

Contents

1	Introduction	1
1.1	Feature Extraction	1
1.1.1	PCA and Subspace Tracking	1
1.1.2	PCA Neural Networks	2
1.1.3	Extension or Generalization of PCA	4
1.2	Basis for Subspace Tracking	5
1.2.1	Concept of Subspace	5
1.2.2	Subspace Tracking Method	8
1.3	Main Features of This Book	10
1.4	Organization of This Book	11
	References	12
2	Matrix Analysis Basics	17
2.1	Introduction	17
2.2	Singular Value Decomposition	18
2.2.1	Theorem and Uniqueness of SVD	18
2.2.2	Properties of SVD	20
2.3	Eigenvalue Decomposition	22
2.3.1	Eigenvalue Problem and Eigen Equation	22
2.3.2	Eigenvalue and Eigenvector	23
2.3.3	Eigenvalue Decomposition of Hermitian Matrix	28
2.3.4	Generalized Eigenvalue Decomposition	30
2.4	Rayleigh Quotient and Its Characteristics	34
2.4.1	Rayleigh Quotient	34
2.4.2	Gradient and Conjugate Gradient Algorithm for RQ	35
2.4.3	Generalized Rayleigh Quotient	36
2.5	Matrix Analysis	38
2.5.1	Differential and Integral of Matrix with Respect to Scalar	38
2.5.2	Gradient of Real Function with Respect to Real Vector	39
2.5.3	Gradient Matrix of Real Function	40

2.5.4	Gradient Matrix of Trace Function	42
2.5.5	Gradient Matrix of Determinant	43
2.5.6	Hessian Matrix	45
2.6	Summary	45
	References.	46
3	Neural Networks for Principal Component Analysis	47
3.1	Introduction	47
3.2	Review of Neural-Based PCA Algorithms	48
3.3	Neural-Based PCA Algorithms Foundation	48
3.3.1	Hebbian Learning Rule	48
3.3.2	Oja's Learning Rule	50
3.4	Hebbian/Anti-Hebbian Rule-Based Principal Component Analysis	51
3.4.1	Subspace Learning Algorithms	52
3.4.2	Generalized Hebbian Algorithm	53
3.4.3	Learning Machine for Adaptive Feature Extraction via PCA	54
3.4.4	The Dot-Product-Decorrelation Algorithm (DPD)	55
3.4.5	Anti-Hebbian Rule-Based Principal Component Analysis	55
3.5	Least Mean Squared Error-Based Principal Component Analysis	57
3.5.1	Least Mean Square Error Reconstruction Algorithm (LMSER)	58
3.5.2	Projection Approximation Subspace Tracking Algorithm (PAST).	59
3.5.3	Robust RLS Algorithm (RRLSA)	60
3.6	Optimization-Based Principal Component Analysis	61
3.6.1	Novel Information Criterion (NIC) Algorithm.	61
3.6.2	Coupled Principal Component Analysis	62
3.7	Nonlinear Principal Component Analysis	63
3.7.1	Kernel Principal Component Analysis.	64
3.7.2	Robust/Nonlinear Principal Component Analysis	66
3.7.3	Autoassociative Network-Based Nonlinear PCA	68
3.8	Other PCA or Extensions of PCA	68
3.9	Summary	70
	References.	71
4	Neural Networks for Minor Component Analysis.	75
4.1	Introduction	75
4.2	Review of Neural Network-Based MCA Algorithms	76
4.2.1	Extracting the First Minor Component	77
4.2.2	Oja's Minor Subspace Analysis	79
4.2.3	Self-stabilizing MCA	79

4.2.4	Orthogonal Oja Algorithm	80
4.2.5	Other MCA Algorithm	80
4.3	MCA EXIN Linear Neuron	81
4.3.1	The Sudden Divergence	81
4.3.2	The Instability Divergence	83
4.3.3	The Numerical Divergence	83
4.4	A Novel Self-stabilizing MCA Linear Neurons	84
4.4.1	A Self-stabilizing Algorithm for Tracking One MC	84
4.4.2	MS Tracking Algorithm	90
4.4.3	Computer Simulations.	94
4.5	Total Least Squares Problem Application.	98
4.5.1	A Novel Neural Algorithm for Total Least Squares Filtering	98
4.5.2	Computer Simulations.	105
4.6	Summary	106
	References.	107
5	Dual Purpose for Principal and Minor Component Analysis.	111
5.1	Introduction	111
5.2	Review of Neural Network-Based Dual-Purpose Methods	113
5.2.1	Chen's Unified Stabilization Approach	113
5.2.2	Hasan's Self-normalizing Dual Systems	114
5.2.3	Peng's Unified Learning Algorithm to Extract Principal and Minor Components.	117
5.2.4	Manton's Dual-Purpose Principal and Minor Component Flow	118
5.3	A Novel Dual-Purpose Method for Principal and Minor Subspace Tracking	119
5.3.1	Preliminaries	119
5.3.2	A Novel Information Criterion and Its Landscape.	122
5.3.3	Dual-Purpose Subspace Gradient Flow	127
5.3.4	Global Convergence Analysis	131
5.3.5	Numerical Simulations	132
5.4	Another Novel Dual-Purpose Algorithm for Principal and Minor Subspace Analysis.	138
5.4.1	The Criterion for PSA and MSA and Its Landscape	139
5.4.2	Dual-Purpose Algorithm for PSA and MSA	141
5.4.3	Experimental Results.	142
5.5	Summary	146
	References.	146
6	Deterministic Discrete-Time System for the Analysis of Iterative Algorithms	149
6.1	Introduction	149

