

Contents

List of Figures	vii
List of Tables	xv
Preface	xvii
Contributing Authors	xxi
Introduction <i>Abdol S. Soofi and Liangyue Cao</i>	1
Part I EMBEDDING THEORY: TIME-DELAY PHASE SPACE RECONSTRUCTION AND DETECTION OF NONLINEAR DYNAMICS	
1	
Embedding Theory: Introduction and Applications to Time Series Analysis <i>F. Strozzi and J. M. Zaldivar</i>	11
1.1 Introduction	11
1.2 Embedding Theories	14
1.3 Chaotic Time Series Analysis	18
1.4 Examples of Applications in Economics	32
1.5 Conclusions	37
2	
Determining Minimum Embedding Dimension <i>Liangyue Cao</i>	43
2.1 Introduction	43
2.2 Major existing methods	44
2.3 False nearest neighbor method	45
2.4 Averaged false nearest neighbor method	47
2.5 Examples	49
2.6 Summary	59
3	
Mutual Information and Relevant Variables for Predictions <i>Bernd Pompe</i>	61
3.1 Introduction	61
3.2 Theoretical Background	64
3.3 Mutual Information Analysis	69
3.4 Mutual Information Algorithm	72

3.5	Examples	78
3.6	Conclusions	88
	Appendix	89
A.1	The Best LMS Predictor	89
A.2	A Property of MI	89
A.3	A Property of GMI	90
Part II METHODS OF NONLINEAR MODELLING AND FORECASTING		
4		
	State Space Local Linear Prediction	95
	<i>D. Kugiumtzis</i>	
4.1	Introduction	96
4.2	Local prediction	97
4.3	Implementation of Local Prediction Estimators on Time Series	104
4.4	Discussion	109
5		
	Local Polynomial Prediction and Volatility Estimation in Financial Time Series	115
	<i>Zhan-Qian Lu</i>	
5.1	Introduction	115
5.2	Local polynomial method	117
5.3	Technical setup for statistical theory	119
5.4	Prediction methods	123
5.5	Volatility estimation	126
5.6	Risk analysis of AOL stock	128
5.7	Concluding remarks	132
6		
	Kalman Filtering of Time Series Data	137
	<i>David M. Walker</i>	
6.1	Introduction	137
6.2	Methods	138
6.3	Examples	147
6.4	Summary	156
7		
	Radial Basis Functions Networks	159
	<i>A. Braga, A. C. Carvalho, T. Ludermir, M. de Almeida, E. Lacerda</i>	
7.1	Introduction	160
7.2	Radial Functions	161
7.3	RBF Neural Networks	161
7.4	An example of using RBF for financial time-series forecasting	172
7.5	Discussions	173
7.6	Conclusions	175
7.7	Acknowledgements	176
8		
	Nonlinear Prediction of Time Series Using Wavelet Network Method	179
	<i>Liangyue Cao</i>	
8.1	Introduction	179
8.2	Nonlinear predictive model	180
8.3	Wavelet network	181
8.4	Examples	185
8.5	Discussion and conclusion	192

Part III MODELLING AND PREDICTING MULTIVARIATE AND INPUT-OUTPUT TIME SERIES

9		
	Nonlinear Modelling and Prediction of Multivariate Financial Time Series	199
	<i>Liangyue Cao</i>	
9.1	Introduction	199
9.2	Embedding multivariate data	200
9.3	Prediction and relationship	202
9.4	Examples	203
9.5	Conclusions and discussions	209
10		
	Analysis of Economic Time Series Using NARMAX Polynomial Models	213
	<i>Luis Antonio Aguirre, Antonio Aguirre</i>	
10.1	Introduction	213
10.2	NARMAX Polynomial Models	216
10.3	Algorithms	220
10.4	Illustrative Results	223
10.5	Discussion	233
11		
	Modeling dynamical systems by Error Correction Neural Networks	237
	<i>Hans-Georg Zimmermann, Ralph Neuneier, Ralph Grothmann</i>	
11.1	Introduction	238
11.2	Modeling Dynamic Systems by Recurrent Neural Networks	239
11.3	Modeling Dynamic Systems by Error Correction	246
11.4	Variants-Invariants Separation	250
11.5	Optimal State Space Reconstruction for Forecasting	253
11.6	Yield Curve Forecasting by ECNN	260
11.7	Conclusion	262

