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Evolutionary Computation for Engineering Design Optimization

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Preface

The historical prospect of solving optimization problems can be traced back to the era of Newton, Lagrange, and Cauchy. The development of differential calculus methods of optimization solely depends on the contributions of Newton and Leibnitz to calculus. The foundations of calculus of variations, which deals with the minimization or maximization of functions, depending on the nature of the objective function were incorporated by Bernoulli, Euler, Lagrange, and Weirstrass. Optimization is meant to maximize the efficiency of a system by intelligently controlling its control parameter(s), possibly subject to a set of stipulated constraints.

In Control System Engineering concerned here is Computational Intelligence (CI). Evolutionary algorithms (EA) fall under the domain of Computational Intelligence and it is dominating other categories of optimization techniques and gaining more research interest. Optimization techniques, having reached a degree of maturity in recent years, are being used in a wide spectrum of industries, including aerospace, automotive, chemical, electrical, construction, and manufacturing industries. With rapidly advancing computer technology, computers are becoming more powerful, and correspondingly, the size and the complexity of the problems that can be solved using optimization techniques are also increasing. To find out the parameter(s) value for making systems more efficient, fast and reliable the need of robust, flexible and improved optimization algorithms are increasing day by day. In this book we have concentrated on optimizing the real-world numerical optimization problems. Detailed analyses of some selected real world optimization problems have been done. Those are optimized using the proposed improved variants based on classical optimization algorithm namely Differential Evolution (DE). The Differential Evolution (DE) algorithm emerged as a very competitive form of evolutionary computing more than a decade ago. The first article on DE published as a technical report by Rainer Storn and Kenneth V. Price in 1995. DE operates through the same computational steps as employed by a standard EA. However, unlike traditional EAs, DE employs difference of the parameter vectors to explore the objective function landscape.

A new algorithm, Fitness based adaptive differential evolution algorithm (FBADE), is introduced to deal with reactive power optimization problem. The optimization goal is to minimize the active power losses while maintaining available voltage profiles. In FBADE, the selection of learning strategies and the two control parameters, F and CR, are gradually self-adapted according to the learning experience. The reactive power optimization results show that FBADE can achieve a better solution than other two algorithms and the saving percent of system losses are obviously higher by FBADE, comparing with differential evolution algorithm (DE).

This book has been organized into 6 chapters. Contents of chapters have been briefed in following paragraphs.

Chapter 1 provides basic understanding of optimization problems definition, introduction in brief about Evolutionary Algorithm (EA), various components of EA, different type of popular EA algorithm, basic idea of classical DE with pseudo code; these are required to understand the consequent chapters.

In Chapter 2, a detailed review the literature of DE algorithms in many optimization problems and its application is provided.

Chapter 3 presents a conceptual outline of the DE algorithm in sufficient details. It then reviews six prominent variants of DE, including DE with trigonometric mutation, DE with arithmetic recombination, DE/rand/1/either-or, self-adaptive DE, opposition-based DE, and the binary DE.

In chapter 4, a detailed discussion about the fitness based adaptation in Differential Evolution and its schemes is provided which show the Mutation and Crossover features.

In chapter 5, a discussion and comparison between DE and Fitness based adaptive DE is made with CEC – 2005 benchmark set. The results of comparison between DE and the Fitness based adaptive DE is also provided for the fuzzy based clustering method.

In chapter 6, the conclusion of the book has been drawn and the guidelines for future research have been developed.

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