GIS Resource Document 02-19 (GIS_RD_02-19) **November, 2002**

ArcGIS Geostatistical Analyst

Stephen A. Matthews

This document provides a brief overview of ArcGIS Geostatistical Analyst, an extension for advanced surface modeling using deterministic and geostatistical methods. Some of the material presented below comes from the excellent text Using ArcGIS Geostatistical Analyst by K. Johnston et al (2001) ESRI as well as Geostatistical Analyst help and www.esri.com.

Basics

Geostatistical Analyst extends ArcMap by adding an advanced toolbar containing tools for exploratory spatial data analysis and a geostatistical wizard to lead you through the process of creating a statistically valid surface. New surfaces generated with Geostatistical Analyst can subsequently be used in GIS models and in visualization using other ArcGIS extensions such as the ArcGIS Spatial Analyst (GIS_RD_02-18) and 3D Analyst (GIS_RD_02-20).

Many geostatistical tools have been available for some time, but never integrated within GIS modeling environments. Geostatistical Analyst bridges the gap between geostatistics and GIS (see K. Krivoruchko and C.A. Gotway. 2002. "Expanding the S in GIS: incorporating Spatial Statistics in GIS" presented at the CSISS Specialist Meeting on New Tools for Spatial Data Analysis (Santa Barbara, May 2002) http://www.esri.com/software/arcgis/arcgisxtensions/geostatistical/spatialstatisticsingis.pdf

Surface fitting using Geostatistical Analyst involves three key steps: (i) exploratory spatial data analysis; (ii) structural analysis (calculation and modeling of the surface properties of nearby locations); (iii) surface prediction and assessment of results. Geostatistical Analyst contains a series of easy-to-use tools and a comprehensive wizard that guides you through each of these steps. It also includes a number of unique tools for statistical spatial data analysis.

Geostatistical Analyst and Interpolation

The Geostatistical Analyst provides a number of interpolation techniques that use sample points to produce surfaces of the phenomena of interest. The interpolation techniques in the Geostatistical Analyst are divided into two main types: deterministic and geostatistical methods.

Deterministic interpolation techniques create surfaces from measured points, based on either the extent of similarity (e.g., Inverse Distance Weighted) or the degree of smoothing (e.g., Radial Basis Functions). These techniques do not use a model of random spatial processes. Deterministic interpolation techniques can be divided into two groups, global and local. Global techniques calculate predictions using the entire dataset. Local techniques calculate predictions from the measured points within neighborhoods, which are smaller spatial areas within the larger study area. The Geostatistical Analyst provides the Global Polynomial as a global interpolator and the Inverse Distance Weighted, Local Polynomial, and Radial Basis Functions as local interpolators.

A deterministic interpolation can either force the resulting surface to pass through the data values or not. An interpolation technique that predicts a value that is identical to the measured value at a sampled location is known as an exact interpolator (e.g., IDW and radial Basis Functions). An inexact interpolator (e.g., Global and Local Polynomials) predicts a value that is different from the measured value. The latter can be used to avoid sharp peaks or troughs in the output surface.

Geostatistics assume that at least some of the spatial variation of natural phenomena can be modeled by random processes with spatial autocorrelation. Geostatistical techniques produce not only prediction surfaces but also error or uncertainty surfaces, giving you an indication of how good the predictions are. Many methods are associated with geostatistics, but they are all in the Kriging family. Ordinary, simple, universal, probability, indicator, and disjunctive kriging, along with their counterparts in cokriging, are available in the Geostatistical Analyst. Kriging is divided into two distinct tasks: quantifying the spatial structure of the data and producing a prediction. Quantifying the structure, known as variography, is where you fit a spatial-dependence model to your data. To make a prediction for an unknown value for a specific location, kriging will use the fitted model from variography, the spatial data configuration, and the values of the measured sample points around the prediction location. The Geostatistical Analyst provides many tools to help you determine which parameters to use, and also provides reliable defaults that you can use to make a surface quickly.

What kind of data can I use with Geostatistical Analyst? (FAQ question 9)

Any data that has associated spatial coordinates can be used in Geostatistical Analyst. This data can be arrayed spatially in any configuration (regular grid, semiregular network, or random). The data may represent the value of a very small area or what may be interpreted as a point in space such as a soil sample, an air temperature measurement, or the square-footage of a house. Average values over a larger area (e.g., a grid cell) or even the centroid of a polygon can also be used. The semivariogram and covariance tools provided with Geostatistical Analyst allows you to analyze the spatial continuity or dependence of your data.

Useful On-line Resources

Information on ArcGIS Geostatistical Analyst extension can be found at
http://www.esri.com/software/arcgis/arcgisxtensions/geostatistical/overview.html

ESRI White Paper (J-8647) ArcGIS Geostatistical Analyst: Statistical Tools for Data Exploration, Modeling, and Advanced Surface Generation
http://www.esri.com/library/whitepapers/pdfs/geostat.pdf

ArcGIS Geostatistical Analyst Frequently Asked Questions (FAQs)
http://www.esri.com/software/arcgis/arcgisxtensions/geostatistical/faqs.html

Penn State Resources

Geostatistical Analyst is installed on all GIA Core PCs and on the PCs in the Computer Lab. Copies of Using ArcGIS Geostatistical Analyst are available in the GIA Core Library in 8th floor of Oswald: an excellent starting point for learning how to use Geostatistical Analyst.