
Contents

Preface	xi
Acknowledgments	xiii
Introduction	xv
Solym Mawaki MANOU-ABI, Sophie DABO-NIANG and Jean-Jacques SALONE	
Part 1. Advances in Mathematical Modeling	1
Chapter 1. Deviations From the Law of Large Numbers and Extinction of an Endemic Disease	3
Étienne PARDOUX	
1.1. Introduction	3
1.2. The three models	5
1.2.1. The SIS model	5
1.2.2. The SIRS model	6
1.2.3. The SIR model with demography	7
1.3. The stochastic model, LLN, CLT and LD	8
1.3.1. The stochastic model	8
1.3.2. Law of large numbers	9
1.3.3. Central limit theorem	10
1.3.4. Large deviations and extinction of an epidemic	10
1.4. Moderate deviations	12
1.4.1. CLT and extinction of an endemic disease	12
1.4.2. Moderate deviations	13
1.5. References	29

Chapter 2. Nonparametric Prediction for Spatial Dependent Functional Data: Application to Demersal Coastal Fish off Senegal	31
Mamadou N'DIAYE, Sophie DABO-NIANG, Papa NGOM, Ndiaga THIAM, Massal FALL and Patrice BREHMER	
2.1. Introduction	31
2.2. Regression model and predictor	34
2.3. Large sample properties	36
2.4. Application to demersal coastal fish off Senegal	39
2.4.1. Procedure of prediction	39
2.4.2. Demersal coastal fish off Senegal data set	40
2.4.3. Measuring prediction performance	41
2.5. Conclusion	48
2.6. References	49
Chapter 3. Space–Time Simulations of Extreme Rainfall: Why and How?	53
Gwladys TOULEMONDE, Julie CARREAU and Vincent GUINOT	
3.1. Why?	53
3.1.1. Rainfall-induced urban floods	53
3.1.2. Sample hydraulic simulation of a rainfall-induced urban flood	54
3.2. How?	58
3.2.1. Spatial stochastic rainfall generator	58
3.2.2. Modeling extreme events	59
3.2.3. Stochastic rainfall generator geared towards extreme events	63
3.3. Outlook	64
3.4. References	66
Chapter 4. Change-point Detection for Piecewise Deterministic Markov Processes	73
Alice CLEYNEN and Benoîte DE SAPORTA	
4.1. A quick introduction to stochastic control and change-point detection	73
4.2. Model and problem setting	76
4.2.1. Continuous-time PDMP model	77
4.2.2. Optimal stopping problem under partial observations	78
4.2.3. Fully observed optimal stopping problem	80
4.3. Numerical approximation of the value functions	82
4.3.1. Quantization	83
4.3.2. Discretizations	84

4.3.3. Construction of a stopping strategy	87
4.4. Simulation study	89
4.4.1. Linear model	89
4.4.2. Nonlinear model	91
4.5. Conclusion	92
4.6. References	93

Chapter 5. Optimal Control of Advection–Diffusion Problems for Cropping Systems with an Unknown Nutrient Service Plant Source 97

Loïc LOUISE and Abdennebi OMRANE

5.1. Introduction	97
5.2. Statement of the problem	99
5.2.1. Existence of a solution to the NTB uptake system	100
5.3. Optimal control for the NTB problem with an unknown source	102
5.3.1. Existence of a solution to the adjoint problem of NTB uptake system with an unknown source	103
5.4. Characterization of the low-regret control for the NTB system	107
5.5. Concluding remarks	110
5.6. References	111

Chapter 6. Existence of an Asymptotically Periodic Solution for a Stochastic Fractional Integro-differential Equation 113

Solym Mawaki MANOU-ABI, William DIMBOUR and Mamadou Moustapha MBAYE

6.1. Introduction	113
6.2. Preliminaries	115
6.2.1. Asymptotically periodic process and periodic limit processes	115
6.2.2. Sectorial operators	117
6.3. A stochastic integro-differential equation of fractional order	118
6.4. An illustrative example	137
6.5. References	138

Chapter 7. Bounded Solutions for Impulsive Semilinear Evolution Equations with Non-local Conditions 141

Toka DIAGANA and Hugo LEIVA

7.1. Introduction	141
7.2. Preliminaries	142
7.3. Main theorems	144
7.4. The smoothness of the bounded solution	151
7.5. Application to the Burgers equation	156
7.6. References	159

