

1. Record Nr.	UNINA9910830501003321
Titolo	Geostatistical functional data analysis // edited by Jorge Mateu, Ramon Giraldo
Pubbl/distr/stampa	Hoboken, New Jersey : , : Wiley, , [2021] ©2021
ISBN	1-119-38790-6 1-119-38791-4 1-119-38788-4
Descrizione fisica	1 online resource (451 pages) : illustrations
Collana	Wiley series in probability and statistics
Disciplina	551.072/7
Soggetti	Functional analysis Kriging Spatial analysis (Statistics) Geology - Statistical methods
Lingua di pubblicazione	Inglese
Formato	Materiale a stampa
Livello bibliografico	Monografia
Nota di bibliografia	Includes bibliographical references and index.
Nota di contenuto	Foreword -- Chapter 1 Introduction to Geostatistical Functional Data Analysis -- 1.1 Spatial Statistics -- 1.2 Spatial Geostatistics -- 1.2.1 Regionalized Variables -- 1.2.2 Random Functions -- 1.2.3 Stationarity and Intrinsic Hypothesis -- 1.3 Spatiotemporal Geostatistics -- 1.3.1 Relevant Spatiotemporal Concepts -- 1.3.2 Spatiotemporal Kriging -- 1.3.3 Spatiotemporal Covariance Models -- 1.4 Functional Data Analysis in Brief -- References -- Part I Mathematical and Statistical Foundations -- Chapter 2 Mathematical Foundations of Functional Kriging in Hilbert Spaces and Riemannian Manifolds -- 2.1 Introduction -- 2.2 Definitions and Assumptions -- 2.3 Kriging Prediction in Hilbert Space: A Trace Approach -- 2.3.1 Ordinary and Universal Kriging in Hilbert Spaces -- 2.3.2 Estimating the Drift -- 2.3.3 An Example: TraceVariogram in Sobolev Spaces -- 2.3.4 An Application to Nonstationary Prediction of Temperatures Profiles -- 2.4 An Operatorial Viewpoint to Kriging -- 2.5 Kriging for ManifoldValued Random Fields -- 2.5.1 Residual Kriging -- 2.5.2 An Application to Positive Definite Matrices -- 2.5.3 Validity of the Local Tangent Space Approximation --

2.6 Conclusion and Further Research -- References -- Chapter 3 Universal, Residual, and External Drift Functional Kriging -- 3.1 Introduction -- 3.2 Universal Kriging for Functional Data (UKFD) -- 3.3 Residual Kriging for Functional Data (ResKFD) -- 3.4 Functional Kriging with External Drift (FKED) -- 3.5 Accounting for Spatial Dependence in Drift Estimation -- 3.5.1 Drift Selection -- 3.6 Uncertainty Evaluation -- 3.7 Implementation Details in R -- 3.7.1 Example: Air Pollution Data -- 3.8 Conclusions -- References.

