ARTIFICIAL NEURAL NETWORKS

Theory and Applications DAN W. PATTERSON

CONTENTS

Pre	ace	xii				
\rightarrow	PART I Introduction, Background and Biological Inspiration					
1	Introduction to Artificial Neural Networks					
	1.1 Introduction 2.2	1				
	1.2 Basic Concepts in Neural Computing	2				
	1.3 Biological Systems: Biological and Cognitive Aspects	6				
	1.4 History of Neural Network Research	9				
	1.5 Artificial Neural Network Applications	14				
	Summary	19				
2	Characteristics of Artificial Networks					
	2.1 Introduction	20				
	2.2 Neural Network Structures	21				
	2.3 Characteristics of ANNs	24				
	2.4 Overview of ANN Learning Methods	28				
	2.5 Neural Network Taxonomies	32				
	Summary Southern Howard Fig. 14 and according to the control of th	36				
	6.5 Error Suctaces and Convergence Properties					
3	Review of Mathematical and Statistical Concepts					
	3.1 Introduction	37				
	3.2 Review of Vector and Matrix Algebra	38				
	3.3 Review of Calculus Concepts	48				
	3.4 Review of Probability Concepts	53				
	3.5 Review of Information Theory Concepts	56				
	3.6 Review of Fuzzy Set Theory and Fuzzy Logic	60				
	3.7 Review of Nonlinear Systems Theory and Chaos	71				
	Summary of Self-segrence States of Miles Newson Summary	84				

VIII

◇ PART II Early Neural Networks and Developments

4		Neural Network Architectures	
	4.1	Introduction	85
	4.2	Simple Perceptrons	86
	4.3	ADALINE Neural Units	98
	4.4	MADALINE Networks	104
	Sumn	nary	111
5	Assoc	ciative Memory Networks	
	5.1	Introduction	113
	5.2	Learning Algorithms for Associative Memories	116
	5.3	Feedforward Heteroassociative Memory Networks	120
	5.4	Feedforward Autoassociative Memory Networks	123
	5.5	Hopfield Networks	125
	5.6	Brain State-in-a-Box	133
	5.7	Bidirectional Associative Memory	135
	Sumn	listory of Negral Network Research	139
-91		THE	mu2
\Diamond	PAR	III Multilayer Feedforward Neural Network Backpropagation	s and
		Backpropagation	
6	Multi	layer Feedforward Neural Networks and Backpropagation	
	6.1	Introduction	141
	6.2	The Generalized Delta Rule or Backpropagation Learning	144
	6.3	BP Activation Functions	155
	6.4	Benchmark Problems for MLFF Network Performance Testing	g 157
	6.5		
		Error Surfaces and Convergence Properties	159
	6.6	Error Surfaces and Convergence Properties	159 163
		Error Surfaces and Convergence Properties Improving the Rate of Convergence	
	6.6	Error Surfaces and Convergence Properties Improving the Rate of Convergence	163
7	6.6 Sumr	Error Surfaces and Convergence Properties Improving the Rate of Convergence	163
\$8. 7 83.	6.6 Sumr	Error Surfaces and Convergence Properties Improving the Rate of Convergence Co	163
88 88 7 4 7 58	6.6 Sumr	Error Surfaces and Convergence Properties Improving the Rate of Convergence nary bilities and Limitations of Multilayer Feedforward Networks	163 178
38 7. 4. 7 55 56	6.6 Sumr Capal 7.1	Error Surfaces and Convergence Properties Improving the Rate of Convergence nary bilities and Limitations of Multilayer Feedforward Networks Introduction	163 178 178
	6.6 Sumr Capal 7.1 7.2	Error Surfaces and Convergence Properties Improving the Rate of Convergence mary bilities and Limitations of Multilayer Feedforward Networks Introduction Mapping Capabilities of MLFF Networks	163 178 180 181
	6.6 Sumr Capal 7.1 7.2 7.3	Error Surfaces and Convergence Properties Improving the Rate of Convergence mary bilities and Limitations of Multilayer Feedforward Networks Introduction Mapping Capabilities of MLFF Networks Learnability and Generalization Stochastic Approach to Generalization Empirical Tests of MLFF Network Mappings	163 178 180 181 188

