

Preface

This book offers an integration of the results of a scientific quest that started in 1994. The quest's goal was to identify levels of complexity in the organisation of nature. For the identification of such levels a scientific tool was developed, a “complexity ladder” that was named the Operator Hierarchy. This ladder adds many new insights to the classical ladder of nature, known as the *scala naturae*, which offered an allegorical ranking of kinds of entities according to “increasing perfection.” The *scala naturae* started with minerals and extended to plants, animals, humans, angels, and god.

There are many reasons why few people consider the classical ranking a scientific approach, for example because it lacks mechanisms and includes non-material entities (e.g. angels). Because of such incongruences, the *scala naturae* has contemptuously been classified as an archaic approach that should be abolished, like scientists have abolished the idea that the sun orbits the earth. However, if one categorically rejects all ideas about ladders, one risks throwing the baby of hierarchical thinking out with the bathwater of allegorical thinking.

A new, mechanistic *scala naturae*

This book explores the hierarchy that emerges when several existing objects integrate to form a single new object, after which the process repeats with the newly formed objects, etc. In this book it will be explained how, amidst many possibilities, the Operator Theory singles out one specific ranking of kinds of objects and how this special ranking can contribute to several lines of fundamental theoretic development. One line is the identification of fixed hierarchical levels. Another line is the development of definitions of concepts that currently lack consensus such as organism, evolution, major transition, and life. In analogy with how one can use Lego bricks for constructing Lego trains and Lego cities, one can also use the objects that are included in the Operator Hierarchy, the so-called operators, as the theoretical and physical building blocks of all systems that consist of interacting operators.

Reflections by multidisciplinary scientists

Since it represents a new approach, the Operator Theory can profit in many ways from discussion and constructive criticism. For this reason, a broad set of renowned scientists were approached with the request of whether they would like to contribute to this book by writing a review chapter. The many enthusiastic reactions covered a wide range of scientific disciplines allowing for a diverse view on the topics at hand. Each scientist was offered a free choice to write, e.g. a supplementary line of reasoning, a critical analysis, a suggestion for links with existing theory, and an inquiry of the practical utility. The multi-faceted contributions of the specialists have increased the richness, depth, and relevancy of this book in many ways. A first step towards further conversations is set in Chap. 18 in which the editor of this book responds to the remarks of the reviewers.

If you long for order and simplicity, you may enjoy reading this book

While in everyday life things seem to increase in complexity all the time, this book pursues simplicity. In line with this goal, this book attempts to reduce the complexity of its themes to the level of irreducible simplicity. Once a conceptual core of irreducible simplicity has been identified, this is used as a basis for scaling up as well as for generalisation. As a further consequence of striving towards a framework that is based on simplicity, this book is structured in a step-by-step way. Basic concepts are introduced in the first chapters and are used in subsequent chapters to handle more complex situations.

Because it focuses on simplicity and core concepts, this book may offer a rich source for conceptually oriented students and researchers from many different backgrounds, including, for example, biology, ecology, physics, philosophy, system science, social science, economy, astrobiology, and artificial life. Some chapters focus on biological questions, including, for example, the question of how to define the organism concept, the question of how to identify levels of biological organisation and major evolutionary transitions, and the question of how to develop an object-based approach to evolution that may assist in organising the many factors that play a role in the extended evolutionary synthesis. Other chapters focus more specifically on system science, for example by elucidating the Operator Hierarchy, and its utility as a basis for the analysis of ecological and societal processes. One chapter focuses on thermodynamics and on how the dispersion of free energy gradients can not only cause chaos, but also forms the basis for organised matter and organised systems. Several chapters pay attention to philosophical aspects of the concepts that are discussed.

Wageningen, Gelderland, The Netherlands

Gerard A.J.M. Jagers op Akkerhuis

Evolution and Transitions in Complexity

The Science of Hierarchical Organization in Nature

Jagers op Akkerhuis, G.A.J.M. (Ed.)

2016, XII, 295 p. 28 illus., 3 illus. in color., Hardcover

ISBN: 978-3-319-43801-6