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Hermann Haken

Synergetic Computers and Cognition

A Top-Down Approach to Neural Nets

Second Enlarged Edition
With 180 Figures

Springer

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Preface to the Second Edition

The first edition of this book has found great interest among scientists and engineers dealing with pattern recognition and among psychologists working on psychophysics or Gestalt psychology. This book also proved highly useful for graduate students of informatics.

The concept of the synergetic computer offers an important alternative to the by now more traditional neural nets. I just mention a few advantages: There are no ghost states so that time-consuming methods such as simulated annealing can be avoided; the synaptic strengths are explicitly determined by the prototype patterns to be stored, but they can equally well be learned, and the learning procedure allows a classification. Also a precise meaning and function can be attributed to "hidden variables". The synergetic computer has found a number of important practical applications in industry.

I use the opportunity of this second edition to include a new section on transformation properties of the equations of the synergetic computer and on the invariance properties of its order parameter equations.

A new section is devoted to the problem of stereopsis that is dealt with by the basic concept of the synergetic computer. Finally, attention is paid to a recent development, namely to the use of pulse-coupled neural nets for pattern recognition. This will allow us to make contact with the functioning of "real" neurons in the brain. Here, I indicate a number of tasks to be solved in future research. It goes without saying that I have made a number of minor additions. I hope that this book will find the same positive response as its first edition.

I wish to thank my secretary Ms. Irmgard Möller for her great help in preparing the additions. She typed the text and composed the formulas in her traditionally fast and perfect manner. My thanks go also to Prof. Wolf Beiglböck and his team for their excellent cooperation.

Stuttgart, March 2004 *Hermann Haken*

Preface

This book will be of interest to graduate students, researchers and teachers in the computer sciences, in the cognitive sciences and in physics. It provides the reader with a novel approach to the design and study of neural nets. The applicability of this approach is shown explicitly by means of realistic examples. In addition, detailed models of the cognitive abilities of humans are included and compared with the performance of the synergetic computer presented in this book.

The work presented here would not have been possible without the important help of my coworkers. Dr. Arne Wunderlin has helped me in many respects over many years and has made essential contributions, in particular to the slaving principle of synergetics. Drs. Michael Bestehorn, Rudolf Friedrich and Wolfgang Weimer have applied the methods of synergetics to spontaneous pattern formation in fluids and have further developed these methods. Armin Fuchs has not only implemented my algorithm on a VAX computer, but has also made his own important contributions, in particular to pattern recognition that is invariant with respect to translation, rotation, and scaling. Thomas Ditzinger, Richard Haas, and Robert Hönlinger have contributed within the work on their diploma theses to the application of our approach to a number of problems that are shared by humans and computers in the field of pattern recognition. I wish to thank all of them. Chapter 14 is the result of a most fruitful cooperation with my colleague and friend Scott Kelso to whom I am most grateful, also for highly stimulating discussions on a variety of problems in sensory-motor control, and for his constant encouragement. I extend my thanks to Ms. Irmgard Möller, who has not only prepared various versions of the manuscript with great diligence, but also helped very efficiently in a variety of ways to bring the manuscript into its final form. I am indebted to Karin Hahn and Maria Haken-Krell who assisted me in many respects. Last but not least I owe thanks to the staff of Springer-Verlag for their excellent cooperation, in particular to Dr. Angela Lahee, who made numerous highly valuable suggestions for the improvement of my manuscript.

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H. Haken

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