Contents				İX

8 329 380 387 344 348 348	8.1 8.2 8.3 8.4	Introduc Classific Control Forecast Pattern	f Multilayer Feedforward Networks with BP tion eation and Diagnosis Applications and Optimization Applications ing and Prediction Applications Recognition Applications	215 216 220 226 236 243
\rightarrow	PART	IV	Dynamic Recurrent and Stochastic Neura Networks	
9	Dynan	nic Recu	arrent Networks 1967 Ingest Neurol Net Stationard Ad	
	9.1		1.3 Constalized Regression Neural Network Applicants	245
	9.2	-	namics of General Recurrent Networks	249
	9.3		Recurrent Networks	254
	9.4		Recurrent Network Architectures 000397	263
	9.5		ecurrent Network Architectures	267
	9.6	Applica	tions of Recurrent Networks and manuficulty and analysis of the second o	268
	Summ	nary		278
			L2 Vector Quantization	
10	Boltzr		achines and Simulated Annealing	
	10.1	Introduc		279
	10.2		eristics of the Boltzmann Machine	280
	10.3	Solving	Optimization Problems	295
	10.4	Other A	applications	299
	Summ	nary		301
			I The AKT I Network Architecture	
\Diamond	PAR	ΓV	Other Neural Network Architectures	
	la la		A Ther ART Networks	
			Network Architectures Total amail another total	202
	11.1	Introdu		
	11.2		d Coulomb Energy Networks	304
	11.3		etwork Applications	313
	11.4		e Correlation Networks—Training and Operation	317
	11.5		e Correlation Network Applications	321
	11.6		Self-Growing Networks	325
	Sumn	nary		328

12	The	Neocognitron Network		
	12.1	Introduction		329
	12.2	Architecture of the Neocognitron		330
	12.3	Training the Neocognitron		337
	12.4	Enhancements to the Neocognitron laboration and a second		340
	12.5	Neocognitron Applications		344
	Sumr	mary have been a second of the		348
13	Stoch	astic-Based Networks		
		Introduction		349
	13.2	Probabilistic Neural Network		350
	13.3	Probabilistic Neural Network Applications		355
	13.4	Generalized Regression Neural Network		358
	13.5	Generalized Regression Neural Network Applications		364
	Sumn	The Dynamics of General Recurrent Networks of historyran		366
\Diamond	PAR	TVI Networks Based on Unsupervised Lea	rnin	g
14		rganizing Feature Maps and Vector Quantization		
	14.1	Introduction		367
	14.2	Vector Quantization		380
	14.3	Modified Forms of Vector Quantization		384
	14.4	Self-Organizing Feature Map Networks		387
	14.5	Applications of VQ and SOFM		395
	Summ	lary aductor		404
15		ve Reasonance Theory		
	15.1	Introduction		405
	15.2	The ART 1 Network Architecture		407
	15.3	The ART 2 Network Architecture		415
	15.4	Other ART Networks		420
	15.5	Applications Using ART Networks		423
	Summ	ary productions of the product product and the home in		429

♦ PART VII Conclusion

16	Neuro-Fuzzy Systems, Soft Computing, Genetic Algorithms and	
	Neuro-Logic Networks	
	16.1 Introduction	431
	16.2 Soft Computing Systems	432
	16.3 Genetic Algorithms	437
	16.4 Overview of Neural Logic Networks	446
	16.5 Future Directions	450
	Summary and the second of the	451
	t acquired some busic knowledge for the newconian tac Hest few chapt	453
Ref	ferences and the second	455
Ind	ex _{to a proportion} and poles of a leading real becomes to the leading of the proportion of the propo	465