

Lecture Notes in Economics and Mathematical Systems

535

Founding Editors:

M. Beckmann
H. P. Künzi

Managing Editors:

Prof. Dr. G. Fandel
Fachbereich Wirtschaftswissenschaften
Fernuniversität Hagen
Feithstr. 140/AVZ II, 58084 Hagen, Germany

Prof. Dr. W. Trockel
Institut für Mathematische Wirtschaftsforschung (IMW)
Universität Bielefeld
Universitätsstr. 25, 33615 Bielefeld, Germany

Editorial Board:

A. Basile, A. Drexler, W. Güth, K. Inderfurth, W. Kürsten, U. Schittko

Springer

Berlin

Heidelberg

New York

Hong Kong

London

Milan

Paris

Tokyo

Xavier Gandibleux
Marc Sevaux
Kenneth Sörensen
Vincent T'kindt (Eds.)

Metaheuristics for Multiobjective Optimisation



Springer

Editors

Prof. Xavier Gandibleux
University of Valenciennes
LAMIH - ROI
UMR CNRS 8530
Campus Le Mont Houy
59313 Valenciennes Cedex 9
France

Prof. Marc Sevaux
University of Valenciennes
LAMIH - SP
UMR CNRS 8530
Campus Le Mont Houy
59313 Valenciennes Cedex 9
France

Prof. Kenneth Sörensen
University of Antwerp
Faculty of Applied Economics
Prinsstraat 13
2000 Antwerp
Belgium

Prof. Vincent T'kindt
University of Tours
Department of Computer Science
Polytech' Tours
64 avenue Jean Portalis
37200 Tours
France

Cataloging-in-Publication Data applied for

Bibliographic information published by Die Deutsche Bibliothek.
Die Deutsche Bibliothek lists this publication in the Deutsche Nationalbibliographie; detailed
bibliographic data is available in the Internet at <<http://dnb.ddb.de>>.

ISSN 0075-8442

ISBN 978-3-540-20637-8 ISBN 978-3-642-17144-4 (eBook)

DOI 10.1007/978-3-642-17144-4

This work is subject to copyright. All rights are reserved, whether the whole or part of the material is concerned, specifically the rights of translation, reprinting, re-use of illustrations, recitation, broadcasting, reproduction on microfilms or in any other way, and storage in data banks. Duplication of this publication or parts thereof is permitted only under the provisions of the German Copyright Law of September 9, 1965, in its current version, and permission for use must always be obtained from Springer-Verlag. Violations are liable for prosecution under the German Copyright Law.

springeronline.com

© Springer-Verlag Berlin Heidelberg 2004

Originally published by Springer-Verlag Berlin Heidelberg New York 2004

The use of general descriptive names, registered names, trademarks, etc. in this publication does not imply, even in the absence of a specific statement, that such names are exempt from the relevant protective laws and regulations and therefore free for general use.

Typesetting: Camera ready by editors

Cover design: *Erich Kirchner*, Heidelberg

Printed on acid-free paper 55/3142/du 5 4 3 2 1 0

Preface

A large number of real-life optimisation problems can only be realistically modelled with several—often conflicting—objectives. This fact requires us to abandon the concept of “optimal solution” in favour of vector optimization notions dealing with “efficient solution” and “efficient set”. To solve these challenging multiobjective problems, the metaheuristics community has put forward a number of techniques commonly referred to as *multiobjective metaheuristics* (MOMH).

By its very nature, the field of MOMH covers a large research area both in terms of the types of problems solved and the techniques used to solve these problems. Its theoretical interest and practical applicability have attracted a large number of researchers and generated numerous papers, books and special issues. Moreover, several conferences and workshops have been organised, often specialising in specific sub-areas such as multiobjective evolutionary optimisation.

The main purpose of this volume is to provide an overview of the current state-of-the-art in the research field of MOMH. This overview is necessarily non-exhaustive, and contains both methodological and problem-oriented contributions, and applications of both population-based and neighbourhood-based heuristics.

This volume originated from the *workshop on multiobjective metaheuristics* that was organised at the Carré des Sciences in Paris on November 4–5, 2002. This meeting was a joint effort of two working groups: EU/ME and PM2O.

EU/ME¹, the *European chapter on metaheuristics* is chaired by Marc Sevaux and Kenneth Sörensen and is a working group of EURO², the European association of operational research societies. The MOMH workshop was the second EU/ME joint meeting.

