PREFACE

The intent of this book is to present a variety of multi-objective problems (MOPs) which have been solved using multi-objective evolutionary algorithms (MOEAs). Due to obvious space constraints, the set of applications included in the book is relatively small. However, the editors believe that such a set is representative of the current trends among both researchers and practitioners across many disciplines.

This book aims not only to present a representative sampling of real-world MOPs currently being tackled by practitioners, but also to provide some insights into the different aspects related to the use of MOEAs in real-world applications. The reader should find the material particularly useful in analyzing the pragmatic (and sometimes peculiar) point of view of each contributor regarding how to choose a certain MOEA and how to validate the results using metrics and statistics.

Another aspect that is worth addressing is the limited variety of MOEAs adopted throughout this book which is not as diverse as those presented in the literature. This indicates a certain degree of maturity within this research community, and at the same time defines some important current trends among practitioners. By reading the chapters, it is evident that certain MOEAs that some researchers in the field might consider "old-fashioned" (e.g., the *Niched Pareto Genetic Algorithm*) continue to be used by various practitioners. At the same time, it is evident that other "modern" MOEAs (e.g., the *Non-dominated Sorting Genetic Algorithm II*) with available software are becoming increasingly popular. As MOEA software evolves and each incorporates an increasingly larger variety of operators, generic MOEA software should be available. For example, such software is currently being integrated into various optimization packages incorporating a variety of search techniques. Of course, the MOEA discipline contin-

ues to evolve more sophisticated variants, hybridization techniques, unique methodologies depending on the problem domain, and use of efficient parallel computation, with application to an increasing broader class of high-dimensional complex problems.

The spectrum of real-world optimization MOPs dealt with in this book include, among others, aircraft design, robot planning, identification of interesting qualitative features in biological sequences, circuit design, production system control, city planning, ecological system management, and bioremediation of chemical pollution. Thus the organization of the book is structured around engineering, biology, chemistry, physics, and management disciplines. Throughout this book, the reader should find not only problems with different degrees of complexity, but also with different practical requirements, user constraints, and a variety of MOEA solution approaches.

We would like to thank all the contributors for providing their insights regarding the use of MOEAs in solving real-world multi-objective problems. Without their serious consideration, contemplation, and devoted efforts in general, the discipline of MOEAs would not have evolved as well as this book. Such activity makes MOEAs a viable approach in finding effective and efficient solutions to complex MOPs. Observe that the contributors are from many countries reflecting the international interest in MOEA applications and the interdisciplinary nature of optimization research.

As indicated, this book presents a collection of MOEA applications which provide the professional and the practitioner with direction to achieving "good" results in their selected problem domain. For the beginner, the Introductory chapter and the variety of MOEA application chapters should provide an understanding of generic MOPs and MOEA parameter and operator selection leading to acceptable results. For the expert, the variety of MOP applications generates a wider understanding of MOEA operator selection and insight to the path leading to problem solutions.

Additional applications and theoretical MOEA papers can be found at the Evolutionary Multi-Objective Optimization (EMOO) Repository internet web site at `http://delta.cs.cinvestav.mx/~ccoello/EMOO/` with mirrors at `http://www.lania.mx/~ccoello/EMOO/` and at `http://neo.lcc.uma.es/emoo/`. As of mid 2004, the EMOO Repository

contained over 1700 bibliographic references, including more than 100 PhD theses, and over 1000 conference papers and 400 journal papers. However, the EMOO Repository is continually being updated. There is not only a large collection of bibliographic references (many of them electronically available), but also contains public-domain MOP and MOEA software and sample test problems as well as some other useful information which allows one to start working in this exciting research field.

The general organization of the book is based on the types of applications considered. Chapter 1 provides some preliminary material intended for those not familiar with the basic concepts and terminology adopted in evolutionary multi-objective optimization. This first chapter also provides a brief description of each of the other 29 chapters that integrate this book. These 29 chapters are divided in four parts. The first part is the largest and it consists of engineering applications (e.g., civil, mechanical, aeronautical, and chemical engineering, among others). This first part includes chapters 2 to 13. The second part consists of scientific applications (e.g., computer science, bioinformatics and physics, among others) and includes chapters 14 to 19. The third part consists of industrial applications (e.g., design, manufacture, packing and scheduling, among others) and includes chapters 20 to 24. The fourth and last part consists of miscellaneous applications such as data mining, finance and management. This last part includes chapters 25 to 30.

The first editor gratefully acknowledges the support obtained from CINVESTAV-IPN and from the NSF-CONACyT project 42435-Y. He also thanks Dr. Luis Gerardo de la Fraga for his continuous support and Erika Hernández Luna for her valuable help during the preparation of this book. The second author acknowledges the support of his graduate students including Rick Day and Mark Kleeman. We also acknowledge the use of an academic license of the `Word2Tex`^{TM} converter (developed by *Chikrii Softlab*) to convert some of the chapters submitted in `MS Word`^{TM} to LaTeX 2_ε, which is the tool that we adopted to process the entire manuscript.

The editors thank Steven Patt, from *World Scientific*, who was very professional, incredibly helpful and always replied promptly to all of the editors' queries. The editors also thank Prof. Xin Yao for deciding to include this book within his *Advances in Natural Computation* series.

Finally, the editors would like to thank their spouses for letting them spend the many hours on the preparation of the manuscript. Also, we thank the many students, researchers and practitioners working in this field. They have contributed directly and indirectly a large variety of ideas that continue to expand this interdisciplinary field of multi-objective evolutionary computation. Their constant efforts and contributions have made possible this book and innovative publications that we expect to see in the years to come.

Carlos A. Coello Coello
Gary B. Lamont
August 2004