
Preface

This book arose from my lectures on neural networks at the Free University of Berlin and later at the University of Halle. I started writing a new text out of dissatisfaction with the literature available at the time. Most books on neural networks seemed to be chaotic collections of models and there was no clear unifying theoretical thread connecting them. The results of my efforts were published in German by Springer-Verlag under the title *Theorie der neuronalen Netze*. I tried in that book to put the accent on a systematic development of neural network theory and to stimulate the intuition of the reader by making use of many figures. Intuitive understanding fosters a more immediate grasp of the objects one studies, which stresses the concrete meaning of their relations. Since then some new books have appeared, which are more systematic and comprehensive than those previously available, but I think that there is still much room for improvement. The German edition has been quite successful and at the time of this writing it has gone through five printings in the space of three years.

However, this book is not a translation. I rewrote the text, added new sections, and deleted some others. The chapter on fast learning algorithms is completely new and some others have been adapted to deal with interesting additional topics. The book has been written for undergraduates, and the only mathematical tools needed are those which are learned during the first two years at university. The book offers enough material for a semester, although I do not normally go through all chapters. It is possible to omit some of them so as to spend more time on others. Some chapters from this book have been used successfully for university courses in Germany, Austria, and the United States.

The various branches of neural networks theory are all interrelated closely and quite often unexpectedly. Even so, because of the great diversity of the material treated, it was necessary to make each chapter more or less self-contained. There are a few minor repetitions but this renders each chapter understandable and interesting. There is considerable flexibility in the order of presentation for a course. Chapter 1 discusses the biological motivation

of the whole enterprise. Chapters 2, 3, and 4 deal with the basics of threshold logic and should be considered as a unit. Chapter 5 introduces vector quantization and unsupervised learning. Chapter 6 gives a nice geometrical interpretation of perceptron learning. Those interested in stressing current applications of neural networks can skip Chapters 5 and 6 and go directly to the backpropagation algorithm (Chapter 7). I am especially proud of this chapter because it introduces backpropagation with minimal effort, using a graphical approach, yet the result is more general than the usual derivations of the algorithm in other books. I was rather surprised to see that *Neural Computation* published in 1996 a paper about what is essentially the method contained in my German book of 1993.

Those interested in statistics and complexity theory should review Chapters 9 and 10. Chapter 11 is an *intermezzo* and clarifies the relation between fuzzy logic and neural networks. Recurrent networks are handled in the three chapters, dealing respectively with associative memories, the Hopfield model, and Boltzmann machines. They should be also considered a unit. The book closes with a review of self-organization and evolutionary methods, followed by a short survey of currently available hardware for neural networks.

We are still struggling with neural network theory, trying to find a more systematic and comprehensive approach. Every chapter should convey to the reader an understanding of one small additional piece of the larger picture. I sometimes compare the current state of the theory with a big puzzle which we are all trying to put together. This explains the small puzzle pieces that the reader will find at the end of each chapter. Enough discussion – Let us start our journey into the fascinating world of artificial neural networks without further delay.

Errata and electronic information

This book has an Internet home page. Any errors reported by readers, new ideas, and suggested exercises can be downloaded from Berlin, Germany. The WWW link is: <http://www.inf.fu-berlin.de/~rojas/neural>. The home page offers also some additional useful information about neural networks. You can send your comments by e-mail to rojas@inf.fu-berlin.de.

Acknowledgements

Many friends and colleagues have contributed to the quality of this book. The names of some of them are listed in the preface to the German edition of 1993. Phil Maher, Rosi Weinert-Knapp, and Gaye Rochow revised my original manuscript. Andrew J. Ross, English editor at Springer-Verlag in Heidelberg, took great care in degermanizing my linguistic constructions.

The book was written at three different institutions: The Free University of Berlin provided an ideal working environment during the first phase of writing. Vilim Vesligaj configured TeX so that it would accept Springer's style.

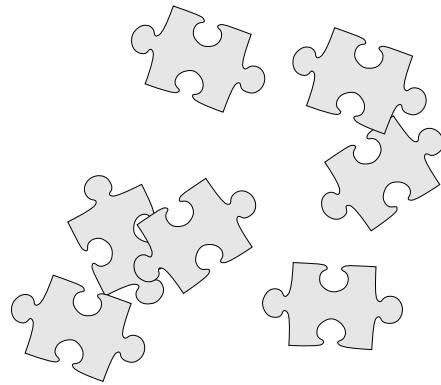
Günter Feuer, Marcus Pfister, Willi Wolf, and Birgit Müller were patient discussion partners. I had many discussions with Frank Darius on damned lies and statistics. The work was finished at Halle's Martin Luther University. My collaborator Bernhard Frötschl and some of my students found many of my early TeX-typos. I profited from two visits to the International Computer Science Institute in Berkeley during the summers of 1994 and 1995. I especially thank Jerry Feldman, Joachim Beer, and Nelson Morgan for their encouragement. Lokendra Shastri tested the backpropagation chapter "in the field", that is in his course on connectionist models at UC Berkeley. It was very rewarding to spend the evenings talking to Andres and Celina Albanese about other kinds of networks (namely real computer networks). Lotfi Zadeh was very kind in inviting me to present my visualization methods at his Seminar on Soft Computing. Due to the efforts of Dieter Ernst there is no good restaurant in the Bay Area where I have not been.

It has been a pleasure working with Springer-Verlag and the head of the planning section, Dr. Hans Wössner, in the development of this text. With him cheering from Heidelberg I could survive the whole ordeal of TeXing more than 500 pages.

Finally, I thank my daughter Tania and my wife Margarita Esponda for their love and support during the writing of this book. Since my German book was dedicated to Margarita, the new English edition is now dedicated to Tania. I really hope she will read this book in the future (and I hope she will like it).

Berlin and Halle
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Raúl Rojas González



“For Reason, in this sense, is nothing but
Reckoning (that is, Adding and Subtracting).”
Thomas Hobbes, *Leviathan*.