Part IV PROBLEMS IN MODELLING AND PREDICTION

12		
	Surrogate Data Test on Time Series	267
	<i>D. Kugiumtzis</i>	
12.1	The Surrogate Data Test	269
12.2	Implementation of the Nonlinearity Test	273
12.3	Application to Financial Data	276
12.4	Discussion	277
13		
	Validation of Selected Global Models	283
	<i>C. Letellier, O. Ménard, L. A. Aguirre</i>	
13.1	Introduction	284
13.2	Bifurcation diagrams for model with parameter dependence	294
13.3	Synchronization	296
13.4	Conclusion	300
14		
	Testing Stationarity in Time Series	303
	<i>Annette Witt, Jürgen Kurths</i>	

14.1	Introduction	303
14.2	Description of the tests	306
14.3	Applications	312
14.4	Summary and discussion	323
15		
	Analysis of Economic Delayed-Feedback Dynamics	327
	<i>Henning U. Voss, Jürgen Kurths</i>	
15.1	Introduction	328
15.2	Noise-like behavior induced by a Nerlove-Arrow model with time delay	329
15.3	A nonparametric approach to analyze delayed-feedback dynamics	332
15.4	Analysis of Nerlove-Arrow models with time delay	336
15.5	Model improvement	337
15.6	Two delays and seasonal forcing	339
15.7	Analysis of the USA gross private domestic investment time series	341
15.8	The ACE algorithm	343
15.9	Summary and conclusion	345
16		
	Global Modeling and Differential Embedding	351
	<i>J. Maquet, C. Letellier, and G. Gouesbet</i>	
16.1	Introduction	351
16.2	Global modeling techniques	352
16.3	Applications to Experimental Data	367
16.4	Discussion on applications	369
16.5	Conclusion	371
17		
	Estimation of Rules Underlying Fluctuating Data	375
	<i>S. Siebert, R. Friedrich, Ch. Renner, J. Peinke</i>	
17.1	Introduction	375
17.2	Stochastic Processes	376
17.3	Dynamical Noise	378
17.4	Algorithm for Analysing Fluctuating Data Sets	378
17.5	Analysis Examples of Artificially Created Time Series	381
17.6	Scale Dependent Complex Systems	389
17.7	Financial Market	390
17.8	Turbulence	393
17.9	Conclusions	396
18		
	Nonlinear Noise Reduction	401
	<i>Rainer Hegger, Holger Kantz and Thomas Schreiber</i>	
18.1	Noise and its removal	402
18.2	Local projective noise reduction	403
18.3	Applications of noise reduction	407
18.4	Conclusion and outlook: Noise reduction for economic data	413
19		
	Optimal Model Size	417
	<i>Jianming Ye</i>	
19.1	Introduction	417
19.2	Selection of Nested Models	419
19.3	Information Criteria: General Estimation Procedures	420
19.4	Applications and Implementation Issues	425

20		
Influence of Measured Time Series in the Reconstruction of Nonlinear Multivariable Dynamics		429
<i>C. Letellier, L. A. Aguirre</i>		
20.1 Introduction		429
20.2 Non equivalent observables		432
20.3 Discussions on applications		444
20.4 Conclusion		448
Part V APPLICATIONS IN ECONOMICS AND FINANCE		
21		
Nonlinear Forecasting of Noisy Financial Data		455
<i>Abdol S. Soofi, Liangyue Cao</i>		
21.1 Introduction		455
21.2 Methodology		457
21.3 Results		459
21.4 Conclusions		462
22		
Canonical Variate Analysis and its Applications to Financial Data		467
<i>Berndt Pilgram, Peter Verhoeven, Alistair Mees, Michael McAleer</i>		
22.1 Non-linear Markov Modelling		470
22.2 Implementation of Forecasting		473
22.3 The GARCH(1,1)-t Model		474
22.4 Data Analysis		475
22.5 Empirical Results		476
22.6 Discussion		479
Index		483