

Contents

Acknowledgments	vii
Preface to the Third Edition	ix
Preface to the Second Edition	xi
Preface to the First Edition	xiii
Chapter 1. Introduction and Role of Artificial Neural Networks	1
Chapter 2. Fundamentals of Biological Neural Networks	5
Chapter 3. Basic Principles of ANNs and Their Early Structures	9
3.1. Basic Principles of ANN Design	9
3.2. Basic Network Structures	10
3.3. The Perceptron's Input-Output Principles	11
3.4. The Adaline (ALC)	13
Chapter 4. The Perceptron	17
4.1. The Basic Structure	17
4.2. The Single-Layer Representation Problem	22
4.3. The Limitations of the Single-Layer Perceptron	22
4.4. Many-Layer Perceptrons	24
4.A. Perceptron Case Study: Identifying Autoregressive Parameters of a Signal (AR Time Series Identification) . .	25
Chapter 5. The Madaline	37
5.1. Madaline Training	37
5.A. Madaline Case Study: Character Recognition	39

Chapter 6.	Back Propagation	59
6.1.	The Back Propagation Learning Procedure	59
6.2.	Derivation of the BP Algorithm	59
6.3.	Modified BP Algorithms	63
6.A.	Back Propagation Case Study: Character Recognition . .	65
6.B.	Back Propagation Case Study: The Exclusive-OR (XOR) Problem (2-Layer BP)	76
6.C.	Back Propagation Case Study: The XOR Problem — 3 Layer BP Network	94
6.D.	Average Monthly High and Low Temperature Prediction Using Backpropagation Neural Networks	112
Chapter 7.	Hopfield Networks	123
7.1.	Introduction	123
7.2.	Binary Hopfield Networks	123
7.3.	Setting of Weights in Hopfield Nets — Bidirectional Associative Memory (BAM) Principle	125
7.4.	Walsh Functions	127
7.5.	Network Stability	129
7.6.	Summary of the Procedure for Implementing the Hopfield Network	131
7.7.	Continuous Hopfield Models	132
7.8.	The Continuous Energy (Lyapunov) Function	133
7.A.	Hopfield Network Case Study: Character Recognition . .	135
7.B.	Hopfield Network Case Study: Traveling Salesman Problem	147
7.C.	Cell Shape Detection Using Neural Networks	170
Chapter 8.	Counter Propagation	185
8.1.	Introduction	185
8.2.	Kohonen Self-Organizing Map (SOM) Layer	186
8.3.	Grossberg Layer	186
8.4.	Training of the Kohonen Layer	187
8.5.	Training of Grossberg Layers	189
8.6.	The Combined Counter Propagation Network	190
8.A.	Counter Propagation Network Case Study: Character Recognition	190
Chapter 9.	Large Scale Memory Storage and Retrieval (LAMSTAR) Network	203
9.1.	Motivation	203
9.2.	Basic Principles of the LAMSTAR Neural Network	204

9.3.	Detailed Outline of the LAMSTAR Network	205
9.4.	Forgetting Feature	211
9.5.	Training vs. Operational Runs	213
9.6.	Operation in Face of Missing Data	213
9.7.	Advanced Data Analysis Capabilities	214
9.8.	Modified Version: Normalized Weights	217
9.9.	Concluding Comments and Discussion of Applicability . .	218
9.A.	LAMSTAR Network Case Study: Character Recognition	220
9.B.	Application to Medical Diagnosis Problems	236
9.C.	Predicting Price Movement in Market Microstructure via LAMSTAR	240
9.D.	Constellation Recognition	253
Chapter 10. Adaptive Resonance Theory		275
10.1.	Motivation	275
10.2.	The ART Network Structure	275
10.3.	Setting-Up of the ART Network	279
10.4.	Network Operation	280
10.5.	Properties of ART	281
10.6.	Discussion and General Comments on ART-I and ART-II	283
10.A.	ART-I Network Case Study: Character Recognition . . .	283
10.B.	ART-I Case Study: Speech Recognition	297
Chapter 11. The Cognitron and the Neocognitron		305
11.1.	Background of the Cognitron	305
11.2.	The Basic Principles of the Cognitron	305
11.3.	Network Operation	305
11.4.	Cognitron's Network Training	307
11.5.	The Neocognitron	309
Chapter 12. Statistical Training		311
12.1.	Fundamental Philosophy	311
12.2.	Annealing Methods	312
12.3.	Simulated Annealing by Boltzman Training of Weights . .	312
12.4.	Stochastic Determination of Magnitude of Weight Change	313
12.5.	Temperature-Equivalent Setting	313
12.6.	Cauchy Training of Neural Network	314
12.A.	Statistical Training Case Study: A Stochastic Hopfield Network for Character Recognition	315

12.B. Statistical Training Case Study: Identifying AR Signal Parameters with a Stochastic Perceptron Model	318
Chapter 13. Recurrent (Time Cycling) Back Propagation Networks	327
13.1. Recurrent/Discrete Time Networks	327
13.2. Fully Recurrent Networks	328
13.3. Continuously Recurrent Back Propagation Networks . . .	330
13.A. Recurrent Back Propagation Case Study: Character Recognition	330
Problems	343
References	349
Author Index	357
Subject Index	361