

Preface

The book you are holding in your hands is the outcome of the “2012 Interdisciplinary Symposium on Complex Systems” held at the beautiful Mediterranean island of Kos of pre-and post-Socratic fame. The event was conceived as a continuation of our series of symposia in the science of complex systems. Only through bringing scientists and philosophers alike from different areas of modern research together, as the organizers felt, the necessary dialogue and heat can be generated in which a new paradigm can take a more definitive shape. The paradigm itself—a “science of complexity” in a both overarching and sharply delineated sense—has different and often not convergent trends because a “single” definition of complexity does not exist. Perhaps, one of the main reasons for not yet having a unique definition is due to the lack of agreement whether complexity is an inherent property of Nature or it only appears when one builds a model for a given phenomenon. Accordingly, prestigious scientists and philosophers with different points of view were brought together along with youthful budding researchers, who jointly contributed previously unheard examples to form an efficient engine to produce new work. Sense of wonder as to what would happen in the next talk was palpable several times. The panel discussion—not reproduced here—did its own part in fostering a spirit of friendship and progress in spite of different viewpoints. The finished papers reproduced here reflect this unique spirit of mental and physical cooperation across disciplines and continents.

The motivation to prepare this book was based on a few facts. The main one is that the research field on complexity is an interesting area that is under intensive investigation from the viewpoint of many branches of science today. Complexity theory with its applications can be found in biology, physics, economy, chemical technologies, aircraft industry, job scheduling, urban planning, and others. Complex systems and their behavior are very important in engineering, because such behavior can be used in many interesting applications as well as in the interdisciplinary combinations forming on a theoretical level. This book is written to present simplified versions of experiments and thought experiments to show how, in principle, complexity can be put to use. Collecting different reasoned opinions with likely different ideas and then assembling a book comprising theoretical physics, mathematics, engineering, and philosophy might appear odd; nevertheless, we found that our endeavor achieved a high efficiency at arriving

at a synthesis in this manner. Furthermore, the history of science has demonstrated that pure mathematics and physics can combine beautifully with practical engineering, as the example of “the strangest man” shows.¹

The book consists of 12 selected papers of the symposium starting with a comprehensive overview and classification of complexity problems. Readers can also find other interesting papers about complexity, its observation, modeling, and its applications in solving various problems. More concretely, readers will have an encounter with the structural complexity of vortex flows, the use of chaotic dynamics within evolutionary algorithms, complexity in synthetic biology, types of complexity hidden inside evolutionary dynamics and possible controlling methods, complexity of rugged landscapes, and more. All selected papers represent innovative ideas, philosophical overviews, and state-of-the-art discussions on the aspects of complexity.

The book can be useful as an instructional material for senior undergraduate and entry-level graduate students in computer science, physics, applied mathematics, and engineering-type work in the area of complexity. Researchers, who are interested how complexity and evolutionary algorithms are merged together as well as researchers interested in the ramifications of complexity in various fields of science and its applications, will find this book very useful as a stepping stone. The book can also be valuable as a resource of material for practitioners who want to apply complexity to solve real-life problems in their own challenging applications. It goes without saying that this book does not encompass all aspects of complexity types and fields of research due to its limited space. Only the main ideas and results of selected papers are reported here. The authors and editors hope that readers will be inspired to do their own experiments and simulations, based on information reported in this book, thereby moving beyond the scope of the book.

As a token of the participants’ affection for genuine progress in the decomplexification of the universe, we dedicate this book to Fabiola Gianotti who bears much responsibility for the discovery in 2012 of the Higgs Boson in fundamental physics. At the same time, the question still remains open whether knowing more about Nature can decomplexify it, or else makes it even nimbler to the fishing mind.

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¹ Four years before his death, Niels Bohr told a colleague that of all the people who had ever visited this institute, Dirac—an engineer by training—was “the strangest man” (cf. Graham Farmelo’s colorful biography of Paul Dirac under this title).

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