Dezső Boda

Complexity in Nature and Society

From Dancing Molecules to Collapsing Societies

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Dezső Boda got his Master degree in Physics from the University of Szeged, Hungary in 1992, PhD in Chemistry from the University of Pannonia, Veszprém, Hungary in 1996, and DSc from the Hungarian Academy of Sciences in 2013. He spent several years at the University of Hong Kong, the Brigham Young University, Provo, USA, and the Rush University Medical Center, Chicago, USA. In the meantime, he pursued his career at the University of Pannonia, where he is a professor now. He spent four years at the Institute of Advanced Studies Kőszeg (iASK) as a grantholder (2015,2019) and as a Research Fellow (2016-2018). While his original research interest is statistical mechanics and computer simulation of molecular systems, his inclination toward multidisciplinarity and understanding the world beyond Physics drove him to iASK where he started to study complexity as a common denominator for systems from Nature to Society (for more details: `https://mscms.uni-pannon.hu`).

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Preface

When I started my studies at the Institute of Advanced Studies in Kőszeg (iASK) in 2015, my ambition was to somehow find a common denominator between natural and social sciences. It was a naive undertaking based on a large amount of ignorance and boldness. My naivety was probably originated from the fact that, as my regular job, I study molecular systems by modeling them. Molecular systems are part of an objective reality whose behavior, on a fundamental level, is well described by physical laws laid down by great predecessors like Newton, Maxwell, Boltzmann, and Heisenberg. Modeling molecules, although far from being trivial, is a relatively straightforward process. Also, it became my built-in instinct that I do not mix models and mental representations with reality. This is quite easy to do in Physics, because molecules do not argue about my models and do not change their behavior just to annoy me. Modeling people's behavior and social processes is much harder, I quickly realized.

Let me cite myself from my 2015 workplan; there is no a better way to introduce myself, and, especially, my-2015-self: "The central action of my research during my whole scientific career was the construction of models. We examine physical and chemical systems, namely materials. The word 'system' is a well-defined central concept of physical chemistry, which is absolutely necessary to be defined if we want to know what do we examine. Practically, the system is defined by its boundaries, the particles inside the boundaries, and

the boundary conditions that determine how the system communicates with its environment. The systems we study are many-particle systems. They are built up of molecules, atoms, or ions. These systems usually do something; that is why they are interesting for us. Liquids can flow, gases can expand, surfaces can adsorb molecules, ion channels can let ions through the cell membrane. We have experimental data for these systems, but they are just numbers without soul. We do not know from measurements how these systems work on the microscopic level. Computer simulations work as a special 'microscope' with which we can look at these systems closely and get some ideas about their mechanisms. We do not see real particles in this 'microscope', however. We just see their representations in a computer or on a computer screen. We represent the particles with models." That is the school I arrive from with a pre-wired brain for modeling and thinking in terms of formal representations.

I realized right at the beginning without knowing much about complexity that social systems are complex: "The question that excites me is that can we even talk about complex systems using simple models in our conversations? Is the portion of reality that is hidden from us by using simple language and simplified ideas important? Should we make our models more complex to describe reality or would we just make our conversations more cluttered with that? Do more detail mean more understanding?"

It was clear that we need to simplify things if we want to understand them: "I am interested about basic mechanisms that drive the behavior of the system under study. Therefore, I model only the basic ingredients of the system, only the important interactions that are crucial to explain the studied phenomenon. With this approach, we loose details, but we gain understanding. We loose resolution, but get the big picture. If the model does not describe the system properly, we include more detail."

I was even unashamed enough to bring up Occam's razor: "I often use Occam's razor (Lex Parsimonae) to shed light on this modeling

philosophy. This principle 'admonishes us to choose from a set of otherwise equivalent models of a given phenomenon the simplest one. In any given model, Occam's razor helps us to 'shave off' those concepts, variables, or constructs that are not really needed to explain the phenomenon. By doing that, developing the model will become much easier, and there is less chance of introducing inconsistencies, ambiguities, and redundancies.'[1]"

The Institute was patient and gave me enough time for living through the process of losing my illusions, picking up some knowledge about biology and sociology, and building up a new storyline from scratch. The tipping point, I think, was that I started to learn about complexity and realized that this is not just another word for "complicated", but a brand new science that aims at exactly what I am trying to do. Complexity is the common denominator I had been searching for and its concepts worked out by complex systems scientists are already out there waiting for me to use them.

The rest was "easy" though required some time. During work I kept in my mind three things: (1) I want to interpret various kinds of systems from diverse areas of Nature and Society as complex systems. (2) I want to focus on the big picture and to create simple models to understand it. (3) I want to get formal models that are applicable in different kinds of complex systems from Nature to Society, from non-living to living, from unconscious to conscious.

This book contains the results of my readings, wonderings, ponderings, talkings, listenings, and conversations. I am grateful to iASK for the possibility of going along this journey, this mental adventure. iASK provided an intellectual community formed by curious and open-minded people. Without that environment, this book would not have been created.

[1] `http://pespmc1.vub.ac.be/occamraz.html` for "Occam's razor" at the Principia Cybernetica Web