Chapter 4 Extending Functional Kriging When Data Are Multivariate Curves: Some Technical Considerations and Operational Solutions -- 4.1 Introduction -- 4.2 Principal Component Analysis for Curves -- 4.2.1 Karhunen-Loève Decomposition -- 4.2.2 Dealing with a Sample -- 4.3 Functional Kriging in a Nutshell -- 4.3.1 Solution Based on Basis Functions -- 4.3.2 Estimation of Spatial Covariances -- 4.4 An Example with the Precipitation Observations -- 4.4.1 Fitting Variogram Model -- 4.4.2 Making Prediction -- 4.5 Functional Principal Component Kriging -- 4.6 Multivariate Kriging with Functional Data -- 4.6.1 Multivariate FPCA -- 4.6.2 MFPCA Displays -- 4.6.3 Multivariate Functional Principal Component Kriging -- 4.6.4 Mixing Temperature and Precipitation Curves -- 4.7 Discussion -- 4.A.1 Computation of the Kriging Variance -- References -- Chapter 5 Geostatistical Analysis in Bayes Spaces: Probability Densities and Compositional Data -- 5.1 Introduction and Motivations -- 5.2 Bayes Hilbert Spaces: Natural Spaces for Functional Compositions -- 5.3 A Motivating Case Study: ParticleSize Data in Heterogeneous Aquifers-Data Description -- 5.4 Kriging Stationary Functional Compositions -- 5.4.1 Model Description -- 5.4.2 Data Preprocessing -- 5.4.3 An Example of Application -- 5.4.4 Uncertainty Assessment -- 5.5 Analyzing Nonstationary Fields of FCs -- 5.6 Conclusions and Perspectives -- References -- Chapter 6 Spatial Functional Data Analysis for Probability Density Functions: Compositional Functional Data vs. Distributional Data Approach -- 6.1 FDA and SDA When Data Are Densities -- 6.1.1 Features of Density Functions as Compositional Functional Data -- 6.1.2 Features of Density Functions as Distributional Data -- 6.2 Measures of Spatial Association for Georeferenced Density Functions. 6.2.1 Identification of Spatial Clusters by Spatial Association Measures for Density Functions -- 6.3 Real Data Analysis -- 6.3.1 The SDA Distributional Approach -- 6.3.2 The Compositional-Functional Approach -- 6.3.3 Discussion -- 6.4 Conclusion -- Acknowledgments -- References -- Part II Statistical Techniques for Spatially Correlated Functional Data -- Chapter 7 Clustering Spatial Functional Data -- 7.1 Introduction -- 7.2 ModelBased Clustering for Spatial Functional Data -- 7.2.1 The Expectation-Maximization (EM) Algorithm -- 7.2.1.1 E Step -- 7.2.1.2 M Step -- 7.2.2 Model Selection -- 7.3 Descendant Hierarchical Classification (HC) Based on Centrality Methods -- 7.3.1 Methodology -- 7.4 Application -- 7.4.1 ModelBased Clustering -- 7.4.2 Hierarchical Classification -- 7.5 Conclusion -- References -- Chapter 8 Nonparametric Statistical Analysis of Spatially Distributed Functional Data -- 8.1 Introduction -- 8.2 Large Sample Properties -- 8.2.1 Uniform Almost Complete Convergence -- 8.3 Prediction -- 8.4 Numerical Results -- 8.4.1 Bandwidth Selection Procedure -- 8.4.2 Simulation Study -- 8.5 Conclusion -- 8.A.1 Some Preliminary Results for the Proofs -- 8.A.2 Proofs -- 8.A.2.1 Proof of Theorem 8.1 -- 8.A.2.2 Proof of Lemma A.3 -- 8.A.2.3 Proof of Lemma A.4 -- 8.A.2.4 Proof of Lemma A.5 -- 8.A.2.5 Proof of Lemma A.6 -- 8.A.2.6 Proof of Theorem 8.2 -- References -- Chapter 9 A Nonparametric Algorithm for Spatially Dependent Functional Data: Bagging Voronoi for Clustering, Dimensional Reduction, and Regression -- 9.1 Introduction

