
Contents

Preface	xiii
Part 1. Integrated Analysis in Geography: The Way to Cloud Computing	xix
Introduction to Part 1	xxi
Dominique LAFFLY	
Chapter 1. Geographical Information and Landscape, Elements of Formalization	1
Dominique LAFFLY	
Chapter 2. Sampling Strategies	7
Dominique LAFFLY	
2.1. References	18
Chapter 3. Characterization of the Spatial Structure	19
Dominique LAFFLY	
Chapter 4. Thematic Information Structures	27
Dominique LAFFLY	
Chapter 5. From the Point to the Surface, How to Link Endogenous and Exogenous Data	35
Dominique LAFFLY	
5.1. References	44

Chapter 6. Big Data in Geography	45
Dominique LAFFLY	
Conclusion to Part 1	55
Dominique LAFFLY	
Part 2. Basic Mathematical, Statistical and Computational Tools	59
Chapter 7. An Introduction to Machine Learning	61
Hichem SAHLI	
7.1. Predictive modeling: introduction	61
7.2. Bayesian modeling	61
7.2.1. Basic probability theory	62
7.2.2. Bayes rule	63
7.2.3. Parameter estimation	63
7.2.4. Learning Gaussians	64
7.3. Generative versus discriminative models	66
7.4. Classification	67
7.4.1. Naïve Bayes	68
7.4.2. Support vector machines	69
7.5. Evaluation metrics for classification evaluation	71
7.5.1. Confusion matrix-based measures	71
7.5.2. Area under the ROC curve (AUC)	73
7.6. Cross-validation and over-fitting	73
7.7. References	74
Chapter 8. Multivariate Data Analysis	75
Astrid JOURDAN and Dominique LAFFLY	
8.1. Introduction	75
8.2. Principal component analysis	77
8.2.1. How to measure the information	78
8.2.2. Scalar product and orthogonal variables	80
8.2.3. Construction of the principal axes	81
8.2.4. Analysis of the principal axes	84
8.2.5. Analysis of the data points	86
8.3. Multiple correspondence analysis	88
8.3.1. Indicator matrix	89
8.3.2. Cloud of data points	90
8.3.3. Cloud of levels	92
8.3.4. MCA or PCA?	94

8.4. Clustering	96
8.4.1. Distance between data points	97
8.4.2. Dissimilarity criteria between clusters	98
8.4.3. Variance (inertia) decomposition	99
8.4.4. k-means method.	101
8.4.5. Agglomerative hierarchical clustering	104
8.5. References	105
Chapter 9. Sensitivity Analysis	107
Astrid JOURDAN and Peio LOUBIÈRE	
9.1. Generalities.	107
9.2. Methods based on linear regression	109
9.2.1. Presentation	109
9.2.2. R practice	111
9.3. Morris' method	114
9.3.1. Elementary effects method (Morris' method)	114
9.3.2. R practice	117
9.4. Methods based on variance analysis	119
9.4.1. Sobol' indices	120
9.4.2. Estimation of the Sobol' indices.	122
9.4.3. R practice	123
9.5. Conclusion	126
9.6. References	127
Chapter 10. Using R for Multivariate Analysis	129
Astrid JOURDAN	
10.1. Introduction	129
10.1.1. The dataset	131
10.1.2. The variables.	134
10.2. Principal component analysis	136
10.2.1. Eigenvalues	137
10.2.2. Data points (Individuals)	139
10.2.3. Supplementary variables	143
10.2.4. Other representations	143
10.3. Multiple correspondence analysis.	144
10.4. Clustering	145
10.4.1. k-means algorithm.	145
10.5. References	151

