Spatial and spatio-temporal dependencies: an excursus through biometrical applications

J. Mateu
Department of Mathematics
Universitat Jaume I, Castellón, Spain
e-mail: mateu@mat.uji.es

Abstract

In recent years, it has become more prevalent the study of some phenomena across both space and time. Consequently, space-time data are being collected in many studies in an increasing number of disciplines. The approach taken in this context is to broaden the classical models and methods to those that recognize the presence and importance of spatial and spatio-temporal information.

Spatial statistics is a vast subject, in large part because spatial data are of so many different types: (a) univariate or multivariate, (b) categorical or continuous, (c) real-value (numerical) or not real-valued, (d) observational or experimental. In addition, the data locations may: (a) be points, regions, line segments, or curves, (b) be regularly or irregularly spaced, (c) regularly or irregularly shaped, (d) belong to a Euclidean or non-Euclidean space. We can distinguish up to three important prototypes: Geostatistical data, Lattice data, and Spatial point patterns. However, the distinctions between these three types are not always clearcut. In the geostatistical case, data corresponds to point observations of a continuously varying quantity over a region, whereas in the point pattern case, the important variable to be analysed is the location of events. The question of interest is whether the pattern is exhibiting complete spatial randomness, clustering, or regularity.

The analysis of the spatial structure is carried out through the analysis of the *large-scale structure* (mean function of a geostatistical process or intensity of a spatial point process), and the analysis of the *small-scale structure* (variogram, covariance function of a geostatistical process, and nearest-neighbour functions for spatial point processes).

The talk will consider essentially the analysis of point patterns and geostatistical data with particular emphasis on solving real problems. The **point pattern** part will consider the following points:

- P1 We envisage some parametric procedures for the analysis of replicated spatial point patterns ([4]).
- P2 We analyse the space-time interdependency of point processes by developing multi-generation point processes to model complex ecological systems ([2]).
- P3 We propose the use of the inhomogeneous pair correlation function in the context of replicated spatial data ([3]). In addition, we analyse forest thinning strategies through the development of space-time growth-interaction simulation models ([9]).
- P4 We consider the problem of detecting features of general shape in spatial point processes in the presence of substantial clutter. We use a method based on local indicators of spatial

association (LISA) functions, particularly on the development of a local version of the product density which is a second-order characteristic of spatial point processes ([5]).

P5 We develop new tools to recognise and mimic particular biological objects ([10]).

The **geostatistical** part will analyse the following aspects:

G1 We propose a new mixture-based modelling for space-time data ([7]).

G2 We build new stationary and nonstationary nonseparable space-time covariance models ([8]).

G3 We propose new models for anisotropic space-time data ([6])

G4 We propose a new procedure for the estimation of space and space-time covariance functions through a weighted composite likelihood approach ([1]).

G5 We introduce the problem of dealing with functional data within the geostatistical context.

Keywords: Forest thinning, Inhomogeneity, LISA functions, Replicated spatial data, Simulated annealing, Space-time covariance functions, Space-time separability, Weighted composite likelihood.

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