

Contents

Preface	vii
1 Introduction	1
1.1 Density Estimation in the Exploration and Presentation of Data	1
1.2 Nonparametric Regression	10
1.3 Time Series Analysis	12
2 Orthonormal Series and Approximation	17
2.1 Introduction to Series Approximation	17
2.2 How Fast Fourier Coefficients May Decrease	30
2.3 Special Topic: Geometry of Square Integrable Functions .	34
2.4 Special Topic: Classical Trigonometric Series	39
2.5 Special Topic: Wavelets	47
2.6 Special Topic: More Orthonormal Systems	51
2.7 Exercises	55
2.8 Notes	57
3 Density Estimation for Small Samples	59
3.1 Universal Orthogonal Series Estimator	59
3.2 Lower Bounds (Oracle Inequalities)	72
3.3 Data-Driven Estimators	77
3.4 Case Study: Survival Analysis	79
3.5 Case Study: Data Contaminated by Measurement Errors .	85
3.6 Case Study: Length-Biased Data	91

3.7	Case Study: Incorporating Special Features	95
3.8	Special Topic: Goodness-of-Fit Tests	98
3.9	Special Topic: Basis Selection	105
3.10	Practical Seminar	108
3.11	Exercises	112
3.12	Notes	116
4	Nonparametric Regression for Small Samples	118
4.1	Classical Model of Homoscedastic Nonparametric Regression	119
4.2	Heteroscedastic Nonparametric Regression	126
4.3	Estimation of Scale Function	131
4.4	Wavelet Estimator for Spatially Inhomogeneous Functions	134
4.5	Case Study: Binary and Poisson Regressions	141
4.6	Case Study: Quantile and Robust Regression	145
4.7	Case Study: Mixtures Regression	151
4.8	Case Study: Dependent Errors	153
4.9	Case Study: Ordered Categorical Data	158
4.10	Case Study: Learning Machine for Inverse Problems with Unknown Operator	161
4.11	Case Study: Measurement Errors in Predictors	165
4.12	Practical Seminar	168
4.13	Exercises	172
4.14	Notes	179
5	Nonparametric Time Series Analysis for Small Samples	181
5.1	Estimation of Trend and Seasonal Components and Scale Function	181
5.2	Estimation of Spectral Density	188
5.3	Example of the Nonparametric Analysis of a Time Series	194
5.4	Case Study: Missing Observations	201
5.5	Case Study: Hidden Components	203
5.6	Case Study: Bivariate Time Series	210
5.7	Case Study: Dynamic Model and Forecasting	215
5.8	Case Study: Change-Point Problem	218
5.9	Practical Seminar	221
5.10	Exercises	224
5.11	Notes	228
6	Estimation of Multivariate Functions for Small Samples	230
6.1	Series Approximation of Multivariate Functions	231
6.2	Density Estimation	235
6.3	Density Estimation in Action: Discriminant Analysis	239
6.4	Nonparametric Regression	242

6.5	Additive Regression Model	245
6.6	Case Study: Conditional Density	249
6.7	Practical Seminar	253
6.8	Exercises	254
6.9	Notes	258
7	Filtering and Asymptotics	259
7.1	Recovery of a Signal Passed Through Parallel Gaussian Channels	259
7.2	Filtering a Signal from White Noise	271
7.3	Rate Optimal Estimation When Smoothness Is Known	277
7.4	Adaptive Estimation	281
7.5	Multivariate Functions	301
7.6	Special Topic: Estimation of Quadratic Functionals	304
7.7	Special Topic: Racing for Constants	308
7.8	Special Topic: Confidence Intervals, Confidence Bands, and Hypothesis Testing	311
7.9	Exercises	314
7.10	Notes	319
8	Nonseries Methods	323
8.1	The Histogram	323
8.2	The Naive Density Estimator	324
8.3	Kernel Estimator	325
8.4	Local Polynomial Regression	334
8.5	The Nearest Neighbor Method	338
8.6	The Maximum Likelihood Method	340
8.7	Spline Approximation	343
8.8	Neural Networks	349
8.9	Asymptotic Analysis of Kernel Estimates	352
8.10	Data-Driven Choice of Smoothing Parameters	358
8.11	Practical Seminar	360
8.12	Exercises	362
8.13	Notes	366
	Appendix A Fundamentals of Probability and Statistics	367
	Appendix B Software	391
	References	394
	Author Index	403
	Subject Index	407