6.2	Review of Performance Analysis Methods for Neural Network-Based PCA Algorithms	150
6.2.1	Deterministic Continuous-Time System Method	150
6.2.2	Stochastic Discrete-Time System Method	151
6.2.3	Lyapunov Function Approach	154
6.2.4	Deterministic Discrete-Time System Method	155
6.3	DDT System of a Novel MCA Algorithm	155
6.3.1	Self-stabilizing MCA Extraction Algorithms	155
6.3.2	Convergence Analysis via DDT System	156
6.3.3	Computer Simulations	165
6.4	DDT System of a Unified PCA and MCA Algorithm	167
6.4.1	Introduction	168
6.4.2	A Unified Self-stabilizing Algorithm for PCA and MCA	168
6.4.3	Convergence Analysis	169
6.4.4	Computer Simulations	180
6.5	Summary	182
	References	183
7	Generalized Principal Component Analysis	185
7.1	Introduction	185
7.2	Review of Generalized Feature Extraction Algorithm	187
7.2.1	Mathew's Quasi-Newton Algorithm for Generalized Symmetric Eigenvalue Problem	187
7.2.2	Self-organizing Algorithms for Generalized Eigen Decomposition	189
7.2.3	Fast RLS-like Algorithm for Generalized Eigen Decomposition	190
7.2.4	Generalized Eigenvector Extraction Algorithm Based on RLS Method	191
7.2.5	Fast Adaptive Algorithm for the Generalized Symmetric Eigenvalue Problem	194
7.2.6	Fast Generalized Eigenvector Tracking Based on the Power Method	196
7.2.7	Generalized Eigenvector Extraction Algorithm Based on Newton Method	198
7.2.8	Online Algorithms for Extracting Minor Generalized Eigenvector	200
7.3	A Novel Minor Generalized Eigenvector Extraction Algorithm	202
7.3.1	Algorithm Description	203
7.3.2	Self-stabilizing Analysis	204
7.3.3	Convergence Analysis	205
7.3.4	Computer Simulations	213

7.4	Novel Multiple GMC Extraction Algorithm	217
7.4.1	An Inflation Algorithm for Multiple GMC Extraction.	217
7.4.2	A Weighted Information Criterion and Corresponding Multiple GMC Extraction	220
7.4.3	Simulations and Application Experiments.	228
7.5	Summary	230
	References.	231
8	Coupled Principal Component Analysis	235
8.1	Introduction	235
8.2	Review of Coupled Principal Component Analysis	237
8.2.1	Moller's Coupled PCA Algorithm	237
8.2.2	Nguyen's Coupled Generalized Eigen pairs Extraction Algorithm	238
8.2.3	Coupled Singular Value Decomposition of a Cross- Covariance Matrix.	243
8.3	Unified and Coupled Algorithm for Minor and Principal Eigen Pair Extraction	243
8.3.1	Couple Dynamical System	244
8.3.2	The Unified and Coupled Learning Algorithms.	246
8.3.3	Analysis of Convergence and Self-stabilizing Property	250
8.3.4	Simulation Experiments	252
8.4	Adaptive Coupled Generalized Eigen Pairs Extraction Algorithms	257
8.4.1	A Coupled Generalized System for GMCA and GPCA	257
8.4.2	Adaptive Implementation of Coupled Generalized Systems.	262
8.4.3	Convergence Analysis.	265
8.4.4	Numerical Examples	271
8.5	Summary	278
	References.	278
9	Singular Feature Extraction and Its Neural Networks	281
9.1	Introduction	281
9.2	Review of Cross-Correlation Feature Method.	283
9.2.1	Cross-Correlation Neural Networks Model and Deflation Method	283
9.2.2	Parallel SVD Learning Algorithms on Double Stiefel Manifold	286
9.2.3	Double Generalized Hebbian Algorithm (DGHA) for SVD	288
9.2.4	Cross-Associative Neural Network for SVD(CANN)	289
9.2.5	Coupled SVD of a Cross-Covariance Matrix	291

9.3	An Effective Neural Learning Algorithm for Extracting Cross-Correlation Feature	294
9.3.1	Preliminaries	295
9.3.2	Novel Information Criterion Formulation for PSS.	297
9.3.3	Adaptive Learning Algorithm and Performance Analysis	305
9.3.4	Computer Simulations.	308
9.4	Coupled Cross-Correlation Neural Network Algorithm for Principal Singular Triplet Extraction of a Cross-Covariance Matrix.	311
9.4.1	A Novel Information Criterion and a Coupled System	312
9.4.2	Online Implementation and Stability Analysis.	315
9.4.3	Simulation Experiments	316
9.5	Summary	320
	References.	321

Principal Component Analysis Networks and Algorithms

Kong, X.; Hu, C.; Duan, Z.

2017, XXII, 323 p. 86 illus., 41 illus. in color., Hardcover

ISBN: 978-981-10-2913-4