Spatial Statistics

PhD School in Statistical Sciences, University of Padua

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Course Description

This course is designed to introduce the students to statistical models for spatial data. The course will cover methods for two major topics of spatial statistics : (i) point-referenced data, (ii) areal/lattice data. Students will also be introduced to the computational aspects of spatial statistics, illustrating the main packages in R for the analysis of spatial data. The real data examples mainly come from environmental sciences.

Program

1. Introduction to spatial statistics:
   (a) point level data
   (b) network data
   (c) spatial point processes
2. Modelling and estimation for point level data:
   (a) parametric models for the spatial correlations
   (b) variogram
   (c) maximum likelihood estimation, restricted maximum likelihood
   (d) estimation methods for large dataset
3. Prediction and interpolation (Kriging):
   (a) Lagrange multiplier approach
   (b) Conditional inference approach
4. Spatio-temporal modeling:
   (a) point-level modeling with continuous time
   (b) nonseparable models
   (c) dynamic space-time models
5. Second order spatial models for network data:
   (a) spatial autocorrelation
   (b) spatial autoregressive models
6. Gibbs-Markov random fields on networks:
   (a) compatibility of conditional distributions
   (b) Gibbs random fields
   (c) Markov random fields and Gibbs random fields
   (d) Besag's auto-models
7. Simulation and estimation of a Markov random field on a network:
   (a) MCMC methods: Gibbs and Metropolis-Hastings algorithm

(b) maximum likelihood

(c) pseudo-likelihood

8. Hierarchical spatial models and Bayesian statistics:

   (a) spatial regression and Bayesian kriging

   (b) hierarchical spatial generalized linear models

   (c) hierarchical spatial model for large data sets.

Recommended texts

- Banerjee, S., Carlin, B.P. and Gelfand. A.E (2014) *Hierarchical Modeling and Analysis for Spatial Data*, CRC Press, New York (second edition)
- Gaetan, C. and Guyon, X. (2010) *Spatial Statistics and Modeling,* Springer, New York.
- Gelfand, A.E., Diggle, P., Guttorp, P. and Fuentes, M. (2010) *Handbook of Spatial Statistics*, CRC Press, New York

Grading

There will be three homeworks, a final exam, and a project. The homeworks will count 20%. The final exam and the project will account for the bulk of the mark (40% and 40%, respectively).

Final exam

The written exam (two hours) will present theoretical questions. It is a closed-book, closed-notes exam. Questions demand that students approach the solution with conceptual understanding of the problem.

Dates

Course

March: 1,8,15,22,29

April: 5,12,19,26

May: 3,10

Exam

June: to be fixed