The Benefits of Adaptive Parameterisation in Multi-objective Tabu Search

by

Tiziano Ghisu, Geoff Parks, Jerome Jarrett and John Clarkson
University of Cambridge
Department of Engineering
Engineering Design Centre, Trumpington Street, Cambridge, CB2 1PZ, England
e-mail: tg269@cam.ac.uk
web page: http://www-edc.eng.cam.ac.uk/

Real-world optimisation problems are often characterised by large design spaces and a large number of objectives and constraints, generating a highly fragmented and multi-modal landscape that can prove particularly challenging for any optimisation algorithm. Tabu Search has proved particularly efficient in the solution of such optimisation problems, thanks to the reliance on a local search algorithm (Hooke & Jeeves pattern search in the case of our implementation) that, by applying small changes to the design vector, is able to navigate the complex design space efficiently. In this work, we present a modification of the local search algorithm that, based on an adaptive change of the design space parameterisation, allows a re-direction of the search towards the most energetic directions of the design space, which are more likely to produce improvements in the figures of merit. The same approach allows also the dimensionality of the problem to be temporarily reduced, leading to a greater effectiveness of the local search (not only because of the smaller number of designs to be evaluated at every optimisation step, but also because of the elimination of the noisy, less important design variables).

The proposed modification, based on a Principal Components' Analysis of the approximation set, was integrated into the multi-objective Tabu Search implementation of [1] and the two algorithms compared on a real-world optimisation problem (the optimisation of a 7-stage axial compressor preliminary design). The results demonstrate that the modification of the design space parameterisation and the reduction of the problem dimensionality to include only the most significant directions allow a substantial improvement in performance to be achieved, while the performance variability is also correspondingly reduced.

References

[1] D. M. Jaeggi, G. T. Parks, T. Kipouros, and P. J. Clarkson. The development of a multi-objective Tabu Search algorithm for continuous optimisation problems. European Journal of Operational Research, 185:1192–1212, 2008.