

Contents

- 1 Data Analysis in Earth Sciences 1
 - 1.1 Introduction 1
 - 1.2 Data Collection 2
 - 1.3 Types of Data 3
 - 1.4 Methods of Data Analysis 7
- 2 Introduction to MATLAB 11
 - 2.1 MATLAB in Earth Sciences 11
 - 2.2 Getting Started 12
 - 2.3 The Syntax 14
 - 2.4 Data Storage and Handling 18
 - 2.5 Data Structures and Classes of Objects 21
 - 2.6 Scripts and Functions 26
 - 2.7 Basic Visualization Tools 29
 - 2.8 Generating M-Files to Regenerate Graphs 32
 - 2.9 Publishing M-Files 35
- 3 Univariate Statistics 37
 - 3.1 Introduction 37
 - 3.2 Empirical Distributions 37
 - 3.3 Example of Empirical Distributions 44
 - 3.4 Theoretical Distributions 51
 - 3.5 Example of Theoretical Distributions 59
 - 3.6 The t-Test 61
 - 3.7 The F-Test 66
 - 3.8 The χ^2 -Test 70
 - 3.9 Distribution Fitting 73

4	Bivariate Statistics	79
4.1	Introduction	79
4.2	Pearson's Correlation Coefficient	80
4.3	Classical Linear Regression Analysis and Prediction	88
4.4	Analyzing the Residuals	92
4.5	Bootstrap Estimates of the Regression Coefficients	94
4.6	Jackknife Estimates of the Regression Coefficients	95
4.7	Cross Validation	98
4.8	Reduced Major Axis Regression	99
4.9	Curvilinear Regression	100
4.10	Nonlinear and Weighted Regression	103
5	Time-Series Analysis	107
5.1	Introduction	107
5.2	Generating Signals	108
5.3	Auto-Spectral and Cross-Spectral Analysis	112
5.4	Examples of Auto-Spectral and Cross-Spectral Analysis	117
5.5	Interpolating and Analyzing Unevenly-Spaced Data	126
5.6	Evolutionary Power Spectrum	131
5.7	Lomb-Scargle Power Spectrum	135
5.8	Wavelet Power Spectrum	139
5.9	Nonlinear Time-Series Analysis (<i>by N. Marwan</i>)	146
6	Signal Processing	161
6.1	Introduction	161
6.2	Generating Signals	162
6.3	Linear Time-Invariant Systems	164
6.4	Convolution and Filtering	166
6.5	Comparing Functions for Filtering Data Series	169
6.6	Recursive and Nonrecursive Filters	172
6.7	Impulse Response	173
6.8	Frequency Response	176
6.9	Filter Design	182
6.10	Adaptive Filtering	185
7	Spatial Data	193
7.1	Types of Spatial Data	193
7.2	The GSHHS Shoreline Data Set	194

7.3	The 2-Minute Gridded Global Relief Data ETOPO2	196
7.4	The 30-Arc Seconds Elevation Model GTOPO30	199
7.5	The Shuttle Radar Topography Mission SRTM	201
7.6	Gridding and Contouring Background	204
7.7	Gridding Example	207
7.8	Comparison of Methods and Potential Artifacts	211
7.9	Statistics of Point Distributions	216
7.10	Analysis of Digital Elevation Models (<i>by R. Gebbers</i>)	224
7.11	Geostatistics and Kriging (<i>by R. Gebbers</i>)	235
8	Image Processing	255
8.1	Introduction	255
8.2	Data Storage	256
8.3	Importing, Processing and Exporting Images	261
8.4	Importing, Processing and Exporting Satellite Images	266
8.5	Georeferencing Satellite Images	268
8.6	Digitizing from the Screen	271
8.7	Color-Intensity Transects of Varved Sediments	274
8.8	Grain Size Analysis from Microscope Images	279
8.9	Quantifying Charcoal in Microscope Images	286
9	Multivariate Statistics	291
9.1	Introduction	291
9.2	Principal Component Analysis	293
9.3	Independent Component Analysis (<i>by N. Marwan</i>)	300
9.4	Cluster Analysis	304
10	Statistics on Directional Data	311
10.1	Introduction	311
10.2	Graphical Representation	312
10.3	Empirical Distributions	313
10.4	Theoretical Distributions	318
10.5	Test for Randomness of Directional Data	320
10.6	Test for the Significance of a Mean Direction	321
10.7	Test for the Difference Between Two Sets of Directions	322
	General Index	327