

Preface

The powerful and yet mysterious human brain system attracts numerous researchers devoting themselves to characterizing what nervous systems do, determining how they function, and understanding why they operate in particular ways. Encompassing various studies of biology, physics, psychology, mathematics, and computer science, theoretical neuroscience provides a quantitative basis for uncovering the general principles by which the nervous systems operate. Based on these principles, neuromorphic cognitive systems introduce some basic mathematical and computational methods to describe and utilize schemes at a cognitive level. Since the mechanisms how human memory cognitively operates and how to utilize the bioinspired mechanisms to practical applications are rarely known, the study of neuromorphic cognitive systems is urgently demanded.

This book presents the computational principles underlying spike-based information processing and cognitive computation with a specific focus on learning and memory. Specifically, the action potential timing is utilized for sensory neuronal representations and computation, and spiking neurons are considered as the basic information processing unit. The topics covered in this book vary from neuronal level to system level, including neural coding, learning in both single- and multi-layered networks, cognitive memory, and applied developments of information processing systems with spiking neurons. From the neuronal level, synaptic adaptation plays an important role on learning patterns. In order to perform higher level cognitive functions such as recognition and memory, spiking neurons with learning abilities are consistently integrated with each other, building a system with the functionality of encoding, learning, and decoding. All these aspects are described with details in this book.

Theories, concepts, methods, and applications are provided to motivate researchers in this exciting and interdisciplinary area. Theoretical modeling and analysis are tightly bounded with practical applications, which would be potentially

beneficial for readers in the area of neuromorphic computing. This book presents the computational ability of bioinspired systems and gives a better understanding of the mechanisms by which the nervous system might operate.

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