# Global Optimization by Multilevel Coordinate Search

Marks 22 of the NAG Fortran Library and the NAG Toolbox for MATLAB and Mark 9 of the NAG C Library include a new Chapter, Global Optimization of a Function (E05), for performing global optimization on a problem with simple bounds using a multilevel coordinate search. This solver is complemented by a number of support routines for initializing the data and setting optional parameters. Derivatives are not required, and the solver is intended for medium-scale problems.

The new solver will be useful in any of the areas in which the existing Local Optimization of a Function (E04) solvers are used, and also in those fields where finding global, not local, optima is vital. Example areas include finance, chemical and phase-equilibrium problems, graph and network analysis, scheduling, protein folding, and robotics.

As a simple illustrative example, Figure 1 shows the global solver applied to the standard test-function of Rastrigin

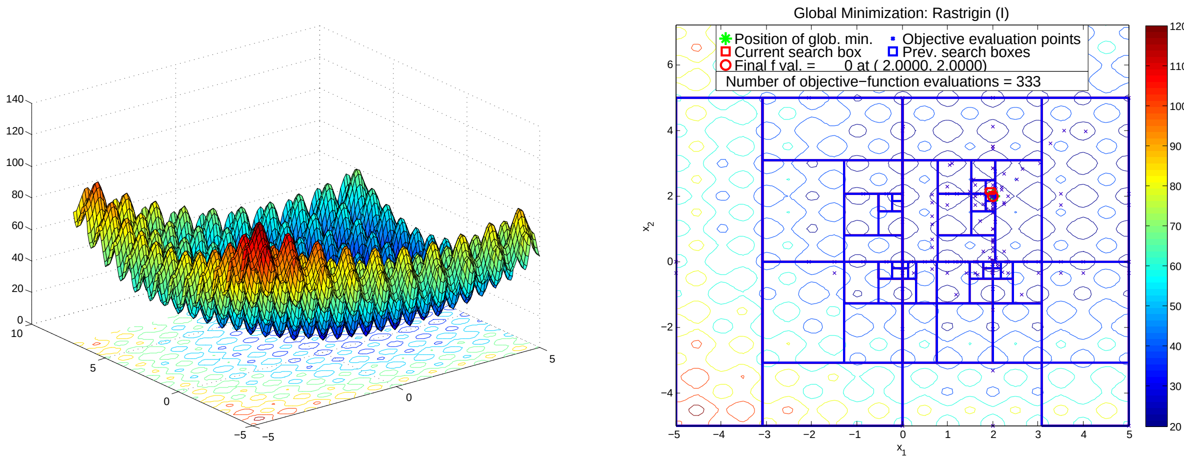
$$f(\boldsymbol{x}) = 10n + \sum_{i=1}^{n} \big((x_i - 2)^2 - 10\cos(2\pi(x_i - 2))\big), \qquad \boldsymbol{x} \in [-5, 5]^n,$$

with $n = 2$. The function has global minimum $f(\boldsymbol{x}^*) = 0$ at $\boldsymbol{x}^* = \mathbf{2}$. The right-hand subfigure shows the boxes in the search space visited by the solver on its way to the global minimum. Note how the solver easily bypasses the 'noisy' areas containing strictly-local minima.

A more realistic problem addressed using a preliminary version of the new solver is described in *Optimizing Omega* [1], by Dr Michael Bartholomew-Biggs (U. Hertfordshire) et al. There, the problem was to compare the performance of a number of financial assets using the so-called *Omega function*, with a view to choosing an optimum portfolio of investments. The Omega function has many local minima, and so the new solver was used in preference to the existing NAG local solvers in order to yield a good approximation to the global minimum. Having found this approximation, more precision can be gained by using local optimization techniques.

## References

[1] S. J. Kane, M. C. Bartholomew-Biggs, M. Cross and M. Dewar, *Optimizing Omega*, J. Global Optimization (online) (2009) (preprint: OptimizingOmegaPaper.pdf)




(a) Contours

(b) Solution

Figure 1: Minimizing Rastrigin's function