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Towards a hybrid algorithm of swarm intelligence[*]

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The work deals with numerical analysis of swarm algorithms for global optimization. Basic Particle Swarm Optimization and its modifications Cat Swarm Optimization and Bee Swarm Optimization are considered and tested on synthetic target functions set. A newly hybrid algorithm based on Cat Swarm and Bee Swarm Optimization is described.

Keywords: Global optimization, hybrid algorithm, non-gradient, particle swarm, bee swarm, cat swarm

The term *swarm intelligence* was proposed in 1989 by Gerardo Beni and Jing Wang [1]. Nowadays it means a family of numerical optimization methods, modeling a swarm behavior, where swarm is a set of implicitly interacting objects of living nature [2]. We analyze basic *Particle Swarm Optimization* (PSO) [3] and two inspired by PSO algorithms *Cat Swarm Optimization* (CSO) [4], modeling cats' behavior, and *Bee Swarm Optimization* (BSO) [5], modeling honey bee behavior. We have put these three algorithms under the same conditions: they were implemented in a unified manner and started numerously from the same sets of starting points.

The paper describes comparison results on a few multi-extremal test functions of different landscape (*Schwefel*, *Rastrigin*, *Ackley*, *Lunacek* [6]). In this work all the tests are of dimension of 100 coordinates.

It is shown that CSO and BSO both outreach basic PSO. It is also shown that BSO is better in global sense than CSO especially for target function with large number of local minima. However, CSO is faster when it is already trapped by a local minimum hopper.

And, finally in the paper, a newly hybrid algorithm with probabilistic choice of BSO or CSO steps is presented. Various stochastic strategies for step choice are also described. The results of testing demonstrate the outperform of proposed algorithm over BSO and CSO.

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