This monograph is the first book to systematically treat the active and expanding field of complex-valued neural networks. It was originally published in Japanese. The only other volume that exists on the subject is a book whose chapters have been written by researchers in the field, and whose editor is the author of the book being reviewed.

Complex-valued neural networks simply stated are neural networks, which are defined in the complex domain. The complex domain has been a main staple in engineering and physics and it is only natural that it has attracted attention in the field of neural networks. Physical quantities are represented and manipulated in a most natural manner when one works in the complex domain. In particular, it is hard to imagine areas such as electromagnetics, electric circuits, signal processing, quantum mechanics, optics, and many others, without the realm of complex numbers. Amplitude and phase, which are so prevalent, are represented as a single quantity. Manipulation, be it through a Fourier transform or a matrix multiplication, is efficiently done in the complex domain.

What advantages do complex-valued neural networks offer? For one, they allow quantities to be represented and manipulated consistently both in the problem domain and in neural networks. This may appear as mere notational convenience, however it is not. Representation, i.e., encoding, of data is important. Consider, for example, the problem of having to classify data belonging to two classes that have the shape of two concentric bands. If magnitude information is included, classification is trivial. However, if one works only in Cartesian coordinates, classification becomes a substantially more difficult task. Another advantage is the ease with which periodicity can be represented with complex exponentials as opposed to real sinusoidal functions. Even when signals can be reconstructed completely from the real part of their complex representation, there may be an advantage in using their complex representation. One such example, which the author mentions, is the representation of real signals as analytic signals via the use of the Hilbert transform to create the imaginary part. Then, such signals can be conveniently processed with the Fourier transform. The book in its latter part provides detailed applications where complex-valued neural networks have been successfully applied.

The book is most useful for researchers who would like to enter the field of complex-valued neural networks, although it can serve as a textbook for advanced undergraduates and graduate students for an introductory course in neural networks. The mathematical background needed is some basic understanding of the complex domain, calculus, and some knowledge of linear algebra. To understand the applications in Part II, familiarity with frequency-domain analysis and electromagnetics is needed.

The book consists of 11 chapters and is divided into two parts. Part I consists of the chapters 1–4 and is titled “Basic Ideas and Fundamentals: Why are complex valued neural networks inevitable?” These chapters serve as an introduction to neural networks with their domain expanded to complex numbers.

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The book includes 123 bibliographic references and an index.
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