

## Preface

Networks are all around us. Nevertheless, only very recently have scientists started to reconsider the traditional reductionism viewpoint that has always driven science. The accumulated evidence that systems as complex as a group of social animals, or as the cells of a living system, cannot be fully understood by simply reducing them to a sum of their fundamental parts, has produced an increasingly large interest in the study of complex systems where interaction networks are crucial, giving rise to the birth of a new science, the *science of complex networks*.

The massive and comparative analysis of real networks has produced, in the last ten years, a series of unexpected and striking results in various fields, and the identification of basic principles common to all the networks are considered. The lifesciences community has certainly been one of the principal actors in the complex networks revolution, and we can say that the network approach has finally affected modern biology. Networks allow in fact a systemic approach to biological problems able to overcome the evident limitations of the strict reductionism of the past twenty years. Biologists have found that several systems can be represented as networks, and they have understood that there is a lot to be learned by studying those networks. Taking into consideration not only the single elements but also the whole complicated web of links connecting the different parts of biological entities is a radical change, a change that makes a substantial difference. The outcomes have been rewarding. New features, hardly detected by standard “mean field” approaches, have emerged. The applications are wide, and they all demonstrate how the network approach has become today an invaluable method to comprehend the functions of biological systems.

*Biological networks* in a broad sense, the subject of this book, have been among the most studied complex networks, and the field has benefited from many important contributions from physicists, mathematicians and computer scientists. Here, we have collected, in a single book, most of the relevant results and novel insights provided by network theory in the biological sciences, putting together topics at the forefront of current research. The subjects covered include: cortical and neural networks, cultured neural networks, functional connectivity in brain networks, Boolean dynamics, gene circuits, metabolic networks, protein folding, evolutionary dynamics, motion coordination, and ecosystems. The subjects have been organized in three main sections: (i) *networks at the cellular level*, (ii) *brain networks*, and

(iii) *networks at the individual and population levels*. The recurrent theme throughout the three sections is to explain how the structure of a biological system influences its function, and the other way around.

When this project was conceived, we considered that the plethora of available results deserved to be summarized and synthesized in a clear and concise source. With this book, we hope to have succeeded in producing a useful tool not only for researchers working on specific subjects of networks biology, but also for the whole community of physicists, biologists, engineers and computer scientists interested in the multidisciplinary applications of complex networks. We also expect that the book can be used as a reference text for academic purposes.

Finally, our heartfelt thanks go to the authors of the Chapters for their generous contributions and willingness to join this project.

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