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by

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Foreword by Leon N. Cooper

Springer Science+Business Media, LLC

Library of Congress Cataloging-in-Publication Data

Morgan, David P., 1961-
Neural networks and speech processing / by David P. Morgan, Christopher L. Scofield ; foreword by Leon N. Cooper.
p. cm. — (The Kluwer international series in engineering and computer science. VLSI, computer architecture, and digital signal processing)
Includes bibliographical references and index.
ISBN 978-1-4613-6763-5 ISBN 978-1-4615-3950-6 (eBook)
DOI 10.1007/978-1-4615-3950-6
1. Neural networks (Computer science) 2. Speech processing systems. I. Scofield, Christopher L., 1957- II. Title.
III. Series.
QA76.87.M67 1991
006.3—dc20 90-27214
CIP

Originally published by Kluwer Academic Publishers in 1991
Softcover reprint of the hardcover 1st edition 1991

Printed on acid-free paper.

To our wives, Christine and Dale,
for their support and encouragement.

Contents

Preface

We would like to take this opportunity to thank all of those individuals who helped us assemble this text, including the people of Lockheed Sanders and Nestor, Inc., whose encouragement and support were greatly appreciated. In addition, we would like to thank the members of the *Laboratory for Engineering Man-Machine Systems* (LEMS) and the *Center for Neural Science* at Brown University for their frequent and helpful discussions on a number of topics discussed in this text. Although we both attended Brown from 1983 to 1985, and had offices in the same building, it is surprising that we did not meet until 1988.

We also wish to thank Kluwer Academic Publishers for their professionalism and patience, and the reviewers for their constructive criticism. Thanks to John McCarthy for performing the final proof, and to John Adcock, Chip Bachmann, Deborah Farrow, Nathan Intrator, Michael Perrone, Ed Real, Lance Riek and Paul Zemany for their comments and assistance. We would also like to thank Khrisna Nathan, our most unbiased and critical reviewer, for his suggestions for improving the content and accuracy of this text. A special thanks goes to Steve Hoffman, who was instrumental in helping us perform the experiments described in Chapter 9.

David P. Morgan
Christopher L. Scofield

Foreword

Today there is a great deal of interest and excitement in the investigation of artificial neural networks. Yet, when things sort themselves out, neural networks will do less than their most fervent supporters in their most enthusiastic moments suggest. But they will do more than the most pessimistic estimates of their most adamant detractors.

We will not waste time pondering the foolish question as to whether neural networks are either inspired by or imitate the brain. Those of us working with neural networks know that they do not duplicate the brain; however, the brain is where the inspiration for neural networks originated. If nothing else, the fact that the brain exists, learns, remembers, and thinks, is an existence proof that shows us that our ultimate goal is achievable. But how realistic is this goal? This is the "sixty-four dollar" question.

The hope from the beginning has been that we might capture the capacity to learn – which is clearly possible given that it exists in our heads. The question is, what does it take to capture that most sought after ability? Does it require an understanding of how individual neurons learn at a cellular level, how and where memory is stored? Does it take an understanding of reasonably complex but manageable subsystems of the brain – an understanding that could, in principal, be duplicated by either a set of instructions in computer simulation or directly in hardware? Or, is this capacity exhibited only as a property of a very large system of neurons containing very complex subsystems, so that in effect to capture these properties, we will have to do something as complex as reconstruct the entire brain!

Many researchers working with neural networks are currently exploring manageable systems that are in fact very much less complicated than the brain. Hopefully, these systems will capture some of its properties, attacking problems that, if not impossible, have been exceedingly difficult to tackle by what we might call conventional means. Among these, speech recognition ranks among the most difficult. It is a problem that combines acoustic recognition, representation, expectation, context and understanding.

Speech recognition and vision are two areas where neural networks can be motivated by underlying neurobiological structures. Although this text covers a variety of speech processing applications and neural

network topologies, David Morgan and Chris Scofield continually return to this theme. Their text describes the basic structure of the mammalian auditory system and contains sufficient background material so that researchers in related disciplines can become acquainted with the use of neural networks for speech processing.

Every area has its holy grail – in the field of neural networks there are several, and one surely is the recognition/understanding of continuous speech. Our capacity to both speak and understand one another seems so uniquely human that to simulate it in a machine would indicate to most that we had, in fact, captured a significant portion of the processing capacity that is contained in our heads.

Leon N. Cooper

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