SUMMARY OF Ph.D. DISSERTATION

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Title

A Study on Global Optimization Methods with Nonlinear Dynamics and Their Coupling Models

Abstract

The development of the global optimization method, which obtains global minima without being trapped at local minima, has been investigated extensively. So-called "Physically Inspired (PI)" optimization methods, which use dynamic models as computation models, have been proposed, and then, "optimization methods with nonlinear dynamics (ND methods)" have been proposed against a backdrop of developments and successes of PI optimization methods. The common characteristic of ND methods is that a global search is executed using the autonomous movement of the search point, which is driven by a vector quantity given by its dynamic system, such as gradient vector, and the search range is narrowed by an operation such as an annealing procedure. In recent years, meta-heuristics (MH), in which very good strategy is implemented to heuristics, have been proposed against a backdrop of the rapid development of computer functionality and have attracted a great deal of attention. Most of MH are implemented as a coupling system of multiple search points, and interaction among multiple search points moving stochastically is mainly used as their driving force. Therefore, MH have a drawback in that once all of search points are attracted to one agent, their driving force based on effective strategies is degenerated, and diversity of the search is lost. Meanwhile, ND methods keep their diversity with their autonomous movements which enables global searches. However, generally, they do not have intensification strategies to regions where the objective function value is smaller, because they do not have search strategies which take the objective function value into consideration. This is related to the fact that mechanisms of optimization models in ND methods are not analyzed enough even though these models obey deterministic equations.

In this paper, we propose "new optimization models in which ND models are used as basic driving models and good strategies of MH is implemented into them". Specifically, in chapter 2, we first quantitatively analyze dynamic characteristics of single point ND models, and then, we propose some improved models taking good strategies of MH into consideration. In particular, we propose a more effective global optimization method "Draining Method". In the new method, the chaotic search trajectory in the discretized gradient system is attracted into regions where the objective function value is smaller and global optimization is achieved. In chapter 3 and chapter 4, we then propose and systematize new optimization methods with coupling systems of multiple search points. In these methods, autonomous searches using ND models as their driving models are executed, and search strategies which take the objective function value into consideration are introduced into ND models by synchronizations with elite search points. Proposed methods are hybrid methods of ND methods and MH. We consider that ND methods and MH cover each other's demerit exploiting their merits in proposed methods. Hence, we expect improvement of global optimization capabilities for high-dimensional and multi-peaked problems.

In this paper, we refer to the recipe of more general benchmark problems in which drawbacks of typical benchmark problems are avoided. Then, we confirm superior global optimization capabilities of proposed methods through their applications to those proper benchmark problems.