Raúl Rojas

Neural Networks

A Systematic Introduction

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Foreword

One of the well-springs of mathematical inspiration has been the continuing attempt to formalize human thought. From the syllogisms of the Greeks, through all of logic and probability theory, cognitive models have led to beautiful mathematics and wide ranging application. But mental processes have proven to be more complex than any of the formal theories and the various idealizations have broken off to become separate fields of study and application.

It now appears that the same thing is happening with the recent developments in connectionist and neural computation. Starting in the 1940s and with great acceleration since the 1980s, there has been an effort to model cognition using formalisms based on increasingly sophisticated models of the physiology of neurons. Some branches of this work continue to focus on biological and psychological theory, but as in the past, the formalisms are taking on a mathematical and application life of their own. Several varieties of adaptive networks have proven to be practical in large difficult applied problems and this has led to interest in their mathematical and computational properties.

We are now beginning to see good textbooks for introducing the subject to various student groups. This book by Raúl Rojas is aimed at advanced undergraduates in computer science and mathematics. This is a revised version of his German text which has been quite successful. It is also a valuable self-instruction source for professionals interested in the relation of neural network ideas to theoretical computer science and articulating disciplines.

The book is divided into eighteen chapters, each designed to be taught in about one week. The first eight chapters follow a progression and the later ones can be covered in a variety of orders. The emphasis throughout is on explicating the computational nature of the structures and processes and relating them to other computational formalisms. Proofs are rigorous, but not overly formal, and there is extensive use of geometric intuition and diagrams. Specific applications are discussed, with the emphasis on computational rather than engineering issues. There is a modest number of exercises at the end of most chapters.

The most widely applied mechanisms involve adapting weights in feed-forward networks of uniform differentiable units and these are covered thoroughly. In addition to chapters on the background, fundamentals, and variations on backpropagation techniques, there is treatment of related questions from statistics and computational complexity.

There are also several chapters covering recurrent networks including the general associative net and the models of Hopfield and Kohonen. Stochastic variants are presented and linked to statistical physics and Boltzmann learning. Other chapters (weeks) are dedicated to fuzzy logic, modular neural networks, genetic algorithms, and an overview of computer hardware developed for neural computation. Each of the later chapters is self-contained and should be readable by a student who has mastered the first half of the book.

The most remarkable aspect of neural computation at the present is the speed at which it is maturing and becoming integrated with traditional disciplines. This book is both an indication of this trend and a vehicle for bringing it to a generation of mathematically inclined students.

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