

Contents

Preface to the 2nd Edition	v
Preface to the 1st Edition	vii
I Descriptive Techniques	1
1 Comparison of Batches	3
1.1 Boxplots	4
1.2 Histograms	10
1.3 Kernel Densities	13
1.4 Scatterplots	17
1.5 Chernoff-Flury Faces	20
1.6 Andrews' Curves	23
1.7 Parallel Coordinate Plots	27
1.8 Boston Housing	28
1.9 Exercises	35
II Multivariate Random Variables	39
2 A Short Excursion into Matrix Algebra	41
2.1 Elementary Operations	41
2.2 Spectral Decompositions	46
2.3 Quadratic Forms	47
2.4 Derivatives	50
2.5 Partitioned Matrices	51
2.6 Geometrical Aspects	52
2.7 Exercises	59
3 Moving to Higher Dimensions	61
3.1 Covariance	61
3.2 Correlation	65
3.3 Summary Statistics	70
3.4 Linear Model for Two Variables	73
3.5 Simple Analysis of Variance	79
3.6 Multiple Linear Model	83
3.7 Boston Housing	87
3.8 Exercises	90

4	Multivariate Distributions	93
4.1	Distribution and Density Function	93
4.2	Moments and Characteristic Functions	98
4.3	Transformations	106
4.4	The Multinormal Distribution	108
4.5	Sampling Distributions and Limit Theorems	111
4.6	Heavy-Tailed Distributions	118
4.7	Copulae	132
4.8	Bootstrap	141
4.9	Exercises	144
5	Theory of the Multinormal	147
5.1	Elementary Properties of the Multinormal	147
5.2	The Wishart Distribution	153
5.3	Hotelling's T^2 -Distribution	154
5.4	Spherical and Elliptical Distributions	156
5.5	Exercises	158
6	Theory of Estimation	161
6.1	The Likelihood Function	161
6.2	The Cramer-Rao Lower Bound	165
6.3	Exercises	168
7	Hypothesis Testing	171
7.1	Likelihood Ratio Test	171
7.2	Linear Hypothesis	179
7.3	Boston Housing	194
7.4	Exercises	196
III	Multivariate Techniques	201
8	Decomposition of Data Matrices by Factors	203
8.1	The Geometric Point of View	203
8.2	Fitting the p -dimensional Point Cloud	205
8.3	Fitting the n -dimensional Point Cloud	208
8.4	Relations between Subspaces	209
8.5	Practical Computation	211
8.6	Exercises	213
9	Principal Components Analysis	215
9.1	Standardized Linear Combination	215
9.2	Principal Components in Practice	219
9.3	Interpretation of the PCs	222
9.4	Asymptotic Properties of the PCs	226
9.5	Normalized Principal Components Analysis	228
9.6	Principal Components as a Factorial Method	229
9.7	Common Principal Components	234
9.8	Boston Housing	237
9.9	More Examples	239
9.10	Exercises	247

10 Factor Analysis	251
10.1 The Orthogonal Factor Model	251
10.2 Estimation of the Factor Model	257
10.3 Factor Scores and Strategies	264
10.4 Boston Housing	265
10.5 Exercises	269
11 Cluster Analysis	271
11.1 The Problem	271
11.2 The Proximity between Objects	272
11.3 Cluster Algorithms	276
11.4 Boston Housing	284
11.5 Exercises	285
12 Discriminant Analysis	289
12.1 Allocation Rules for Known Distributions	289
12.2 Discrimination Rules in Practice	295
12.3 Boston Housing	300
12.4 Exercises	301
13 Correspondence Analysis	305
13.1 Motivation	305
13.2 Chi-square Decomposition	307
13.3 Correspondence Analysis in Practice	310
13.4 Exercises	318
14 Canonical Correlation Analysis	321
14.1 Most Interesting Linear Combination	321
14.2 Canonical Correlation in Practice	325
14.3 Exercises	330
15 Multidimensional Scaling	331
15.1 The Problem	331
15.2 Metric Multidimensional Scaling	336
15.3 Nonmetric Multidimensional Scaling	339
15.4 Exercises	346
16 Conjoint Measurement Analysis	347
16.1 Introduction	347
16.2 Design of Data Generation	349
16.3 Estimation of Preference Orderings	351
16.4 Exercises	356
17 Applications in Finance	359
17.1 Portfolio Choice	359
17.2 Efficient Portfolio	360
17.3 Efficient Portfolios in Practice	365
17.4 The Capital Pricing Model (CAPM)	367
17.5 Exercises	368
18 Computationally Intensive Techniques	371
18.1 Simplicial Depth	371
18.2 Projection Pursuit	375

18.3 Sliced Inverse Regression	379
18.4 Support Vector Machines	385
18.5 Classification and Regression Trees	401
18.6 Boston Housing	417
18.7 Exercises	418
IV Appendix	421
A Symbols and Notations	423
B Data	427
B.1 Boston Housing Data	427
B.2 Swiss Bank Notes	427
B.3 Car Data	430
B.4 Classic Blue Pullovers Data	432
B.5 U.S. Companies Data	432
B.6 French Food Data	434
B.7 Car Marks	434
B.8 French Baccalauréat Frequencies	435
B.9 Journaux Data	435
B.10 U.S. Crime Data	436
B.11 Plasma Data	437
B.12 WAIS Data	438
B.13 ANOVA Data	439
B.14 Timebudget Data	440
B.15 Geopol Data	441
B.16 U.S. Health Data	443
B.17 Vocabulary Data	444
B.18 Athletic Records Data	445
B.19 Unemployment Data	447
B.20 Annual Population Data	447
B.21 Bankruptcy Data	448
Bibliography	451
Index	455