To Eva, Leon, Benna, and Zimba

Foreword

Rigorously proven upper and lower run-time bounds for simplified evolutionary algorithms on artificial optimization problems on the one hand and endless tables of benchmark results for real-world algorithms on today's or yesterday's hardware on the other, is that all one can do to justify their invention, existence, or even spreading use? Thomas Bartz-Beielstein gives thoughtful answers to such questions that have bothered him since he joined the team of researchers at the Chair of Systems Analysis within the Department of Computer Science at the University of Dortmund. He brings together recent results from statistics, epistemology of experimentation, and evolutionary computation.

After a long period in which experimentation has been discredited in evolutionary computation, it is regaining importance. This book far exceeds a discussion of often-met points of criticism of the usual experimental approach like missing standards, different measures, and inaccurate and irreproducible results. Also, fundamental objections against the experimental approach are discussed and cleared up. This work shows ways and means to close the gap between theoretical and experimental approaches in algorithm engineering. It becomes clear that statistical tests are the beginning and not the end of experimental analyses. Vital in this context is the differentiation between statistically relevant and scientifically meaningful results, which is clearly developed by Thomas Bartz-Beielstein.

The results of this book—especially the sequential parameter optimization developed in Chap. 7—can directly be applied. They have been used in the evolutionary optimization of algorithmic chemistries, in chemical engineering, machining technology, electrical engineering, and for other real-world problems such as the optimization of elevator group controllers.

The impact of the author's insights goes beyond the field of computer science. The techniques presented are also of great interest for designing procedures in numerical mathematics.

I would like to call this book a first innovative attempt—I do not know any other—to create a theory of trying. Impressive is the wide epistemological arc

the author draws from the philosophy of science over the behavioral sciences to numerical mathematics and computer science to legitimate a method that is commonly applied by optimization practitioners. He lays a solid base for scientific experimentation in computer science and proposes a course of action that is reliable as far as possible.

However, experiments require a lot of work, so the reader may be warned: Performing a good experiment is as demanding as proving a new theorem.

Dortmund, November 2005 *Hans-Paul Schwefel*

Preface

Before we go into medias res, I would like to acknowledge the support of many people who made this book possible.

First and foremost, I would like to thank Hans-Paul Schwefel, the head of the Chair of Systems Analysis, for providing a cooperative and stimulating work atmosphere. His thoughtful guidance and constant support in my research were very valuable and encouraging. This book is based on my dissertation "New Experimentalism Applied to Evolutionary Computation" (Bartz-Beielstein 2005b). I am thankful to Peter Buchholz for his kindness in being my second advisor, and I would like thank Ingo Wegener for valuable discussions.

Thomas Bäck supported my scientific research for many years, beginning when I was a student and working at the Chair of Systems Analysis and during the time I did work for NuTech Solutions. He also established the contact to Sandor Markon, which resulted in an inspiring collaboration devoted to questions related to elevator group control and the concept of threshold selection. Sandor Markon also provided guidance in Korea and Japan, which made my time there very enjoyable.

I greatly appreciated the discussions with Dirk Arnold relating to threshold selection. They built the cornerstone for a productive research that is devoted to selection and decision making under uncertainty.

The first official presentation of the ideas from this book during the CEC tutorial on experimental research in evolutionary computation in 2004 was based on the collaboration and the helpful discussions with Mike Preuß. Tom English's support during the preparation and presentation of this tutorial were very comforting. I also very much enjoyed the constructive exchange of information with the people from the evolutionary computation "task force," Steffen Christensen, Gwenn Volkert, and Mark Wineberg. Many thanks go to Jürgen Branke for inspiring discussions about experimental approaches and to Burkhard Hehenkamp and Thomas Stützle for their comments on early versions of this work.

My colleagues Boris Naujoks, Karlheinz Schmitt, and Christian Lasarczyk shared their knowledge and resources, helped in many discussions to clarify my ideas, and made the joint work a very fortunate experience. Konstantinos E. Parsopoulos and Michael N. Vrahatis aroused my interest in particle swarm optimization. Discussions with students, especially with Christian Feist, Marcel de Vegt, and Daniel Blum, have been a valuable source of inspiration during this research.

This book would not have been completed without the help from Ronan Nugent, who supported the editorial process.

Additional material (exercises, solutions to selected exercises, program sources) is available under the following link:
`http://www.springer.com/3-540-32026-1`

Dortmund, November 2005 *Thomas Bartz-Beielstein*