¹ <http://www.ruca.ua.ac.be/eume>, <http://www.euro-online.org/eume/>

² <http://www.euro-online.org>

The second organising group was the French working group PM2O³ on multiobjective mathematical programming, chaired by Xavier Gandibleux and Vincent T'kindt. Created in 1999 as the continuation of a one-day meeting on multiobjective programming, PM2O was formally recognized in 2000 as a working group of the french Operational Research society, ROADEF, to become in 2003 a working group of the CNRS inside the GDR I3⁴. This group organises two meetings per year.

Attendance to the MOMH workshop was free of charge. To keep the costs to a minimum, all communication was done electronically and all expenses were sponsored by PM2O and EU/ME. The workshop attracted 60 participants, coming from France, Belgium, United Kingdom, Spain, Germany, Portugal and Norway, but also from Cuba and Mexico.

During the workshop 27 presentations were done in three kinds of sessions: tutorial, technical and poster sessions, with only one stream of presentations to ensure fruitful exchanges. All the information related to this event is available at the MOMH web site⁵, where the interested reader can also download the abstracts and/or slides of the presentations.

At the end of the workshop we announced the creation of this volume and 17 full papers were submitted. After a stringent reviewing process only 9 papers were accepted for publication. The quality of this volume is largely the result of the excellent work done by the 41 referees involved in the process. We would therefore like to express our sincerest gratitude to all of them:

Jürgen Branke
 Luciana Buriol
 Rafael Caballero Fernández
 Victor Cavalcante
 Carlos Coello Coello
 Clarisse Dhaenens
 Luca Di Gaspero
 Wout Dullaert
 Dorabela Gamboa
 António Gaspar-Cunha
 Jean-Marc Godart
 Andrea Grosso
 Gregory Gutin
 Thomas Hanne
 Hisao Ishibuchi
 Andrzej Jaszekiewicz
 Joshua Knowles
 Christos Koulamas

³ <http://www.li.univ-tours.fr/pm2o>

⁴ <http://sis.univ-tln.fr/gdri3/>

⁵ <http://www.ruca.ac.be/eume/momh.html>

Marek Kubiak
Dario Landa Silva
Marco Laumanns
Heikki Maaranen
Lawrence Mandow Andaluz
Sheik Meeran
Julian Molina
Hiroyuki Morita
Alan Murray
Domenico Quagliarella
Serpil Sayin
Frederic Semet
Patrick Siarry
Thomas Stuetzle
El-ghazali Talbi
Dagmar Tenfelde-Podehl
Jonathan Thompson
Daniel Tuyttens
David Van Veldhuizen
Michel Vasquez
Antony Vignier
Jef Wijsen
Eckart Zitzler

With both methodologically oriented chapters and problem oriented chapters, this volume proposes to the reader all the elements needed to enter the field of MOMH or to discover original metaheuristics applied to multiobjective optimisation. Enjoy it!

September 2003,

Xavier Gandibleux,
Marc Sevaux,
Kenneth Sörensen,
Vincent T'kindt.

Contents

Part I Methodology

1 A Tutorial on Evolutionary Multiobjective Optimization <i>Eckart Zitzler, Marco Laumanns, Stefan Bleuler</i>	3
2 Bounded Pareto Archiving: Theory and Practice <i>Joshua Knowles, David Corne</i>	39
3 Evaluation of Multiple Objective Metaheuristics <i>Andrzej Jaszkiewicz</i>	65
4 An Introduction to Multiobjective Metaheuristics for Scheduling and Timetabling <i>J. Dario Landa Silva, Edmund K. Burke, Sanja Petrovic</i>	91

Part II Problem-oriented Contributions

5 A Particular Multiobjective Vehicle Routing Problem Solved by Simulated Annealing <i>Daniel Tuyttens, Jacques Teghem, Nasser El-Sherbeny</i>	133
6 A Dynasearch Neighborhood for the Bicriteria Traveling Salesman Problem <i>Eric Angel, Evripidis Bampis, Laurent Gourvès</i>	153
7 Pareto Local Optimum Sets in the Biobjective Traveling Salesman Problem: An Experimental Study <i>Luis Paquete, Marco Chiarandini, Thomas Stützle</i>	177
8 A Genetic Algorithm for Tackling Multiobjective Job-shop Scheduling Problems <i>Joost Garen</i>	201

**9 RPSGAe - Reduced Pareto Set Genetic Algorithm:
Application to Polymer Extrusion**

António Gaspar-Cunha, José A. Covas 221