

Natural Computing Series

Design by Evolution

Advances in Evolutionary Design

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1. Auflage 2008. Buch. xii, 352 S. Hardcover

ISBN 978 3 540 74109 1

Format (B x L): 15,5 x 23,5 cm

Gewicht: 707 g

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Preface

It is often stated that the 19th century was the century of chemistry, the 20th century was the century of physics and that the 21st century will be the century of biology. We wonder just who first said this. Perhaps Polykarp Kusch should be credited with the phrase “century of physics”, from his 1955 acceptance speech for the Nobel Prize in Physics (though the quote was actually “We live, I think, in the century of science and, perhaps, even in the century of physics” [2]). It may have been US President Bill Clinton who first made the observation and coined the phrase “century of biology” [1], or maybe Kenneth Shine, President of the Institute of Medicine, who actually said “... the 20th century will be known as the century of physics and astronomy ... the 21st century will be the century of the life sciences in all their ramifications” [3]. Many people seem to have appropriated the idea and offer it as their own. But, whoever said it first, it is widely accepted now that advances in biology will lead to many great marvels in our lifetimes. One of the keys to this progress is our new and ever improving understanding of genetics and the processes of natural evolution. And much of this new understanding is driven by computation, which is where we, as computer scientists, come in.

Our own interests are in Artificial Intelligence (AI) – the attempt to model and understand intelligence through computational models. Evolutionary Computation (EC) is one way to do this using models based on the principles of natural evolution. We feel very fortunate to be working in EC, which allows us to indulge our fascination with both AI and evolution. This work has taken us into evolutionary design: two of us on evolving designs for ore processing plants, and the other on a wide range of real world applications. This is what motivated us to organise a special session on evolutionary design at the IEEE World Congress on Evolutionary Computation in Edinburgh in 2005 (CEC’05), and, partly as a response to the interesting ideas presented at that session, to embark on collecting together the contributions that make up this book. Along the way, we have realised that there are deep and beautiful connections between work done by scientists, engineers and artists, each with

their own specific knowledge and culture, all striving to understand evolution as a design process or as a tool.

We would like to thank all our authors, our reviewers, Lucas Bradstreet and Mark Wittkamp, for their help in proof-reading the book, and, most especially, our area leaders for biology (Kay Wiese), art (Jon McCormack), embryogeny (Daniel Ashlock), and engineering (Kalyanmoy Deb), whose creative suggestions and diligence have made an immense contribution to the quality of the final result.

In this book, the reader will find chapters drawing on many diverse, yet interconnected topics. There are chapters on creating evolved art using EC along with L-systems, cellular automata and Mandelbrot sets, making images of biological life or beguiling abstract patterns. Chapters about simulations of biological processes that produce images so beautiful they must be called art. Chapters describing our progress from understanding how morphogenesis works in biology, to using such processes to create art or other physical artefacts, towards designing systems to control the process of morphogenesis itself. Chapters about using what we have learned to solve practical engineering design problems and even some more philosophical discussions about what this all means and how it relates to our place in the universe.

Whatever the reader's penchant, we hope there is something new here for everyone, that will educate, inspire, and delight.

Philip Hingston

Luigi Barone

Zbigniew Michalewicz

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