A New Accelerated Multi-objective Particle Swarm Algorithm. Applications to Truss Topology Optimization

R. Ellaia[1], A. Habbal[2] and E. Pagnacco [3]

[1]LERMA, Mohammed V - Agdal University, Engineering Mohammadia School, Rabat, BP. 765, Ibn Sina avenue, Agdal, Morocco, ellaia@emi.ac.ma

[2]J.A. Dieudonné Laboratory, Nice Sophia-Antipolis University and INRIA Sophia-Antipolis, France, habbal@polytech.unice.fr

[3]LOFIMS, EA 3828, INSA Rouen BP 8, 76801 Saint-Etienne du Rouvray, France, Emmanuel.Pagnacco@insa-rouen.fr

Abstract. We propose a new algorithm of computation using particle swarm in order to solve multi-objective problems more quickly and effectively. This approach, called accelerated multi-objective particle swarm, is partially based on our previous work [2] and incorporates a vector function as objective function and it uses matrix computation to develop the Pareto front. It contrast with the existing multi-objective algorithms which use an external archive[6].

For example, the study presented in [5] proposes multi-objective PSO with time variant inertia and acceleration coefficients where inertia weight and PSO algorithm parameters expressions depend to iteration number. Other study developed in [9] proposes multi-objective PSO with dynamic population size. Others studies presented in [3, 4, 8] which use hybridization technique.

Unlike all these studies which use inertia weight to develop Pareto front and an external archive to save non-dominated solution, we will modify this algorithm for causing it to use matrix computation, then this algorithm incorporates function vector as objective function and uses Pareto dominance for selecting best solutions and updating Pareto set. In addition, we also propose a new strategy of initialization that contributes too to the acceleration of the algorithm. The resulting algorithm is applied to multi-objective topology optimization of truss structures.

The results produced by such a strategy illustrate that the algorithm is competitive with NSGA-II, MISA and SPEA2 in terms of converging to the true Pareto front. It maintains the diversity of the population, generates better trade-offs and demonstrates that the matrix computation PSO can be used as a reliable numerical optimization tool.

References

[1] Alvarez-Benitez, J. E., Everson, R. M. and Fieldsend, J. E. (2005). A MOPSO algorithm based exclusively on Pareto dominance concepts. Lecture notes in computer science Vol. 3410, pp. 459-473. Springer-Verlag.

[2] H. Bilil, R. Ellaia & M. Maaroufi A New Optimal Multi-objective Reactive Power Dispatch Approach Using Particle Swarm Optimization Based on Matrix Computation. International Conference on Multimedia Computing and Systems (ICMCS), 2012.

[3] Leticia Cagnina, Susana Esquivel and Carlos A. Coello Coello, A Particle Swarm Optimizer for Multi-Objective Optimization, JCS&T Vol. 5 No. 4, pp.204-210, 2005.

[4] Carlos A. Coello Coello, Handling Multiple Objectives With Particle Swarm Optimization, IEEE Transactions on Evolutionary Computation, Vol. 8, No. 3, pp.256-279, 2004.

[5] Praveen Kumar Tripathi, Sanghamitra Bandyopadhyay and Sankar Kumar Pal, Multi-Objective Particle Swarm Optimization with time variant inertia and acceleration coefficients, Information Sciences 177, pp.5033-5049, 2007.

[6] James N. Richardson, Sigrid Adriaenssens, Philippe Bouillard, Rajan Filomeno Coelho. Multiobjective topology optimization of truss structures with kinematic stability repair. Struct Multidisc.Optim DOI 10.1007/s00158-012-0777-5. 28 Feb 2012.

[7] H. Zidani, E. Pagnacco, R. Sampaio, R. Ellaia and J. E. Souza de Cursi. Multi-objective optimization by a new hybridized method: applications to random mechanical systems. Engineering Optimization. DOI:10.1080/0305215X.2012.713355. 04 Sep 2012.

[8] Xiaodong Li, Better Spread and Convergence: Particle Swarm Multiobjective Optimization Using the Maximin Fitness Function ,K. Deb et al. (Eds.): GECCO 2004, LNCS 3102, pp. 117-128, 2004.

[9] Wen-Fung Leong and Gary G. Yen, Dynamic Population Size in PSO-based Multiobjective Optimization, Proceedings of IEEE Congress on Evolutionary, Computation Sheraton Vancouver Wall Centre Hotel, Vancouver, BC, Canada, pp. 6182-6189, 2006.