

# Contents

## PART 1 METHODS FOR INVESTIGATING BIVARIATE DATA

<b>1. Peeling Bivariate Data</b>	3
<i>P. J. Green</i>	
1.1 Convex hulls	3
1.2 Peeling generally	8
1.3 Distribution theory	11
1.4 Correlation	14
1.5 Location	15
1.6 Conclusion	17
References	18
<b>2. A Brief Description of Natural Neighbour Interpolation</b>	21
<i>R. Sibson</i>	
2.1 The interpolation problem	21
2.1.1 Comments	22
2.2 Existing methods	23
2.2.1 Finite element methods	23
2.2.2 Kriging	24
2.2.3 Stiff lamina methods	24
2.3 Natural neighbour interpolation	25
2.4 Computing the natural neighbour interpolant in two dimensions	31
2.5 Looking at functions over the plane	33
2.6 Example	35
References	35
<b>3. Density Estimation for Univariate and Bivariate Data</b>	37
<i>B. W. Silverman</i>	
3.1 General considerations	37
3.1.1 Exploratory analysis	38
3.1.2 Confirmatory analysis	39
3.1.3 Presentation	40
3.1.4 Choice of smoothing parameter	41

3.2 Computing kernel estimates	43
3.2.1 The univariate case	43
3.2.2 The bivariate case	46
References	51
<b>4. Some Graphical Methods in the Analysis of Spatial Point Patterns</b>	55
<i>P. J. Diggle</i>	
4.1 Preliminary testing	57
4.2 Model fitting	60
4.3 Probability surfaces	63
4.4 Sparsely sampled patterns	68
References	72
<b>5. The Statistics of Shape</b>	75
<i>D. G. Kendall</i>	
References	80
<b>PART II REDUCTION, DISPLAY, AND ANALYSIS OF DATA MATRICES AND MULTIWAY TABLES</b>	
<b>6. Expressing Complex Relationships in Two Dimensions</b>	83
<i>J. C. Gower and P. G. N. Digby</i>	
6.1 Data as a two-way table or matrix	84
6.1.1 Picture displays	84
6.1.2 Units plotted in two dimensions	85
6.1.3 Principal components analysis	85
6.1.4 Putting extra information on a point plot	87
6.1.5 Displaying goodness-of-fit	88
6.1.6 Representation of variates	90
6.1.7 The biplot	90
6.1.8 Correspondence analysis	93
6.2 Data as a symmetric matrix	95
6.2.1 Metric scaling	95
6.2.2 Multidimensional unfolding	99
6.2.3 Non-metric scaling	100
6.2.4 Considering a symmetric matrix as a two-way table	101
6.3 Asymmetric square tables	103
6.4 Graphical methods with 3-way data	106
6.4.1 Individual scaling	107
6.4.2 Generalized Procrustes analysis	108

6.5	Hierarchical representation	111
6.5.1	Classification order	111
6.5.2	Shading	111
6.5.3	Reordering of the data matrix	115
6.5.4	Ordination	116
	References	117
<b>7.</b>	<b>Practical Correspondence Analysis</b>	119
	<i>M. J. Greenacre</i>	
7.1	Introduction	119
7.2	Geometric definition of correspondence analysis: a simple example	122
7.3	Applications of correspondence analysis	131
7.3.1	Display of frequency data in ecology	132
7.3.2	Display of ratings in psychology	136
7.3.3	Displays of heterogeneous data in meteorology	140
7.4	Concluding remarks	144
	References	145
<b>8.</b>	<b>Biplot Display of Multivariate Matrices for Inspection of Data and Diagnosis</b>	147
	<i>K. R. Gabriel</i>	
8.1	The biplot	147
8.2	Inspection of data	150
8.3	Diagnosis of models	160
8.4	Some general comments	171
	References	173
<b>9.</b>	<b>Statistical Applications of Real-Time Interactive Graphics</b>	175
	<i>D. F. Andrews</i>	
9.1	Introduction	175
9.2	Displays of measures of fit	176
9.2.1	Models with up two terms	176
9.2.2	Models with more than two terms	177
9.2.3	An example of measure display	178
9.3	Displays of fits	180
9.3.1	Examples	182
9.4	Quick rotations	184
	References	185

