this issue, recent algorithms such as MOEA/D[2] make use of a
uniformly scattered set of reference points/vectors that indicates search
directions in the objective space. This issue becomes critical in Many-
objective Optimization, promoting the development of many generation
techniques having a rich underlying theory mainly arising from chemistry
and statistics areas.

Among these methods, the Uniform Design (UD) is based on the min-
imization of a discrepancy metric, which measures how well equidis-
tributed the points are in a sample space. Of particular interest in this
work is the centered L_2 discrepancy metric proposed in [1]. An expo-
nentially increasing number of candidate sets can be generated using the
Good Lattice Point (GLP) technique, which involves a huge computa-
tional cost (memory and time). It was demonstrated that the problem
of finding a uniform design under a given discrepancy metric is NP-hard
when the number of runs, $n \to \infty$ and the number of factors, $s > 1$.

In order to solve this optimization problem, a parallel Tabu Search (TS)
is implemented in this work. A specific feature is the tabu list that only
reports "generator parameters", which are the input needed by the GLP
algorithm to generate the set of final reference points. The best reference
sets founded by TS were subsequently used to solve two classical MO
problems with MOEA/D (using the Tchebycheff scalarizing function).
The results are compared with those of the Simplex Lattice Design (SLD)
in terms of the Hypervolume (HV) and Δ-diversity indicators. Results
highlight that the UD allows a significant improvement, particularly re-
garding diversity and when the number of objectives increases.

References

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