

Preface

This book is written for engineers, scientists, and students studying/working in the Optimization, Artificial Intelligence (AI) or Computational Intelligence (CI) arena, and particularly involved in the Collective Intelligence (COIN) field. Mainly, the book in detail provides the core and underlying principles and analysis of the different concepts associated with an emerging AI tool in the framework of COIN for modeling and controlling distributed Multi-Agent Systems (MAS) referred to as Probability Collectives (PC). The tool was first proposed by David Wolpert in 1999 in a technical report presented to NASA and was further elaborated by Stefan Bieniawski in 2005.

More specifically, the book in detail discusses the modified PC approach proposed by the authors of this book. The modifications reduced the computational complexity and improved the convergence and efficiency of the PC methodology. In order to further extend the PC approach and make it more generic and powerful, a number of constraint handling techniques are incorporated into the overall framework to develop the capability for solving constrained problems since real-world practical problems are inevitably constrained problems. In the course of these modifications, various inherent characteristics of the PC methodology are thoroughly explored, investigated, and validated. The book demonstrates the validation of the modified PC approach by successfully optimizing several unconstrained test problems. The first constrained PC approach exploits various problem-specific heuristics for successfully solving two test cases of the Multi-Depot Multiple Traveling Salesmen Problem (MDMTSP) and several cases of the Single Depot MTSP (SDMTSP). The second constrained PC approach incorporating penalty functions into the PC framework is tested by solving a number of constrained test problems. In addition, two variations of the feasibility-based rule for handling constraints are proposed and are tested solving two cases of the Circle Packing Problem (CPP) as well as various cases of the Sensor Network Coverage Problem (SNCP). The results highlighted the robustness of the PC algorithm solving all the cases of the SNCP. In addition, PC with feasibility-based rule is successfully applied for solving several discrete and mixed variable problems in the structural and mechanical engineering domain.

The mathematical level in all the chapters is well within the grasp of the scientists as well as the undergraduate and graduate students from the engineering and computer science streams. The reader is encouraged to have basic knowledge of probability and mathematical analysis. In presenting the PC and associated modifications and contributions, emphasis is placed on development of the fundamental results from basic concepts. Numerous examples/problems are worked out in the text to illustrate the discussion. These illustrative examples may allow the reader to gain further insight into the associated concepts.

Over a period of 7 years, the material has been tested extensively and published in various prestigious journals and conferences. The suggestions and criticism of various reviewers and colleagues had a significant influence on the way the work has been presented in this book.

We are much grateful to our friends and colleagues for reviewing the different parts of the manuscript and for providing us valuable feedback. The authors would like to thank Dr. Thomas Ditzinger, Springer Engineering In-house Editor, Studies in Computational Intelligence Series, Professor Janusz Kacprzyk (Editor-in-Chief, Springer Studies in Computational Intelligence Series), and Mr. Holger Schäpe (Editorial Assistant, Springer Verlag, Heidelberg) for the editorial assistance and excellent cooperative collaboration to produce this important scientific work. We hope that the reader will share our excitement to present this volume on ‘Meta-heuristic Clustering’ and will find it useful.

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Probability Collectives

A Distributed Multi-agent System Approach for
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