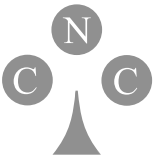
Natural Computing Series



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Benjamin Doerr • Frank Neumann
Editors

Theory of Evolutionary Computation

Recent Developments in Discrete Optimization

Springer

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Preface

The theory of evolutionary computation, or, more generally, randomized search heuristics, is aimed at understanding how these methods work and why they are so successful in many applications. While there has always been theoretical work in this field, and even more since Ingo Wegener (1950–2008) pushed for a mathematical approach inspired by the classical field of randomized algorithms, this research area remains young and many astonishing advances have only been made in the last five to ten years. These include new and more powerful methods, the solution of long-standing open problems, and the analysis of heuristics that could not be analyzed before. Not only have the topics changed and become closer to what is the state of the art in applications, but also the field has progressed from only analyzing existing methods to finding unexpected and more powerful parameter choices, designing new building blocks such as mutation operators, selection operators, and mechanisms that adjust parameters on the fly, and even proposing completely new heuristics.

In this edited book, we report on some of these recent developments. Our aim is to give a concise summary of the state of the art to experts in the field and to make this exciting area more accessible to students and researchers in related fields.

The book starts with two chapters on mathematical methods that are often used in the analysis of randomized search heuristic. These are followed by three chapters on how to measure the complexity of a search heuristic: we discuss black-box complexity, a counterpart of classical complexity theory in black-box optimization, parameterized complexity, aimed at a more fine-grained view of the difficulty of problems, and the fixed-budget perspective, which answers the question of how good a solution will be after investing a certain computational budget. We then describe theoretical results on three important questions in evolutionary computation, namely how to profit from changing the parameters during the run of an algorithm, how evolutionary algorithms are able to cope with dynamically changing or stochastic environments, and how population diversity influences performance. Finally, we look

at three algorithm classes that have only recently become the focus of theoretical work, namely estimation-of-distribution algorithms, artificial immune systems, and genetic programming.

We hope that this book will help students and researchers in the field and around it to access these topics, to deepen their understanding, and possibly to join this young and exciting area, in which many very fundamental questions are still wide open.

We thank all authors for accepting the time-consuming task of writing a book chapter and for completing this task to perfection. We are very grateful to the reviewers of each chapter, whose careful reading is a guarantee of the high quality we aim at. Our final thanks go to the publisher, and, in particular, Ronan Nugent, for all their help and responsiveness, and to the copyeditor, Douglas Meekison, for his work on the book manuscript.

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