

Preface

In this book, a novel optimization method inspired by a paradigm from nature is introduced. The chemical reactions are used as a paradigm to propose an optimization method that simulates these natural processes. The proposed algorithm is described in detail and then a set of typical complex benchmark functions is used to evaluate the performance of the algorithm. Simulation results show that the proposed optimization algorithm can outperform other methods in a set of benchmark functions.

This chemical reaction optimization paradigm is also applied to solve the tracking problem for the dynamic model of a unicycle mobile robot by integrating a kinematic and a torque controller based on fuzzy logic theory. Computer simulations are presented confirming that this optimization paradigm is able to outperform other optimization techniques applied to this particular robot application.

This book is intended to be a reference for scientists and engineers interested in applying optimization techniques for solving problems in pattern recognition, intelligent control, intelligent manufacturing, robotics, and automation. This book can also be used as a reference for graduate courses like the following: soft computing, intelligent pattern recognition, computer vision, applied artificial intelligence, and similar ones. We consider that this book can also be used to get novel ideas for new lines of research, or to continue the lines of research proposed by the authors of the book.

In [Chap. 1](#), we begin by offering a brief introduction to the potential use of the chemical optimization method in different real-world applications. We describe the use of this method for optimizing type-2 fuzzy systems in problems of intelligent control of nonlinear plants. We also mention other possible applications of the proposed chemical optimization paradigm.

We describe in [Chap. 2](#) the basic concepts, notation, and theory of nature-inspired optimization in general, and then of chemical optimization, in particular. This chapter overviews the background, main definitions, and basic concepts, useful for the development of this investigation work.

We describe in [Chap. 3](#) a brief overview of the basic concepts from chemical methods needed for this work. In this chapter, some definitions of the chemical reactions are offered as a basis for understanding the proposed chemical optimization algorithm.

[Chapter 4](#) introduces the chemical reaction algorithm and describes the main characteristics and definitions. Once the optimization algorithm is presented, it is applied to a set of benchmark functions; the obtained results are compared with the results obtained with genetic algorithms and other optimization paradigms. In the second stage, this chemical reaction algorithm is applied to optimize the parameters of the membership functions of a Type-1 and Type-2 fuzzy logic controller for the tracking of a unicycle mobile robot. With this work, we demonstrate that this novel optimization paradigm is able to perform well in these specific topics and will encourage its use in different soft computing approaches.

We describe in [Chap. 5](#) the application problems used to test the proposed chemical method. In this chapter, first a set of benchmark mathematical functions are presented, which are standard functions usually considered to test new optimization algorithms. In a second phase a more complicated problem of designing type-1 and type-2 fuzzy controllers for an autonomous mobile robot is also considered as a test for the chemical optimization paradigm.

We describe in [Chap. 6](#) the simulation results and comparison with other approaches for both kinds of application problems presented in [Chap. 5](#). First, the simulation results for a set of benchmark mathematical functions are presented. Second, the simulation results for the problem of designing type-1 and type-2 fuzzy controllers for an autonomous mobile robot is presented and compared against other methods, like genetic algorithms.

We offer in [Chap. 7](#) the conclusions of this work, and envision some future research work. Basically, a new optimization method based on mimicking the chemical reactions in nature was introduced. The main characteristics of this algorithm are the exploiting mechanisms combined with the elitist survival strategy, which prevents the algorithm from stagnating in local optima.

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