Decomposition and Cooperative Coevolution Techniques for Large Scale Global Optimization

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Abstract

Many real-world optimization problems involve a large number of decision variables. For example, in shape optimization a large number of shape design variables are often used to represent complex shapes, such as turbine blades, aircraft wings, and heat exchangers. However, existing optimization methods are ill-equipped in dealing with this sort of large scale global optimization (LSGO) problems. A natural approach to tackle LSGO problems is to adopt a *divide-and-conquer* strategy. A good example is the early work on a cooperative coevolutionary (CC) algorithm by Potter and De Jong (1994), where a problem is decomposed into several subcomponents of smaller sizes, and then each subcomponent is "cooperatively coevolved" with other subcomponents.

In this tutorial we will provide an overview on the recent development of CC algorithms for LSGO problems, in particular those extended from the original Potter and De Jong's CC model. One key challenge in applying CC is how to best decompose a problem in a way such that the inter-dependency between subcomponents can be kept at minimum. Another challenge is how to best allocate a fixed computational budget among different subcomponents when there is an imbalance of contributions from these subcomponents. Equally dividing the budget among these subcomponents and optimizing each through a round-robin fashion (as in the classic CC method) may not be a wise strategy, since it can waste lots of computational resource. Many more research questions still remain to be answered. In recent years, several interesting decomposition methods (or variable grouping methods) have been proposed. This tutorial will survey these methods, and identify their strengths and weakness. The tutorial will also describe a contribution-based method for better allocating computation among the subcomponents. Finally we will present a newly designed variable grouping method, namely *differential grouping*, which outperforms those early surveyed decomposition methods. We will provide experimental results on CEC'2010 LSGO benchmark functions to demonstrate the effectiveness of this method.

Targeted audience

This tutorial should be of interest to both new beginners and experienced researchers in the area of large scale global optimization. The tutorial will provide a unique opportunity to showcase the latest development on this hot research topic to the EC research community. We expect the tutorial will last about 2 hours.

Course material

The tutorial material will be made available prior to WCCI'2014 via the following URL associated with the CEC'2014 special session on large scale global optimization:
http://goanna.cs.rmit.edu.au/~xiaodong/cec14-lsgo/index.html