ALMA MATER STUDIORUM
UNIVERSITÀ DI BOLOGNA
REPRESENTACIÓN EN BUENOS AIRES

Course: "Statistical Methods for Spatial Data Analysis and Applications"

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Francesca Bruno
Researcher in statistics at the Department of Statistical Sciences, University of Bologna, Italy.
PhD in Statistical Methodology for Scientific Research at the Department of Statistical Sciences, University of Bologna, Italy.

Fedele Greco
Researcher in statistics at the Department of Statistical Sciences, University of Bologna, Italy.
PhD in Statistical Methodology for Scientific Research at the Department of Statistical Sciences, University of Bologna, Italy.

Christian Haedo
Researcher in econominc statistics at the Research Center, University of Bologna, Argentina.
PhD in Statistical Methodology for Scientific Research at the Department of Statistical Sciences, University of Bologna, Italy.

Giovanni Motta
Researcher in Econometrics at the Department of Quantitative Economics, Maastricht University, The Netherlands.
PhD in Mathematical Statistics at the Institut de Statistique, Université Catholique de Louvain, Belgium.

Alejandra Epíscopo
GIS Tech Support & Training Manager of Aeroterra S.A., Argentina.
Bachelor of Computer Information Systems, Universidad de Belgrano, Argentina.

Introduction

Statistical methods for spatial data have been an intense area of research in the last twenty years. Spatial statistics, as an area within statistics, grew out of numerous real-world problems (e.g., environmental, epidemiology, medicine, criminology, ecology, forestry, geography, geology, archaeology, economics and marketing) and includes statistical methods applied to data that are spatially referenced. Most of these methods operate under the following idea: data collected over a region in space found close together tend to be more alike than points farther apart. Much of the methodology developed for analyzing spatial data mimics that of analyzing time series data (data correlated over time), where the data have a natural temporal ordering. However, for data in two or more dimensions, no such ordering is generally present. This is the primary stumbling block preventing a straightforward extension of time series methods to spatial data.
The course will cover the methodology and modern developments for spatial modeling estimation and prediction, and goes beyond standard practices, exposes the researcher to many developments and state of the art techniques for spatial and spatiotemporal data. All the methods presented will be introduced in the context of a specific dataset, and then the motivation behind a particular method will be evident as it is developed.

Objectives

The goal of this course is to provide an introduction to the range of statistical techniques used in the analysis of spatial and spatiotemporal data. The course focuses on exploration, description and modeling spatial data.
A tentative list of more specific topics is:

- Introduction to spatial statistics: point level models; areal (lattice) models; and spatial point processes
- Estimation and modeling of spatial correlations
- Prediction and interpolation (kriging): predicting at multiple sites
- Modeling spatial dependent data
- Modeling spatiotemporal data
- Finding spatial clusters
- Finding reduced rank structures in spatio-temporal datasets
- Modeling and estimation of common spatial factor models

All topics will be introduced with examples using real data. Participants will learn how to use existing software with emphasis on analysis of real data from the environmental sciences, epidemiology and economics.

The investigation and modeling of spatial data is the focus of this course with a strong emphasis on the "hands-on" application of data utilizing spatial statistical techniques, which are discussed in class. The main software to be used is the statistical packages R, Winbugs, GeoDa and ArcGIS.

Course topics

The course is organized into five broad topics. An outline of this course is sketched bellow.

1. Introduction to spatial data analysis
- Focus on main concepts
- Motivation for spatial analysis
- Distinguishing characteristics of spatial analysis

2. Geostatistics
- Spatial random field
- Spatial stationarity
- Variogram, semi-variogram: estimation of the variogram, and variogram model fitting
- Spatial prediction, kriging
- Applications: environmental science

3. Point Pattern Analysis
- Types of data: points, marks and covariates
- Intensity, interaction, covariate effects, segregation and dependence
- Investigating intensity and tests of Complete Spatial Randomness (CSR)
- Maximum likelihood for Poisson processes and checking a fitted Poisson model
- Distance methods for point patterns and inference using summary statistics
- Marked point patterns and multitype Poisson models
- Identify spatial clusters
- Applications: economics and geomarketing

4. Areal (lattice) data and spatial regression analysis
- Descriptive measures of spatial correlation
- Specifying regression models with spatial multipliers and spatial externalities
- Simultaneous and conditional models (SAR and CAR) and Maximum likelihood
- Hierarchical models: Bayesian approache
- Moran's I test for regression residuals
- Lagrange multiplier tests
- Applications: epidemiology and economics

5. Spatiotemporal models
- Separability in spatiotemporal covariance functions
- Hierarchical models: classical and Bayesian approaches
- Dynamic state space models
- Applications: environmental science, epidemiology, medicine and economics

6. Dimension reduction for large spatio-temporal datasets
- Motivation for factor analysis in spatio-temporal models
- Common factors and dimension reduction
- Principal components analysis (PCA) in time series
- Spatial PCA with R

7. Spatial statistics with ArcGIS
- Introduction to GIS, ArcGIS a complete system
- Specify the characteristics of geographic data needed to perform common GIS tasks
- Geocoding process to create GIS data
- Spatial data analysis: structured approach to data analysis, interpolation methods, and surface types
- Regression analysis techniques to examine how phenomena vary over space, predict where phenomena may occur, and help explain the factors behind observed spatial patterns
- Create and distinguish between prediction maps, standard error maps, quantile maps, and probability maps

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Informes e inscripción

Alma Mater Studiorum - Università di Bologna, Representación en Buenos Aires
Rodríguez Peña 1464 (C1021ABF), Buenos Aires, Argentina
Tel: (011) 4878 2900 ext. 227 de 15 a 19 hs.
E-mail: spatial@unibo.edu.ar

Fecha: del 1 al 17 de noviembre de 2010, de 18 a 22 hs.

Lugar: Laboratorio de Informática del Alma Mater Studiorum - Università di Bologna

Duración: 48 hs.

Idioma: inglés y español

Costo total del curso: 2.000 ARS

Las solicitudes de admisión podrán ser presentadas hasta el 22 de octubre de 2010.

Curso organizado por la Representación en Buenos Aires y el Departamento de Ciencias Estadísticas del Alma Mater Studiorum - Università di Bologna

Dirección: Francesca Bruno
Coordinación académica: Christian Haedo

Calendario – Noviembre, 2010

Lunes	Martes	Miércoles	Jueves	Viernes	Sábado	Domingo
1 18 a 22 hs Geostatistics	**2** 18 a 22 hs Geostatistics	**3** 18 a 22 hs Lattice Data	**4** 18 a 22 hs Lattice Data	**5** 18 a 22 hs Lattice Data Spatio-Temporal	**6**	**7**
8 18 a 22 hs Spatio-Temporal Spatial Point Pattern	**9** 18 a 22 hs Spatial Point Pattern	**10** 18 a 22 hs Spatial Point Pattern Spatial PCA	**11** 18 a 22 hs Spatial PCA	**12** 18 a 22 hs Spatial PCA	**13**	**14**
15	**16** 18 a 22 hs Spatial Statistics with ArcGIS	**17** 18 a 22 hs Spatial Statistics with ArcGIS	**18**	**19**	**20**	**21**

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