Spatial and spatio-temporal models for analysing land use raster data

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Land use maps are produced by a wide range of institutions and are utilized by policy makers and researchers in fields such as ecology, forestry and urban geography. Usually, land use datasets come in two possible spatial format, vectorial and raster maps. Vectorial maps are a collection of polygons, each polygon classified with a land use category. Raster maps result from converting the original polygonal map into a regular lattice or grid, where each grid box is assigned a land-use category. CORINE land cover programme by the Environmental European Agency is a widely adopted protocol for land use data classification.

Visual inspection of land use maps can immediately carry out important information on land use distribution over space. Also the availability of GIS software enables land cover change computation on the basis of rasterized versions of land use maps. However, the information content in land use maps is not fully exploited and analysed using statistical models. From a statistical modelling point of view, the pattern observed in a land use map is a realization of a random field defined all over the study area. Both vectorial and raster maps are discretised versions of such a continuous field, or surface. Modelling the spatial dependencies across the surface with popular Matern class covariance models is often problematic since the large dimensionality of these maps. To develop efficient spatial models for land use categorical maps is the purpose of this work. These models would be very useful both to learn about the process underlying the data, and to detect regions of land use change, with associated uncertainty evaluation.

In particular, focus will be on urban residential land use and therefore on binary maps. The use of low-dimensionality spline smoothers based on P-splines will be investigated when dealing with rasters. The Stochastic Partial Differential Equation (SPDE) approach will be considered as a way to reduce grid resolution and computational cost in model fitting. Model estimation will be performed via Integrated Nested Laplace Approximations (INLA) as an efficient alternative to Monte Carlo Markov Chain algorithms. Model outputs allow several features of the estimated urban surface to be investigated, such as the location of relevant changes across space and time. An application is illustrated on urban data taken by aerial photos on the metropolitan area around the city of Bologna, Italy.

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