

# **Studies in Computational Intelligence**

Volume 626

## **Series editor**

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Donald Davendra · Ivan Zelinka  
Editors

# Self-Organizing Migrating Algorithm

Methodology and Implementation

 Springer

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*Donald Davendra would like to dedicate this  
book to his father Michael Davendra.*

# Foreword

Since the beginning of our civilization, the human race in its engineering challenges has had to confront numerous technological problems such as finding optimal solutions for various problems in civil engineering, scheduling, control technologies, and in many other fields. These examples encompass both ancient and modern technologies such as automatic theater controlled by special programs in ancient Greece (Heron of Alexandria), the first electrical energy distribution network in the USA, mechanical, electronic as well as computational controllers, and control and scheduling of the space exploration. Technology development of these and related areas has had and continues to have a profound impact on our civilization and our everyday lifestyle.

A special class of algorithms that plays an important role in the solution process of the above-mentioned problems is the so-called nature-inspired algorithms. The oldest in this class are evolutionary algorithms that are based on Darwinian evolution theory and Mendel's theory of propagation of genetic information. These algorithms are simple, flexible, mathematically unrestrictive, and very powerful. This book discusses one of such algorithms that was proposed in 1999 and subsequently further developed and published as conference articles, journal articles, and book chapters. It is SOMA: Self-Organizing Migrating Algorithm that mimics competitive-cooperative behavior of a pack of intelligent agents. SOMA can be regarded as a member of the family of swarm intelligence algorithms and is based on effective combination of exploration and exploitation. The SOMA has been used during its existence by numerous researchers from different countries for solving diverse tasks such as controller design, chaos control, synthesis and identification, electronic circuit synthesis, synthesis of control program for an artificial ant (Santa Fe trail), aircraft wing design, mathematical model synthesis for astrophysical data, artificial neural network synthesis, and learning among many others.

The book you are holding in your hands consists of a detailed description of SOMA principles, its history with all relevant references and selected new as well as summarized application of this algorithm. Authors of the chapters are well-experienced practitioners and researchers in their respective fields.

The topics discussed in this book cover the above-mentioned areas and they are cohesively joined into a comprehensive text, which while discussing the specific selected topics gives a deeper insight into the interdisciplinary fusion of those modern and promising areas of emerging technologies in computer science.

Therefore, this book titled *Self-Organizing Migrating Algorithm: Methodology and Implementation*, edited by Donald Davendra and Ivan Zelinka, is a timely volume to be welcomed by the community focused on innovative algorithms of optimization, computational intelligence, and beyond. This book is devoted to the studies of common and related subjects in intensive research fields of nature-inspired algorithms. For these reasons, I enthusiastically recommend this book to our students, scientists, and engineers working in the aforementioned fields of research and applications.

Singapore  
October 2015

Ponnuthurai Nagaratnam Suganthan

# Preface

Swarm-based algorithms have become one of the foremost researched and applied heuristics in the field of evolutionary computation within the past decade. One of the new and novel approaches is that of the self-organizing migrating algorithm (SOMA). Initially developed and published in 2001 by Prof. Ivan Zelinka, SOMA has been actively researched by a select group of researchers over the past decade and a half.

SOMA is conceptualized on a predator/prey relationship, where the sampling of the search space is conducted on a multidimensional facet, with the dimension selection conducted pre-sampling, using a randomly generated PRT vector. Two unique aspects of SOMA, which differentiate it from other swarm-based algorithms, are the creation and application of the PRT vector, and the path length, which specifies the distance and sampling required within a particular dimension.

Over the past few years, SOMA has been modified to solve combinatorial optimization problems. This discrete variant so-called discrete self-organizing migrating algorithm (DSOMA) has been proven to be robust and efficient.

With its ever-expanding applications and utilization, it was thought beneficial and timely to produce a collated work of all the active applications of SOMA, which shows its current state of the art. To this effect, we have reached out and have obtained original research topics in SOMA and its application from a very diverse group of academics and researchers. This provides a rich source of material and ideas for both students and researchers.

**Chapter authors' background:** Chapter authors are to the best of our knowledge the originators or closely related to the originators of the different variants and applications of SOMA.



## Organization of the Chapters

The book is divided into two parts. The first part methodology is divided into two chapters. The first chapter “[SOMA—Self-organising Migrating Algorithm](#)” written by the originator of SOMA, Ivan Zelinka, introduces SOMA to the broad audience. The second chapter “[DSOMA—Discrete Self-Organising Migrating Algorithm](#)” by Davendra, Zelinka, Pluhacek, and Senkerik describes the discrete variant of SOMA.

The second part of the book describes the different implementations of SOMA. The chapters in this section are given in the following order. Chapter “[SOMA and Strange Dynamics](#)” by Zelinka introduces the concepts of chaos and complex networks in SOMA.

Chapter “[Multi-objective Self-organizing Migrating Algorithm](#)” by Kadlec and Raida introduces multi-objective SOMA (MOSOMA), whereas chapter “[Multi-objective Design of EM Components](#)” describes its application to EM component design.

Chapter by Běhálek, Gajdůs, and Davendra shows the “[Utilization of Parallel Computing for Discrete Self-organizing Migration Algorithm](#)” using OpenMP and CUDA.

Chapter “[C-SOMAQI: Self-organizing Migrating Algorithm with Quadratic Interpolation Crossover Operator for Constrained Global Optimization](#)” by Singh, Agarway, and Deep introduces another variant of SOMA, C-SOMAQI, to solve constrained optimization problems. Another hybrid variant C-SOMGA also used to solve constrained optimization problems is given in chapter “[Optimization of Directional Overcurrent Relay Times Using C-SOMGA](#)” by Deep and Singh. SOMAGA is further expanded in chapter “[SOMGA for Large Scale Function Optimization and its Application](#)” to solve large-scale and real-life problems.

Chapter “[Solving the Routing Problems with Time Windows](#)” by Čičková, Brezina, and Pekár describes the application of SOMA to the vehicle routing problem. The same authors apply SOMA to financial modeling in chapter “[SOMA in Financial Modeling](#).”

The final two chapters deal with SOMA parameters and influences. Chapter “[Setting of Control Parameters of SOMA on the Base of Statistics](#)” by Čičková and Lukáčik looks at different statistical bases for SOMA parameter settings. The final chapter “[Inspired in SOMA: Perturbation Vector Embedded into the Chaotic PSO Algorithm Driven by Lozi Chaotic Map](#)” by Pluhacek, Zelinka, Senkerik, and Davendra looks at the influences of the PRT vector in the PSO algorithm.

**Audience:** The book will be an instructional material for senior undergraduate and entry-point graduate students in computer science, applied mathematics, statistics, management and decision sciences, and engineering, who are working in

the area of modern optimization. The book will also serve as a resource handbook and material for practitioners who want to apply SOMA to solve real-life problems and challenging applications.

USA and Czech Republic  
October 2015

Donald Davendra  
Ivan Zelinka

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