**PART III     GRAPHICAL DISPLAY OF DATA SETS IN 3 OR MORE DIMENSIONS**

<b>10. Preparation; Prechosen Sequences of Views</b>	<b>189</b>
<i>P. A. Tukey and J. W. Tukey</i>	
10.1 Introduction	189
10.1.1 The opportunity and the challenge	189
10.1.2 Scales for important quantities	194
10.1.3 General outline of material in Chapters 10–12	195
10.2 Preparation	195
10.2.1 Centring and scaling	196
10.2.2 Spherling	196
10.2.3 Curvature reduction	197
10.2.4 Looking at shape	198
10.3 Prechosen direct views	201
10.3.1 Prechosen direct views of three-dimensional point clouds	202
10.3.2 Prechosen direct views of four-dimensional point clouds	206
10.3.3 Automatic view selection in still higher dimensions	210
References	212
<b>11. Data-Driven View Selection; Agglomeration and Sharpening</b>	<b>215</b>
<i>P. A. Tukey and J. W. Tukey</i>	
11.1 The need for careful selection	215
11.1.1 Cap sizes	215
11.1.2 Ways out	216
11.2 Selecting direct views	217
11.2.1 Composites, coordinates, etc.	217
11.2.2 Judgment composites and residuals	218
11.2.3 Pursuing a criterion	218
11.2.4 The Friedman–Tukey projection-pursuit algorithm	219
11.2.5 Quadratic criterion approaches	226
11.2.6 Other components	227
11.3 Agglomeration and sharpening	228
11.3.1 Agglomerated views and agglomerated clouds	228
11.3.2 Balloon densities	233
11.3.3 Sharpening	237
References	242

<b>12. Summarization; Smoothing; Supplemented Views</b>	245
<i>P. A. Tukey and J. W. Tukey</i>	
12.1 Summarization	245
12.1.1 Kinds of summarization of back variables	245
12.1.2 Smoothing, mainly in the view-plane	246
12.1.3 Traces and delineations in the view	250
12.2 Supplemented views	253
12.2.1 Characters and glyphs	253
12.2.2 Collective characters and other special considerations	260
12.2.3 Backgrounds	262
12.2.4 Deployment of tools	266
12.3 Topics not covered	272
12.3.1 Some omissions	272
References	274

#### PART IV      SPECIFIC METHODS AND PRACTICAL APPLICATIONS

<b>13. Plotting the Optimum Positions of an Array of Cortical Electrical Phosphenes</b>	279
<i>B. S. Everitt and J. C. Gower</i>	
13.1 Minimization method	280
13.2 Weighted generalized Procrustes method	283
13.3 Conclusions	287
References	287
<b>14. Analysing Data from Multivariate Directed Graphs: An Application to Social Networks</b>	289
<i>S. E. Fienberg, M. M. Meyer, and S. S. Wasserman</i>	
14.1 Introduction	289
14.2 A specific network: Towertown, U.S.A.	292
14.3 Log-linear models for multivariate directed graphs	295
14.4 Fitting the models to data	298
14.5 Initial analyses of the Towertown data	301
14.6 A possible graphical display for multivariate directed graphs	304
References	305

<b>15. Some Graphical Procedures for the Preliminary Processing of Longitudinal Data</b>	<b>307</b>
<i>H. Goldstein</i>	
15.1 The adjustment procedure	307
15.2 Data analysis	308
15.3 Standardization for variance	309
15.4 Outlier detection	316
15.5 Conclusions	319
References	319
<b>16. Interpreting Archaeological Data</b>	<b>321</b>
<i>I. Graham</i>	
16.1 Spatial analysis	321
16.1.1 The definition of 'random'	323
16.1.2 Spectral analysis	324
16.1.3 Preliminary results	327
16.2 Results	329
References	333
<b>17. Bayesian Approaches to Multivariate Structure</b>	<b>335</b>
<i>A. F. M. Smith and D. J. Spiegelhalter</i>	
17.1 Vague prior information and imaginary observations	337
17.2 Hypotheses involving means	338
17.2.1 One sample: hypothesis of zero mean	338
17.2.2 Two samples: hypothesis of equality of mean vectors	340
17.2.3 Several samples: hypothesis of equality of means	341
17.3 Hypotheses involving covariances	341
17.3.1 Two samples: hypothesis of equal covariances	341
17.3.2 Several samples: hypothesis of equal covariances	342
17.4 A mixture form of classification rule	343
17.5 Transformation to normality	344
17.6 Numerical illustrations	347
References	347
<b>Bibliography</b>	<b>349</b>
<b>Composite Reference List</b>	<b>353</b>
<b>Index</b>	<b>365</b>