February 2012, Université Paris-Sud 11

"**EVOLUTIONARY ALGORITHMS AS OPTIMIZATION TOOLS**"

Author: Prof. Andrea MASSA

Abstract

Optimization strategies based on Evolutionary Algorithms (EAs) have been effectively applied to several problems in engineering and sciences. EAs are based on stochastic iterative procedures which consider a pool of trial solutions at each iteration thus enabling an efficient sampling of the solution space as compared to single-agent stochastic optimization algorithms (e.g., Simulated Annealing). The pool of solutions iteratively updates through the use of proper operators/rules until a convergence criterion is reached.

EAs have shown many attractive features suitable for dealing with large, complex, and nonlinear problems. More specifically, they are hill-climbing algorithms which not require the differentiation of the cost function, which is a "must" for gradient-based methods. Moreover, a-priori information can be easily introduced, usually in terms of additional constraints on the actual solution, and they can directly deal with real values as well as with a coded representation of the unknowns (e.g., binary coding). As regards to the architecture of their implementation, EAs can be effectively hybridized with deterministic procedures and are suitable for parallel computing.

Despite several positive advantages offered by the EAs, further researches are required in this framework to overcome the well-known drawbacks. As a matter of fact, the high computational load and the low convergence rate should be reduced especially when dealing with either high-dimension or highly nonlinear problems.

References

Tutorials

[1] H. Holland, Adaptation in Natural and Artificial Systems. Ann Arbor, MI: University of Michigan Press, 1975.

[2] D. E. Goldberg, Genetic Algorithms in Search, Optimization, and Machine Learning. Boston, MA: Addison-Wesley, 1989.

[3] J. Kennedy, R. C. Eberhart, and Y. Shi, Swarm Intelligence. San Francisco, CA: Morgan Kaufmann, 2001.

[4] M. Dorigo and T. Stutzle, Ant Colony Optimization, Cambridge, MA: MIT Press, 2004.

Advanced

[5] R. L. Haupt and D. H. Werner, Genetic Algorithms in Electromagnetics. Hoboken, NJ: John Wiley & Sons., 2007.

[6] P. Rocca, M. Benedetti, M. Donelli, D. Franceschini, and A. Massa, "Evolutionary optimization as applied to inverse scattering problems," Inverse Problems, vol. 24, pp. 1-41, 2009.

[7] P. Rocca, G. Oliveri, and A. Massa, "Differential Evolution as applied to electromagnetics," IEEE Antennas Propagation Magazine, vol. 53, no. 1, pp. 38-49, Feb. 2011.

Specialized

[8] M. Donelli, G. Franceschini, A. Martini, and A. Massa, "An integrated multiscaling strategy based on a particle swarm algorithm for inverse scattering problems," IEEE Trans. Geoscience Remote Sensing, vol. 44, no. 2, pp. 298–312, Feb. 2006.

[9] P. Rocca, L. Manica, and A. Massa, "An improved excitation matching method based on an ant colony optimization for suboptimal-free clustering in sum-difference compromise synthesis," IEEE Trans. Antennas and Propagation, vol. 57, no. 8, pp. 2297-2306, Aug. 2009.

[10] G. Oliveri, M. Donelli, and A. Massa, "Genetically-designed arbitrary length almost difference sets," Electronics Letters, vol. 5, no. 23, pp. 1182-1183, Nov. 2009.

Table of Contests