L-PSO: A limited-memory quasi-Newton method for global optimisation

M. B. Reed*, N. Thomas†

*Dept of Mathematical Sciences, University of Bath, UK, mbr20@bath.ac.uk
†Dept of Mathematical Sciences, University of Bath, UK, nt207@bath.ac.uk

Quasi-Newton methods are effective and efficient iterative methods for locating a local minimum of a convex differentiable function, from a sufficiently close starting-point. Limited-memory variants such as L-BFGS [1] are of practical use in minimising functions of high dimension. Convergence is poor, however, for non-convex functions or from badly-located initial points. In this paper we propose a hybrid algorithm suitable for multimodal functions, which can find a succession of local minima, leading to the global minimum. To do this, we borrow a paradigm from evolutionary computation, namely Particle Swarm Optimisation (PSO) [2]. From a random initial swarm of points, PSO is used to determine the initial iterate for L-BFGS, leading to a local minimum. A new swarm is then formed, and the algorithm subsequently switches between L-BFGS and PSO search.

A particular feature of the algorithm is that position and gradient information of recent L-BFGS iterates is extracted and used in setting particles of the new swarm. The strategy of combining these particles together with random particles (to increase diversity) in the swarm, proves to be most effective on functions such as Rastrigin and Ackley. The method is also tested on functions with "multi-funnel" landscapes, such as double-Rastrigin [3].

References

[1] D. C. Liu and J. Nocedal, On the limited memory BFGS method for large scale optimization, *Math Prog*, vol. 45, pp. 503-528, 1989.

[2] R. Eberhart and J. Kennedy, A new optimiser using particle swarm theory, *Proc 6th Int Symposium on Micro Machine and Human Science* pp. 39-43, 1995.

[3] M. Lunacek, D. Whitley and A. Sutton, The Impact of Global Structure on Search, *Proc 10th Conference on Parallel Problem Solving from Nature, Dortmund, Germany*, 2008.