

Preface

Evolutionary algorithms constitute a class of well-known numerical methods, which are based on the Darwinian theory of evolution and Mendelian theory of heritage. They are partly based on random and partly based on deterministic principles. Due to this nature, it is challenging to predict its performance in solving complex nonlinear problems. Many techniques and hybridization methods have been developed to improve the algorithmic performances. These methods are typically based on statistical approaches and usually lead to a recommended setting for a given algorithm or a class of algorithms. Also, very diverse hybridizations are suggested by utilizing deterministic chaos instead of using other pseudorandom number generators, showing promising features and unique advantages. Recently, the study of evolutionary dynamics is focused not only on the traditional investigations, but also on the understanding and analyzing new principles, with the intention of controlling and utilizing their properties and performances toward more effective real-world applications.

This book, based on many years of intensive research of the authors, is proposing novel ideas about advancing evolutionary dynamics toward new phenomena including many new topics, even the dynamics of equivalent social networks. In fact, it includes more advanced complex networks and incorporates them with the CMLs (coupled map lattices), which are usually used for spatiotemporal complex systems simulation and analysis, based on the observation that chaos in CML can be controlled, so does evolution dynamics. It will be shown that evolutionary algorithms can be understood just like dynamical systems with feedback. Thus, at least in theory, all engineering control methods can be applied. All such ideas will be illustrated and discussed in the following chapters. All the chapter authors are, to the best of our knowledge, originators of the ideas mentioned above and researchers on evolutionary algorithms and chaotic dynamics as well as complex networks, who will provide benefits to the readers regarding modern scientific research on related subjects.

The organization of the chapters in the book is as follows. The book consists of three parts. The first part (Theory) discusses and explains basic ideas about swarm dynamics and evolutionary algorithms related to complex networks and CML systems. Chapter 1 presents most important notions with comprehensive references. Chapter 2 discusses how to create networks from evolutionary dynamics, based on a few selected evolutionary algorithms, like ant colony optimization, with original experiments and visualizations. The second part (Applications) shows how the idea above can be applied to developing various effective algorithms and what levels of success it can reach to. Chapter 3 reports the use of the differential evolution algorithms and its conversion into networks with performance improvements. Chapters 4–6 explain, in more details, the conversion, analysis, and improvement of the SOMA algorithm using the complex network framework. In Chap. 7, the use of complex networks in particle swarm algorithms is discussed, followed by an investigation of artificial bee colony algorithms in Chap. 8. Chapter 9 then presents different views on how randomization and complex networks can be constructed for meta-heuristic algorithms. The last part (Miscellanies) contains a few interesting chapters as possible extensions of the above-discussed ideas to other directions. Chapter 11 discusses possibilities for dynamics and communications of swarm computer viruses to be visualized as a network. This can be necessary for its analysis and prevention in the future. Today, the most advanced virus-attacking technology is perhaps Botnet or viruses developed based on the CnC (command and control) technology, e.g., Stuxnet or Gauss. Such new viral technologies can be used not only for swarm intelligence, but also for the evolution of virus codes. This chapter predicts the future merging of technologies such as swarm intelligence, evolution dynamics, and complex networks. Chapter 12 further explains how networks are related to the way they are extended to cellular automata. Chapter 13 studies the topic of this book but from an opposite point of view as for how evolutionary dynamics can be used to design power grid networks. Chapter 14 discusses the dynamic analysis of genetic regulatory networks which can be an inspiration to be applied to topics mentioned above.

Regarding the readership of the book, it presents instructional materials for senior undergraduate and graduate students in computer science, physics, applied mathematics and engineering, among others, who are working in the fields of complex networks and evolutionary algorithms, and even chaotic dynamics. Researchers who want to learn more on how evolutionary algorithms can be constructed, analyzed, or controlled, as well as the relationships among swarm dynamics, complex networks, and CML systems, will find this book very useful. The book will be a resource handbook and material collection for practitioners who want to apply these methods to solve real-life problems in challenging applications.

This book is by no means comprehensive on the three fields of research due to its page limitation. Only selected basic ideas and main results are reported. For further

info, it is recommended to read referenced literature, which contains all relevant research results and the latest research progress. The editors and the chapter authors hope that the readers will find the book informative and valuable for their studies, experiments, and simulations.

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Methodology, Perspectives and Implementation

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