Part 3. Computer Science	153
Chapter 11. High Performance and Distributed Computing	155
Sebastiano Fabio SCHIFANO, Eleonora LUPPI, Didin Agustian PERMADI, Thi Kim Oanh NGUYEN, Nhat Ha Chi NGUYEN and Luca TOMASSETTI	
11.1. High performance computing	155
11.2. Systems based on multi-core CPUs	157
11.2.1. Systems based on GPUs	159
Chapter 12. Introduction to Distributed Computing	163
Eleonora LUPPI	
12.1. Introduction	163
12.1.1. A brief history	163
12.1.2. Design requirements	165
12.1.3. Models	168
12.1.4. Grid computing	171
12.2. References	176
Chapter 13. Towards Cloud Computing	179
Peio LOUBIÈRE and Luca TOMASSETTI	
13.1. Introduction	179
13.1.1. Generalities	179
13.1.2. Benefits and drawbacks	180
13.2. Service model	180
13.2.1. Software as a Service	181
13.2.2. Platform as a Service	182
13.2.3. Infrastructure as a Service	182
13.2.4. And many more: XaaS	182
13.3. Deployment model	183
13.3.1. Public cloud	183
13.3.2. Private cloud	183
13.3.3. Hybrid cloud	184
13.4. Behind the hood, a technological overview	184
13.4.1. Structure	184
13.4.2. Virtualization	185
13.4.3. Scalability	186
13.4.4. Web-Oriented Architecture	187
13.5. Conclusion	187
13.6. References	188

Chapter 14. Web-Oriented Architecture – How to design a RESTFull API	191
Florent DEVIN	
14.1. Introduction	191
14.2. Web services	192
14.2.1. Introduction	192
14.2.2. SOAP web services	193
14.2.3. REST web services	195
14.3. Web-Oriented Applications – Microservice applications	198
14.3.1. Stateless and scalability	199
14.3.2. API	200
14.3.3. HTTP Methods	201
14.3.4. Example of an API	202
14.4. WSDL example	203
14.5. Conclusion	205
14.6. References	205
Chapter 15. SCALA – Functional Programming	207
Florent DEVIN	
15.1. Introduction	207
15.1.1. Programming languages	208
15.1.2. Paradigm	208
15.2. Functional programming	212
15.2.1. Introduction	212
15.2.2. Why now?	212
15.2.3. High order function	213
15.2.4. Basic functional blocks	215
15.3. Scala	217
15.3.1. Types systems	218
15.3.2. Basic manipulation of collection	222
15.4. Rational	224
15.5. Why immutability matters?	224
15.6. Conclusion	226
15.7. References	227
Chapter 16. Spark and Machine Learning Library	229
Yannick LE NIR	
16.1. Introduction	229
16.2. Spark	230
16.2.1. Spark introduction	230

16.2.2. RDD presentation	230
16.2.3. RDD lifecycle	231
16.2.4. Operations on RDD	232
16.2.5. Exercises for environmental sciences	236
16.3. Spark machine learning library	237
16.3.1. Local vectors.	237
16.3.2. Labeled points	237
16.3.3. Learning dataset	238
16.3.4. Classification and regression algorithms in Spark	238
16.3.5. Exercises for environmental sciences	239
16.4. Conclusion	242
Chapter 17. Database for Cloud Computing	245
Peio LOUBIÈRE	
17.1. Introduction	245
17.2. From myGlsrbms to NoSQL	245
17.2.1. CAP theorem.	246
17.2.2. From ACID to BASE	247
17.3. NoSQL database storage paradigms	248
17.3.1. Column-family oriented storage	249
17.3.2. Key/value-oriented storage	249
17.3.3. Document-oriented storage	250
17.3.4. Graph-oriented storage	251
17.4. SQL versus NoSQL, the war will not take place	251
17.5. Example: a dive into MongoDB	252
17.5.1. Presentation	253
17.5.2. First steps.	254
17.5.3. Database level commands	254
17.5.4. Data types	255
17.5.5. Modifying data.	255
17.6. Conclusion	273
17.7. References	273
Chapter 18. WRF Performance Analysis and Scalability on Multicore High Performance Computing Systems	275
Didin Agustian PERMADI, Sebastiano Fabio SCHIFANO, Thi Kim Oanh NGUYEN, Nhat Ha Chi NGUYEN, Eleonora LUPPI and Luca TOMASSETTI	
18.1. Introduction	276
18.2. The weather research and forecast model and experimental set-up	276
18.2.1. Model architecture.	276

18.3. Architecture of multicore HPC system	282
18.4. Results	283
18.4.1. Results of experiment E1	283
18.4.2. Results of experiment E2	286
18.5. Conclusion	288
18.6. References	288
List of Authors	291
Index	293
Summaries of other volumes	295