

Contents

Acknowledgments	vii
Preface to the First Edition	ix
Preface to the Second Edition	xi
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)	12
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	23
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
Chapter 7.	Hopfield Networks	113
7.1.	Introduction	113
7.2.	Binary Hopfield Networks	113
7.3.	Setting of Weights in Hopfield Nets — Bidirectional Associative Memory (BAM) Principle	114
7.4.	Walsh Functions	117
7.5.	Network Stability	118
7.6.	Summary of the Procedure for Implementing the Hopfield Network	121
7.7.	Continuous Hopfield Models	122
7.8.	The Continuous Energy (Lyapunov) Function	123
7.A.	Hopfield Network Case Study: Character Recognition	125
7.B.	Hopfield Network Case Study: Traveling Salesman Problem	136
Chapter 8.	Counter Propagation	161
8.1.	Introduction	161
8.2.	Kohonen Self-Organizing Map (SOM) Layer	161
8.3.	Grossberg Layer	162
8.4.	Training of the Kohonen Layer	162
8.5.	Training of Grossberg Layers	165
8.6.	The Combined Counter Propagation Network	165
8.A.	Counter Propagation Network Case Study: Character Recognition	166
Chapter 9.	Adaptive Resonance Theory	179
9.1.	Motivation	179
9.2.	The ART Network Structure	179
9.3.	Setting-Up of the ART Network	183
9.4.	Network Operation	184
9.5.	Properties of ART	186
9.6.	Discussion and General Comments on ART-I and ART-II	186
9.A.	ART-I Network Case Study: Character Recognition	187
9.B.	ART-I Case Study: Speech Recognition	201
Chapter 10.	The Cognitron and the Neocognitron	209
10.1.	Background of the Cognitron	209
10.2.	The Basic Principles of the Cognitron	209

10.3. Network Operation	209
10.4. Cognitron's Network Training	211
10.5. The Neocognitron	213
Chapter 11. Statistical Training	215
11.1. Fundamental Philosophy	215
11.2. Annealing Methods	216
11.3. Simulated Annealing by Boltzman Training of Weights	216
11.4. Stochastic Determination of Magnitude of Weight Change	217
11.5. Temperature-Equivalent Setting	217
11.6. Cauchy Training of Neural Network	217
11.A. Statistical Training Case Study — A Stochastic Hopfield Network for Character Recognition	219
11.B. Statistical Training Case Study: Identifying AR Signal Parameters with a Stochastic Perceptron Model	222
Chapter 12. Recurrent (Time Cycling) Back Propagation Networks	233
12.1. Recurrent/Discrete Time Networks	233
12.2. Fully Recurrent Networks	234
12.3. Continuously Recurrent Back Propagation Networks	235
12.A. Recurrent Back Propagation Case Study: Character Recognition	236
Chapter 13. Large Scale Memory Storage and Retrieval (LAMSTAR) Network	249
13.1. Basic Principles of the LAMSTAR Neural Network	249
13.2. Detailed Outline of the LAMSTAR Network	251
13.3. Forgetting Feature	257
13.4. Training vs. Operational Runs	258
13.5. Advanced Data Analysis Capabilities	259
13.6. Correlation, Interpolation, Extrapolation and Innovation-Detection	261
13.7. Concluding Comments and Discussion of Applicability	262
13.A. LAMSTAR Network Case Study: Character Recognition	265
13.B. Application to Medical Diagnosis Problems	280
Problems	285
References	291
Author Index	299
Subject Index	301