
Preface to the Second Edition

The Second Edition of *Modeling in the Neurosciences* appears on the fifth anniversary of the publication of the first edition. Inspired by the wealth of new work since that date, we were determined to bring the book up to date, to discuss the most important new developments in neuronal and neuronal systems modeling, including use of robotics to test brain models.

The goal of the book is to probe beyond the realm of current research protocols toward the uncharted seas of synthetic neural modeling. The book is intended to help the reader move beyond model ingredients that have been widely accepted for their simplicity or appeal from the standpoint of mathematical tractability (e.g., bidirectional synaptic transfer, updates to synaptic weights based on nonlocal information, or mean-field theories of rate-coded point neurons), and learn how to construct more structured (integrative) models with greater biological insight than heretofore attempted. The book spans the range from gene expression, dendritic growth, and synaptic mechanics to detailed continuous-membrane modeling of single neurons and on to cell–cell interactions and signaling pathways, including nonsynaptic (ephaptic) interactions. In the final chapters, we deal with complex networks, presenting graph- and information-theoretic methods of analyzing complexity and describing in detail the use of robotic devices with synthetic model brains to test theories of brain function.

The book is neither a handbook nor an introductory volume. Some knowledge of neurobiology, including anatomy, physiology, and biochemistry is assumed, as well as familiarity with analytical methods including methods of solving differential equations. A background knowledge of elementary concepts in statistics and applied probability is also required. The book is suitable as an advanced textbook for a graduate-level course in neuronal modeling and neuroengineering. It is also suited to neurophysiologists and neuropsychologists interested in the quantitative aspects of neuroscience who want to be informed about recent developments in mathematical and computer modeling techniques. Finally, it will be valuable to researchers in neural modeling interested in learning new methods and techniques for testing their ideas by constructing rigorously realistic models based on experimental data.

The first edition of *Modeling in the Neurosciences* has contributed impressively to the analytical revolution that has so completely changed our perception of quantitative methods in neuroscience modeling. Nevertheless many different views persist regarding the most satisfactory approaches to doing theoretical neuroscience. The source of this plethora of interpretations is, perhaps, the fact that “computational” interpretations of brain function are not satisfactory, as discussed in the introductory chapter by G. Reeke. Thus, it seems appropriate in this book to attempt to obtain a more balanced picture of all the elements that must be taken into account to get a better understanding of how nervous systems in fact function in the real world where adaptive behavior is a matter of life or death. We hope the integrative viewpoint we advocate may serve as a Rosetta stone to guide the development of modern analytical foundations in the neurosciences.

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To accomplish this, we have commissioned authors to provide in-depth treatments of a number of unresolved technical and conceptual issues which we consider significant in theoretical and integrative neuroscience, and its analytical foundations. We hope that this second edition will help and inspire neuroscientists to follow threads revealed herein for many years to come.

We acknowledge the support of the many colleagues who have made this book possible, in particular, the authors who have given so freely of their time to create the chapters now before you. We are also indebted to Dr. John Gillman, Publisher at Harwood Academic Publishers, Reading, UK, who authorized the commissioning of the second edition in the winter of 2001; Dr. Grant Soannes, Publisher at Taylor & Francis, London, UK, who contracted for the book in the fall of 2003; and Barbara Norwitz, Publisher at Taylor & Francis, Boca Raton, Florida, who finalized the arrangements in January of 2004. Last but not least, we thank Pat Roberson and her team for their continuing efforts in the production of a truly immaculate volume.

Sadly, one of the contributors, Aron M. Gutman, passed away soon after the launch of the first edition in the spring of 1999. Aron Gutman was born in Zhitomir, Ukraine in 1936. He received his Ph.D. (externally) from the Department of Physics of Leningrad University in 1962. From 1959 to 1999 he worked in the Neurophysiological Laboratory of Kaunas Medical Institute (now University). He was a prolific writer with more than 150 scientific publications, including two monographs (in Russian) and about 50 papers in international journals. As a distinguished biophysicist, particularly known for his work on the theory of N-dendrites, he has made a profound impact on the scientific community. In Gutman's own words: "small cells use dendritic bistability with slow rich logic."

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