Preface

A book should be luminous not voluminous.

Christian Nevell Bovee

This brief (non-voluminous) book is dedicated to deterministic global optimization dealing with optimization models characterized by the objective functions with several local optima (typically, their number is unknown and can be very high). Since the best set of parameters should be determined for these multiextremal models, traditional local optimization techniques and many heuristic approaches can be inappropriate and, therefore, global optimization methods should be applied. Moreover, in these problems the objective functions and constraints to be examined are often *black-box* and hard to evaluate. For example, their values can be obtained by executing some computationally expensive simulation, by performing a series of experiments, and so on. Such a kind of problems is frequently met in various fields of human activity (e.g., automatics and robotics, structural optimization, safety verification problems, engineering design, network and transportation problems, mechanical design, chemistry and molecular biology, economics and finance, data classification, etc.) and corresponds to computationally challenging global optimization problems, being actively studied around the world.

To obtain reliable estimates of the global solution based on a finite number of functions evaluations, some suppositions on the structure of the objective function and constraints (such as continuity, differentiability, convexity, and so on) should be indicated. These assumptions play a crucial role in the construction of any efficient global search algorithm, able to outperform simple uniform grid techniques in solving multiextremal problems. In fact, it is well known that if no particular assumptions are made on the objective function and constraints, any finite number of function evaluations does not guarantee getting close to the global minimum value of the objective function, since this function may have very high and narrow peaks.

One of the natural and powerful (from both the theoretical and the applied points of view) assumptions on the global optimization problem is that the objective function and constraints have bounded slopes. In other words, any limited change in the object parameters yields some limited changes in the characteristics of the objective performance. This assumption can be justified by the fact that in technical systems the energy of change is always bounded. One of the most popular mathematical formulations of this property is the Lipschitz continuity condition, which assumes that the absolute difference of any two function values is majorized by the difference of the corresponding function arguments (in the sense of a chosen norm), multiplied by a positive factor $L < \infty$. In this case, the function is said to be *Lipschitzian* and the corresponding factor L is said to be *Lipschitz constant*. The problem involving Lipschitz functions (the objective function and constraints) is said to be *Lipschitz global optimization problem*.

This brief book is dedicated to deterministic global optimization methods based on the Lipschitz condition. Multiextremal continuous problems with an unknown structure (black-box) with Lipschitz objective functions and functions having the first Lipschitz derivatives defined over hyperintervals are taken into consideration. Such problems arise very frequently in electrical and electronic engineering and other kinds of engineering applications. A brief survey of derivative-free methods and global optimization methods using the first derivatives is given for both one-dimensional and multidimensional cases. Algorithms using several techniques to balance local and global information during the search are described. A class of *diagonal algorithms* based on an efficient strategy that is applied for partitioning the search domain is described. Non-smooth and smooth minorants and acceleration techniques that can speed up several kinds of global optimization methods are introduced and investigated. Convergence conditions, examples of applications, numerical examples, and illustrations are provided. The book is essentially self-contained and is based mainly on results of the authors made in cooperation with a number of colleagues working in several countries.

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