Sparse Grids: A New Tool For Analysing Geographic Data.

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Biography

Dr Shawn Laffan is a lecturer in the Centre for Remote Sensing and GIS in the School of Biological, Earth and Environmental Sciences at the University of New South Wales. His research interests are in the geocomputational analysis of spatial data, including plant species, regolith, weeds and epidemiology.

Introduction

We introduce in this paper a new analysis tool known as sparse grids. Sparse grids were originally developed for the solution of partial differential equations (Zenger, 1991), and later adapted to data mining (Garcke et al. 2001). They have great applicability to the analysis and understanding of geographic data and processes.

The sparse grids analysis system models the functional relationship between a set of predictor variables and a response variable by using a combination of easily computable functions defined on grids of varying mesh sizes in attribute space. In many ways, the sparse grids approach follows a similar approach to that used by the additive models of Hastie and Tibshirani (1986). However, the sparse grids system uses fewer degrees of freedom and circumvents the so-called "curse of dimensionality". It does this by using, instead of a costly high-dimensional grid a with a fine mesh size in every dimension, a combination of grids that are coarse along some dimensions but fine along others. The combination of these grids gives an approximation of the solution that is more efficient than using a complete lattice of grid points (Figures 1 and 2). It is also possible to use adaptive methods to select combinations of grids that suit a particular data set.

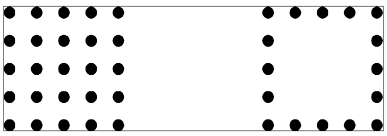
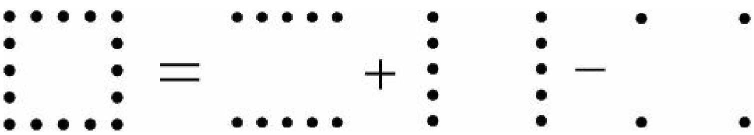


Figure 1. The number of grid points used by the sparse grid system (right) is much less than that used for the full grid system (left).



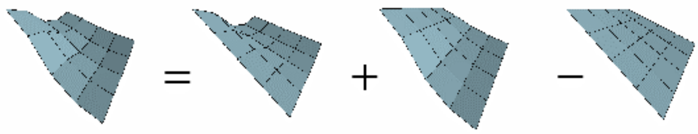


Figure 2. The combination of sparse grids approximates more complex functions (plan and three dimensional view).

The advantage of the Sparse Grids approach for geographic analyses is that the parameters defining these lattices can be used to interpret relationships in terms of spatial scale and resolution. For example, the distribution of mesh points used in the set of lattices describes the complexity of the relationships present. It can be used to understand if the system is responding to fine scale variations (many mesh points used) or to gross patterns (few mesh points used). This is valuable information for modelling.

An Application

We will demonstrate the approach using a large and spatially extensive geochemical dataset from Weipa, Australia (see Laffan, 2002, Laffan and Lees, submitted), including the extension of the system to use a geographical weighting approach similar to that of Geographically Weighted Regression (GWR).

We will compare the results with those using other tools such as Artificial Neural Networks and GWR (Laffan and Lees, submitted).

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