

Contents

1	Introduction	1
1.1	Motivating Examples	1
1.1.1	The Pinus Radiata Dataset	1
1.1.2	The Murray Smelter Site Dataset.....	4
1.1.3	Similarity Between Images.....	5
1.2	Objective of the Book	7
1.3	Layout of the Book	7
1.4	Computation	7
1.5	Preliminaries and Notation	8
1.5.1	Spatial Processes	8
1.5.2	Intrinsic Stationary Processes and the Variogram	11
1.5.3	Estimation of the Variogram	17
1.5.4	Kriging	17
1.5.5	The Cross-Variogram	18
1.5.6	Image Analysis.....	21
1.6	Problems for the Reader.....	23
	References	25
2	The Modified t test	29
2.1	Introduction	29
2.2	The modified t test	29
2.3	Estimation of the effective sample size	31
2.4	Applications and R computations.....	34
2.4.1	Application 1: Murray Smelter site revisited	35
2.4.2	Application 2: Modified t -test between images.....	37
2.5	A permutation test under spatial correlation	39
2.5.1	Application 3: Permutation t -test between images	42
2.6	Assessing correlation between one process and several others ..	43
2.6.1	Application 4: Pinus Radiata dataset revisited	45
2.7	Problems for the reader	46
	References	47

3	A Parametric Test based on Maximum Likelihood	49
3.1	Introduction	49
3.1.1	Parametric bivariate covariance models	49
3.2	A parametric test based on ML under increasing domain asymptotics	55
3.3	A parametric test based on ML under fixed domain asymptotics	58
3.4	Examples with the R package GeoModels	60
3.4.1	An example of test of independence using a separable Matérn model	60
3.4.2	An example of test for assessing the correlation using a nonseparable Matérn model	62
3.5	Application to the Pinus Radiata Dataset	64
3.6	Problems for the reader	69
	References	70
4	Tjøstheim's Coefficient	73
4.1	Measures of Association	73
4.2	Definition of the Measure and Its Properties	75
4.3	Applications and R Computations	76
4.3.1	The R Function <code>cor.spatial</code>	76
4.3.2	Application 1: Murray Smelter Site Revisited	77
4.3.3	Application 2: Flammability of carbon nanotubes	78
4.4	Problems for the Reader	79
	References	81
5	The Codispersion Coefficient	83
5.1	Introduction	83
5.2	The Codispersion Index	83
5.2.1	Relationship Between Codispersion and Correlation	84
5.2.2	Differentiating Correlation and Spatial Association	85
5.3	Codispersion for Spatial Autoregressive Processes	87
5.4	Asymptotic Results	91
5.5	Hypothesis Testing	96
5.6	Numerical Experiments	99
5.6.1	Simulation of Spatial Autoregressive Models	99
5.6.2	Simulation of Spatial Moving Average Models	99
5.6.3	Coverage Probability	102
5.7	The codispersion Map	103
5.7.1	The Map for Data Defined on a General Lattice	103
5.7.2	The Map for Data Defined on a Regular Grid	105
5.8	Applications and R computations	105
5.8.1	The R function <code>codisp</code>	105
5.8.2	Application 1: Flammability of Carbon Nanotubes Revisited	106

5.8.3	Application 2: Comovement Between Time Series	108
5.8.4	Application 3: Codispersion Maps for Images	110
5.8.5	Computational Time Comparison	110
5.9	Problems for the Reader	114
	References	116
6	A Nonparametric Coefficient	121
6.1	Introduction	121
6.2	Linear Smoothers and Kernel Functions	121
6.3	A Nadaraya-Watson Codispersion Coefficient	123
6.4	Asymptotic Results	124
6.5	Selection of the Bandwidth	126
6.5.1	Bandwidth Selection for the Semi-Variogram	126
6.5.2	Bandwidth Selection for the Cross-Variogram	130
6.6	Simulations	130
6.7	R computations and Applications	131
6.7.1	The R Function <code>Codisp.Kern</code>	133
6.7.2	Application: The <code>Camg</code> Dataset	133
6.8	Problems for the Reader	134
	References	136
7	Association for More Than Two Processes	139
7.1	Introduction	139
7.2	The Codispersion Matrix	139
7.3	Asymptotic Results and Examples	141
7.4	Spectral Band Selection	144
7.5	Applications and R Computations	146
7.6	Final Comments	149
7.7	Problems for the Reader	150
	References	151
8	Spatial Association Between Images	153
8.1	Introduction	153
8.2	The Structural Similarity Index	154
8.3	Some Extensions	157
8.3.1	The CQ Coefficient	157
8.3.2	The CQ_{\max} Coefficient	158
8.3.3	The CSIM Coefficient	160
8.4	Numerical Experiments	161
8.4.1	Performance of the Directional Contrast	161
8.4.2	Performance of the Coefficients Under Distortions	165
8.5	Applications and R Computations	168
8.5.1	Application : Stochastic Resonance	168
8.6	Problems for the Reader	171
	References	172

A Proofs 175

B Effective Sample Size 187

 References 188

C Solutions to Selected Problems 191