Preface

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In this book, we propose original perspectives in theoretical biology. We refer extensively to physical methods of understanding phenomena but in an untraditional manner. At times, we directly employ methods from physics, but more importantly, we radically contrast physical ways of constructing knowledge with what, we claim, is required for conceptual constructions in biology.

One of the difficult aspects of biology, especially with respect to physical insights, is the understanding of organisms and by extension the implications of what it means for an object of knowledge to be a part of an organism. The question of which conceptual and technical frameworks are needed to achieve this understanding is remarkably open. One such framework we propose is extended criticality. Extended criticality, one of our main themes, ties together the structure of coherence that forms an organism and the variability and historicity that characterize it. We also note that this framework is not meant to be pertinent in understanding the inert.

We are aware that our theoretical proposals are of a kind of abstraction that is unfamiliar to most biologists. An epistemological remark can hopefully make this kind of abstract thinking less unearthly. At the core of mathematical abstractions, not unlike in biological experiments, lies the "gesture" made by the scientist. By gesture we mean bodily movements, real or imagined, such as rearranging a sequence of numbers in the abstract or seeding the same number of cells over several wells. Gestures may remain mostly virtual in mathematics, yet any mathematical proof is basically a series of acceptable gestures made by the mathematician — both the ones described by a given formalism and the ones performed at the level of more fundamental intuitions (which motivate the formalisms themselves). For example, symmetries refer to applying transformations (e.g. rotating) and order refers to sorting (eg: the well-ordering of integer numbers and the ordering of oriented time), both of which are gestures. Since Greek geometry until contemporary physics, symmetries (defining invariance) and order (as for optimality) have jointly laid the foundation of mathematics and theoretical physics within the human spaces of action and knowl-

edge. In summary, the theoretician singles out conceptual contours and organizes the World similarly as the experimenter prepares and executes scientific experiments.

From this perspective, biological theory directly relates to the acceptable moves, both abstract and concrete, that can be performedwhile experimenting and reflectiong on biological organisms. Symmetries and their changes, order and its breaking will guide our approach in an interplay with physics — often a marked differentiation. Again, the question of building a theory of organisms is a remarkably open one. With this book, we hope to contribute in explicitly raising this question and providing some elements of answer.

Interactions are as fundamental in knowledge construction as they are in biological evolution and ontogenesis. We would like to acknowledge that this book is the result and the continuation of an intense collaboration of three people: the listed authors and our friend Francis Bailly. The ideas presented here are extensions of work initiated by/with Francis, who passed away in 2009. We are extremely grateful to have had the priveledge to work with him. His insights sparked the beginning of the second author's PhD thesis which was completed in 2011.

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