-- 9.2 The Motivating Application -- 9.2.1 Data Preprocessing -- 9.3 The Bagging Voronoi Strategy -- 9.4 Bagging Voronoi Clustering (BVClu) -- 9.4.1 BVClu of the Telecom Data -- 9.4.1.1 Setting the BVClu Parameters -- 9.4.1.2 Results -- 9.5 Bagging Voronoi Dimensional Reduction (BVDim) -- 9.5.1 BVDim of the Telecom Data. 9.5.1.1 Setting the BVDim Parameters -- 9.5.1.2 Results -- 9.6 Bagging Voronoi Regression (BVReg) -- 9.6.1 Covariate Information: The DUSAF Data -- 9.6.2 BVReg of the Telecom Data -- 9.6.2.1 Setting the BVReg Parameters -- 9.6.2.2 Results -- 9.7 Conclusions and Discussion -- References -- Chapter 10 Nonparametric Inference for Spatiotemporal Data Based on Local Null Hypothesis Testing for Functional Data -- 10.1 Introduction -- 10.2 Methodology -- 10.2.1 Comparing Means of Two Functional Populations -- 10.2.2 Extensions -- 10.2.2.1 Multiway FANOVA -- 10.3 Data Analysis -- 10.4 Conclusion and Future Works -- References -- Chapter 11 Modeling Spatially Dependent Functional Data by Spatial Regression with Differential Regularization -- 11.1 Introduction -- 11.2 Spatial Regression with Differential Regularization for Geostatistical Functional Data -- 11.2.1 A Separable Spatiotemporal Basis System -- 11.2.2 Discretization of the Penalized SumofSquare Error Functional -- 11.2.3 Properties of the Estimators -- 11.2.4 Model Without Covariates -- 11.2.5 An Alternative Formulation of the Model -- 11.3 Simulation Studies -- 11.4 An Illustrative Example: Study of the Waste Production in Venice Province -- 11.4.1 The Venice Waste Dataset -- 11.4.2 Analysis of Venice Waste Data by Spatial Regression with Differential Regularization -- 11.5 Model Extensions -- References -- Chapter 12 Quasimaximum Likelihood Estimators for Functional Linear Spatial Autoregressive Models -- 12.1 Introduction -- 12.2 Model -- 12.2.1 Truncated Conditional Likelihood Method -- 12.3 Results and Assumptions -- 12.4 Numerical Experiments -- 12.4.1 Monte Carlo Simulations -- 12.4.2 Real Data Application -- 12.5 Conclusion -- References -- Chapter 13 Spatial Prediction and Optimal Sampling for Multivariate Functional Random Fields -- 13.1 Background. 13.1.1 Multivariate Spatial Functional Random Fields -- 13.1.2 Functional Principal Components -- 13.1.3 The Spatial Random Field of Scores -- 13.2 Functional Kriging -- 13.2.1 Ordinary Functional Kriging (OFK) -- 13.2.2 Functional Kriging Using Scalar Simple Kriging of the Scores (FKSK) -- 13.2.3 Functional Kriging Using Scalar Simple Cokriging of the Scores (FKCK) -- 13.3 Functional Cokriging -- 13.3.1 Cokriging with Two Functional Random Fields -- 13.3.2 Cokriging with P Functional Random Fields -- 13.4 Optimal Sampling Designs for Spatial Prediction of Functional Data -- 13.4.1 Optimal Spatial Sampling for OFK -- 13.4.2 Optimal Spatial Sampling for FKSK -- 13.4.3 Optimal Spatial Sampling for FKCK -- 13.4.4 Optimal Spatial Sampling for Functional Cokriging -- 13.5 Real Data Analysis -- 13.6 Discussion and Conclusions -- References -- Part III Spatio-Temporal Functional Data -- Chapter 14 Spatio-temporal Functional Data Analysis -- 14.1 Introduction -- 14.2 Randomness Test -- 14.3 ChangePoint Test -- 14.4 Separability Tests -- 14.5 Trend Tests -- 14.6 Spatio-Temporal Extremes -- References -- Chapter 15 A Comparison of Spatiotemporal and Functional Kriging Approaches -- 15.1 Introduction -- 15.2 Preliminaries -- 15.3 Kriging -- 15.3.1 Functional Kriging -- 15.3.1.1 Ordinary Kriging for Functional Data -- 15.3.1.2 Pointwise Functional Kriging -- 15.3.1.3 Functional Kriging Total Model -- 15.3.2 Spatiotemporal Kriging -- 15.3.3 Evaluation of Kriging Methods -- 15.4 A Simulation Study -- 15.4.1 Separable -- 15.4.2 Nonseparable -- 15.4.3 Nonstationary -- 15.5 Application: Spatial Prediction of Temperature Curves in the Maritime Provinces of

Sommario/riassunto

Spatial functional data (SFD) arises when we have functional data (curves or images) at each one of the several sites or areas of a region. Statistics for SFD is concerned with the application of methods for modeling this type of data. All the fields of spatial statistics (point patterns, areal data and geostatistics) have been adapted to the study of SFD. For example, in point patterns analysis, the functional mark correlation function is proposed as a counterpart of the mark correlation function; in areal data, analysis of a functional areal dataset consisting of population pyramids for 38 neighborhoods in Barcelona (Spain) has been proposed; and in geostatistical analysis diverse approaches for kriging of functional data have been given. In the last few years, some alternatives have been adapted for considering models for SFD, where the estimation of the spatial correlation is of interest. When a functional variable is measured in sites of a region, i.e. when there is a realisation of a functional random field (spatial functional stochastic process), it is important to test for significant spatial autocorrelation and study this correlation if present. Assessing whether SFD are or are not spatially correlated allows us to properly formulate a functional model. However, searching in the literature, it is clear that amongst the several categories of spatial functional methods, functional geostatistics has been much more developed considering both new methodological approaches and analysis of a wide range of case studies covering a wealth of varied fields of applications.
