

# Theoretical Neuroscience: Computational and Mathematical Modeling of Neural Systems (Computational Neuroscience Series)

By Peter Dayan, Laurence F. Abbott

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Theoretical neuroscience provides a quantitative basis for describing what nervous systems do, determining how they function, and uncovering the general principles by which they operate. This text introduces the basic mathematical and computational methods of theoretical neuroscience and presents applications in a variety of areas including vision, sensory-motor integration, development, learning, and memory.

The book is divided into three parts. Part I discusses the relationship between sensory stimuli and neural responses, focusing on the representation of information by the spiking activity of neurons. Part II discusses the modeling of neurons and neural circuits on the basis of cellular and synaptic biophysics. Part III analyzes the role of plasticity in development and learning. An appendix covers the mathematical methods used, and exercises are available on the book's Web site.

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## **Editorial Review**

Review

Peter Dayan and L.F. Abbott have crafted an excellent introduction to the various methods of modeling nervous system function. The chapters dealing with neural coding and information theory are particularly welcome because these are new areas that are not well represented in existing texts.

(Phillip S. Ulinski)

Dayan and Abbott inspire us with a work of tremendous breadth, and each chapter is more exciting than the next. Everyone with an interest in neuroscience will want to read this book. A truly remarkable effort by two of the leaders in the field.

(P. Read Montague, Professor, Division of Neuroscience, and Director, Center for Theoretical Neuroscience, Baylor College of Medicine)

It will not be surprising if this book becomes the standard text for students and researchers entering theoretical neuroscience for years to come.

(M. Brandon Westover Philosophical Psychology)

Not only does the book set a high standard for theoretical neuroscience, it defines the field.

#### (Dmitri Chklovskii Neuron)

An excellent book. There are a few volumes already available in theoretical neuroscience but none have the scope that this one does.

(Bard Ermentrout, Department of Mathematics, University of Pittsburgh)

*Theoretical Neuroscience* provides a rigorous introduction to how neurons code, compute, and adapt. It is a remarkable synthesis of advances from many areas of neuroscience into a coherent computational framework. This book sets the standards for a new generation of modelers.

(Terrence J. Sejnowski, Howard Hughes Medical Institute, Salk Institute for Biological Studies, and University of California, San Diego)

The first comprehensive textbook on computational neuroscience. The topics covered span the gamut from biophysical faithful single cell models to neural networks, from the way nervous systems encode information in spike trains to how this information might be decoded, and from synaptic plasticity to supervised and

unsupervised learning. And all of this is presented in a sophisticated yet accessible manner. A must buy for anybody who cares about the way brains compute.

(Christof Koch, Lois and Victor Troendle Professor of Cognitive and Behavioral Biology, California Institute of Technology)

*Theoretical Neuroscience* marks a milestone in the scientific maturation of integrative neuroscience. In the last decade, computational and mathematical modelling have developed into an integral part of the field, and now we finally have a textbook that reflects the changes in the way our science is being done. It will be a standard source of knowledge for the coming generation of students, both theoretical and experimental. I urge anyone who wants to be part of the development of this science in the next decades to get this book. Read it, and let your students read it.

(John Hertz, Nordita (Nordic Institute for Theoretical Physics), Denmark)

#### About the Author

L.F. Abbott is the Nancy Lurie Marks Professor of Neuroscience and Director of the Volen Center for Complex Systems at Brandeis University. He is the coeditor of *Neural Codes and Distributed Representations* (MIT Press, 1999).

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#### Paula Mendoza:

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