Chapter 8.5

Technical Outline of a W3 Spatial (Decision Support) Prototype

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ABSTRACT

The present research focuses on the first software to offer spatial autocorrelation and association measures, spatial exploratory tools, variography and Ordinary Kriging spatial interpolation in the World Wide Web. Exploiting IE® (Internet Explorer), ASP® (Active Server Pages), PHP® (Hypertext Preprocessor) and IIS® (Internet Information Server) capabilities, SAKWeb© (Spatial Autocorrelation and Kriging Web) was designed in an attractive and straightforward way for any GIS user. Hence, this chapter concentrates on the technical development and design of this Internet application. The differences between server and client side techniques are emphasized in the preamble section while the following one discusses the controversial debate between GIS (Geographical Information System) and SDSS (Spatial Decision Support System) concepts. The opening prospect given by the Internet platform is presented in section three. The next section fully reviews the main technological software used for its construction. References are made to their use within SAKWeb©. Some particular capabilities as an end-user were not forgotten, as well. The conclusion section leads to some future hints regarding its potential.

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PREAMBLE

The death of specialized software is often cited as one of the main reasons for the lack of acceptance of spatial data analysis by empirical analysts (Anselin, 1992). Although this situation has much improved in the last fifteen years, SAKWeb© is the first Web prototype in operation that provides access to an E-Learning audience for geostatisticians at New University of Lisbon, Portugal. SAKWeb© version 2.0 is not a comprehensive statistical package in the tradition of solving everyone's problems. Written for the Internet Information Server® (IIS) environment, it was developed with the philosophy that spatial autocorrelation and Kriging interpolation software is needed as an E-Learning tool by individuals with limited geostatistical knowledge. The incorporation of statistics to explain Earth processes (spatial statistics) has been developed furiously in the last two decades. Interpolation Kriging, the best linear unbiased estimator (BLUE) for spatial domains, is a good example. Using a LaGrangean system of linear equations where the error of prediction should be minimized in some sense, Kriging uses the covariance to measure the spatial autocorrelation among samples (including anisotropy and quadrant search) in order to estimate the value of an unknown site given the values of some other known points. In an elegant matrix layout (cf. Figure 1), each interpolated value is calculated as the sum of weighted known points whose weights are calculated from the (n+1) simultaneous linear equations set: $\mathbf{A}\times\mathbf{W}=\mathbf{B}$ or $\mathbf{W}=\mathbf{A}^{-1}\times\mathbf{B}$. The statistical distance between sample points and distances from each sample to the grid point are used to compute the model variance reproduced on matrices **A** (between samples) and **B** (between each sample and the estimated location). While $\mathbf{A}^{-1}$ underlies the declustering factor, **B** represents the structural distance between the estimation and all samples. In addition, the product of $\mathbf{A}^{-1}$ by **B** adjusts the raw inverse statistical distance weights in matrix **B** to account for possible redundancies between samples. As expected, if no spatial autocorrelation is found among the available samples then the Kriging estimator equals the sample average. This technique has been used in mining, hydrogeology, natural resources, remote sensing and environmental issues (Goovaerts, 1997, Zimmerman, D. *et al.*, 1998).

In addition, it can satisfy the needs of individuals with more training. SAKWeb© deals with deterministic and stochastic interpolation in conjunction with spatial association and autocorrelation measures in a Web continuum process instead of a loose local spatial function. From this view point, an element of its originality and innovation can, thus, be appreciated.

To make this project come to life, several WWW technologies were used. Active Server Pages® (ASP®), PHP® and Dreamweaver® were the main development framework in an Internet application context. WebChart®, ActiveBar®, FrontPage® Server Extensions, Flash® and JavaScript® were the other components required to accomplish this project.

Figure 1. Cov(x1,y1) represent the variance of sample 1, Cov(x1,yn) equals the covariance between sample 1 and sample n, Cov(x1,x0) is the covariance between sample 1 and the estimated unknown site x0, W1 denotes the first weight while Ψ stands for the LaGrange multiplier as a result of the constraint of the weights sum to one.

$$A=\begin{vmatrix} \text{Cov(x1,y1)} & \dots & \text{Cov(x1,yn)} & 1 \\ \dots & \dots & \dots & \dots \\ \text{Cov(xn,y1)} & & \text{Cov(xn,yn)} & 1 \\ 1 & \dots & 1 & 0 \end{vmatrix} \quad B=\begin{vmatrix} \text{Cov(x1,x0)} \\ \dots \\ \text{Cov(xn,x0)} \\ 1 \end{vmatrix} \quad W=\begin{vmatrix} \text{w1} \\ \dots \\ \text{wn} \\ \text{Ø} \end{vmatrix}$$

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