

Larry Wasserman

All of Nonparametric Statistics

With 52 Illustrations

 Springer

Contents

1	Introduction	1
1.1	What Is Nonparametric Inference? ;:'	1
1.2	Notation and Background	2
1.3	Confidence Sets	5
1.4	Useful Inequalities	8
1.5	Bibliographic Remarks	10
1.6	Exercises	10
2	Estimating the CDF and Statistical Functionals	13
2.1	The CDF	13
2.2	Estimating Statistical Functionals	15
2.3	Influence Functions	18
2.4	Empirical Probability Distributions	21
2.5	Bibliographic Remarks	23
2.6	Appendix	23
2.7	Exercises	24
3	The Bootstrap and the Jackknife	27
3.1	The Jackknife	27
3.2	The Bootstrap	30
3.3	Parametric Bootstrap	31
3.4	Bootstrap Confidence Intervals	32
3.5	Some Theory	35

3.6	Bibliographic Remarks	37
3.7	Appendix	37
3.8	Exercises	39

Smoothing: General Concepts 43

4.1	The Bias-Variance Tradeoff	50
4.2	Kernels	55
4.3	Which Loss Function?	57
4.4	Confidence Sets	57
4.5	The Curse of Dimensionality	58
4.6	Bibliographic Remarks	59
4.7	Exercises	59

Nonparametric Regression • 61

5.1	Review of Linear and Logistic Regression	63
5.2	Linear Smoothers	66
5.3	Choosing the Smoothing Parameter	68
5.4	Local Regression	71
5.5	Penalized Regression, Regularization and Splines	81
5.6	Variance Estimation	85
5.7	Confidence Bands	89
5.8	Average Coverage	94
5.9	Summary of Linear Smoothing	95
5.10	Local Likelihood and Exponential Families	96
5.11	Scale-Space Smoothing	99
5.12	Multiple Regression	100
5.13	Other Issues	111
5.14	Bibliographic Remarks	119
5.15	Appendix	119
5.16	Exercises	120

Density Estimation • 125

6.1	Cross-Validation	126
6.2	Histograms	127
6.3	Kernel Density Estimation	131
6.4	Local Polynomials	137
6.5	Multivariate Problems	138
6.6	Converting Density Estimation Into Regression	139
6.7	Bibliographic Remarks	140
6.8	Appendix	140
6.9	Exercises	142

Normal Means and Minimax Theory 145

7.1	The Normal Means Model	145
7.2	Function Spaces	147

7.3	Connection to Regression and Density Estimation	149
7.4	Stein's Unbiased Risk Estimator (SURE).	150
7.5	Minimax Risk and Pinsker's Theorem	153
7.6	Linear Shrinkage and the James-Stein Estimator	155
7.7	Adaptive Estimation Over Sobolev Spaces.	158
7.8	Confidence Sets.	159
7.9	Optimality of Confidence Sets.	166
7.10	Random Radius Bands?	170
7.11	Penalization, Oracles and Sparsity.	171
7.12	Bibliographic Remarks.	172
7.13	Appendix.	173
7.14	Exercises.	180
8	Nonparametric Inference Using Orthogonal Functions	183
8.1	Introduction	183
8.2	Nonparametric Regression.	183
8.3	Irregular Designs	190
8.4	Density Estimation	192
8.5	Comparison of Methods.	193
8.6	Tensor Product Models.	193
8.7	Bibliographic Remarks.	194
8.8	Exercises.	194
9	Wavelets and Other Adaptive Methods	197
9.1	Haar Wavelets.	199
9.2	Constructing Wavelets.	203
9.3	Wavelet Regression.	206
9.4	Wavelet Thresholding	208
9.5	Besov Spaces.	211
9.6	Confidence Sets.	214
9.7	Boundary Corrections and Unequally Spaced Data.	215
9.8	Overcomplete Dictionaries.	215
9.9	Other Adaptive Methods.	216
9.10	Do Adaptive Methods Work?	220
9.11	Bibliographic Remarks.	221
9.12	Appendix.	221
9.13	Exercises.	223
10	Other Topics	227
10.1	Measurement Error.	227
10.2	Inverse Problems.	233
10.3	Nonparametric Bayes.	235
10.4	Semiparametric Inference	235
10.5	Correlated Errors.	236
10.6	Classification.	236

10.7	Sieves	237
10.8	Shape-Restricted Inference	237
10.9	Testing	238
10.10	Computational Issues.	240
10.11	Exercises	240
Bibliography		243
List of Symbols		259
Table of Distributions		261
Index		263