Chapter 8. The History of a Mathematical Model and Some of Its Criticisms up to Today: The Diffusion of Heat That Started with a Fourier “Thought Experiment”	161
Jean DHOMBRES	
8.1. Introduction	161
8.2. A physical invention is translated into mathematics thanks to the heat flow	163
8.3. The proper story of proper modes	164
8.3.1. Mathematical position of the lamina problem	165
8.3.2. Simple modes are naturally involved	166
8.3.3. A remarkable switch to proper modes	167
8.4. The numerical example of the periodic step function gives way to a physical interpretation	169
8.4.1. A calculation that <i>a priori</i> imposes an extension to the function f at the base of the lamina	169
8.4.2. A crazy calculation	170
8.4.3. Fourier is happily confronted with the task of finding an explanation for the simplicity of the result about coefficients	174
8.4.4. Criticisms of the modeling	175
8.5. To invoke arbitrary functions leads to an interpretation of orthogonality relations	177
8.5.1. Function is a leitmotiv in Fourier’s intellectual career	180
8.6. The modeling of the temperature of the Earth and the greenhouse effect	181
8.7. Axiomatic shaping by Hilbert spaces provides a good account for another dictionary part in Fourier’s theory, and also to its limits, so that his representation finally had to be modified to achieve efficient numerical purposes	184
8.7.1. Another dictionary: the Fourier transform for tempered distributions	184
8.7.2. Heisenberg inequalities may just be deduced from the existence of a scalar product	185
8.7.3. Orthogonality and a quick look to wavelets	187
8.8. Conclusion	187
8.9. References	189
Part 2. Some Topics on Mayotte and Its Region	191
Chapter 9. Towards a Methodology for Interdisciplinary Modeling of Complex Systems Using Hypergraphs	193
Jean-Jacques SALONE	
9.1. Introduction	193
9.1.1. The ARESMA project	193

9.1.2. Towards a methodology of interdisciplinary modeling	194
9.2. Systemic and lexicometric analyses of questionnaires	195
9.2.1. Complex systems	195
9.2.2. Methodology	198
9.2.3. Results	199
9.2.4. Conclusion of the section	205
9.3. Hypergraphic analyses of diagrams	205
9.3.1. Hypergraphs and modeling of a complex system	205
9.3.2. Methodology	208
9.3.3. Results	208
9.3.4. Conclusion of the section	212
9.4. Discussion and perspectives	212
9.5. Appendix	214
9.5.1. Other properties of a connected hypergraph	214
9.5.2. Metric over an FHT	214
9.6. References	217
Chapter 10. Modeling of Post-forestry Transitions in Madagascar and the Indian Ocean: Setting Up a Dialogue Between Mathematics, Computer Science and Environmental Sciences	221
Dominique HERVÉ	
10.1. Introduction	221
10.2. Interdisciplinary exploration of agrarian transitions	223
10.2.1. Exploration of post-forestry transitions in rainforests of Madagascar	223
10.2.2. Applications to dry forests in southwestern Madagascar	228
10.2.3. Viability	229
10.3. Community management of resources, looking for consensus	232
10.3.1. Degradation, violation, sanction	232
10.3.2. Local farmers' maps and conceptual graphs	234
10.4. Discussion and conclusion	237
10.5. References	240
Chapter 11. Structural and Predictive Analysis of the Birth Curve in Mayotte from 2011 to 2017	245
Julien BALICCHI and Anne BARBAIL	
11.1. Introduction	245
11.1.1. Motivation	245
11.1.2. Context	246
11.1.3. About the literature on the birth curve in Mayotte	247
11.1.4. Objective of ARS OI	248
11.2. Origin of the data	248

11.3. Methodologies and results	248
11.3.1. Methodological approach	248
11.3.2. Annual trend	249
11.3.3. Monthly trend	249
11.3.4. Characterization of the explosion risk of the number of births	250
11.3.5. Autocorrelation	252
11.3.6. Modeling by an ARIMA process (p, d, q)	253
11.3.7. Predictions for the year 2018	256
11.4. Discussion	257
11.5. Conclusion	259
11.6. References	259
Chapter 12. Reflections Upon the Mathematization of Mayotte's Economy	261
Victor BIANCHINI and Antoine HOCHET	
12.1. Introduction	261
12.2. Justifying the mathematization of economics	263
12.2.1. The ontological and linguistic arguments	264
12.2.2. Towards a naturalization of modeling in economics	265
12.2.3. A number of caveats	267
12.3. For a reasonable mathematization of economics: the case of Mayotte	268
12.3.1. The trend towards the mathematization of the economics of Mayotte	269
12.3.2. From Mayotte's formal economy to its informal one	269
12.3.3. When the formal economy interacts with the informal one: some issues for the modelization of complex systems	270
12.4. Concluding remark	273
12.5. References	273
List of Authors	279
Index	281