Syllabus - General Information

This course is an introduction to the analysis, description and modeling of geospatial data. The practical applications of software tools, underlying theory, and the correct application of these tools is emphasized through the use of various software (including GIS software) to analyze and model data. Although geologic applications and examples are emphasized, the concepts, theory, and software are intended to be equally applicable across disciplines, and students are expected to bring a data set (preferably thesis-related) to class, to be analyzed as a term project.

Prerequisites for the course are an introductory statistics course or permission of the instructor, and familiarity with computer manipulation of data. Knowledge of ArcView or other GIS software is encouraged but not necessary. All course software will be on a PC platform, so that students must be familiar with PC computing. Both Windows and DOS (command line driven) software will be utilzed.

Selected material will be on library reserve, and some available for checkout from the instructor; assigned readings will be used to stimulate in-class discussion, and all students will research, present, and lead a class discussion on a published article of their choosing, focusing on concepts and applications of geostatistical analysis, kriging, or stochastic simulation.

Two 80-minute lectures plus one-hour computer lab per week. Office hours: one hour after each class and by appointment. Textbook: Isaaks and Srivastava (1989).

<u>Grading will be based on</u>:
40% - weekly computer lab problem sets
30% - term project, oral presentation, and final report
15% - analysis, oral presentation, and classroom discussion of published literature
15% - class participation in discussion of assigned readings

Week	Material
1 - 3	Univariate statistics review, regionalized variables, exploratory data analysis
4 - 6	Quantification of spatial continuity: variogram analysis
7 - 9	Spatial estimation: kriging, indicator kriging
10 - 13	Spatial simulation (indicator-based, conditional) and applications
14 - 16	Probability mapping; scaling issues; term project presentations

<u>Assigned Readings from:</u> (* on Obeler Library reserve; + check out from instructor; # web access):

General statistics references:

* Till, Roger (1974) Statistical Methods for the Earth Scientist; Wiley, NY
* Cheeney, R.F. (1983) Statistical Methods in Geology; George Allen & Unwin, Boston
* Koch, G.S. and Link, R.F. (1971) Statistical Analysis of Geological Data, Vol. 1, 2; Wiley, NY

Geostatistics (G), kriging (K), stochastic simulation (S), and software (W) references:

* Isaaks and Srivastava (1989), Introduction to Applied Geostatistics, Oxford Univ. Press, (G, K; superb)
+ Deutsch and Journel (1997) Geostatistical Software Library and User’s Guide, Oxford (W)
+ Goovaerts, P. (1997) Geostatistics for Natural Resources Evaluation, Oxford (G, K, S; theory focus)
# Houlding, S.W. (1999) Practical Geostatistics, Springer (G, K, S)
* Clark, I. (1979) Practical Geostatistics, Applied Science Publishers (G, K; mining focus)
* Yarus, J.M. and Chambers, R.L. (1994) Stochastic Modeling and Geostatistics, AAPG (G,K,S,W)
Pannatier, Y. (1996) VarioWin: Software for Spatial Data Analysis in 2D, Springer (W)
Armstrong, M. (1998) Basic Linear Geostatistics, Springer (G, K)
Kitanidis, P.K. (1997) Intro to Geostatistics: Applications in Hydrogeology, Cambridge U. Press (G, K)

Syllabus - Outline of Course Contents

Overview, Course Topics and Case Study:
Overview of applications and techniques to be covered in the course: univariate and multivariate statistics; spatial continuity analysis; estimation; simulation. Overview of spatial statistics, estimation, and modeling via an example.

Exploratory Data Analysis:
Statistical summarization, analysis; mapping of the data set, histogram and probability distibution, correlation in multivariate data, data transformations (logarithmic, indicator, normal-score, rank-order); software use and applications

Quantification of Spatial Continuity:
Calculation of experimental variograms, fitting models to experimental variogram, concepts of anisotropy and nested structures in variograms, other techniques for defining spatial variability (indicator, covariance), spatial co-variability of multiple variables; application of basic variogram analysis and modeling software.

Spatial Estimation (Kriging):
Review of techniques available for spatial estimation, explanation of the concepts of a 'best' linear unbiased estimate, introduction to the kriging system of equations, use and misuse of kriging variance, application of basic kriging software.

Stochastic Simulation:
Simulation vs. kriging, adaptation of the kriging system of equations to simulation, theory and application of basic gaussian and indicator simulation algorithms.

Scaling and Sample Support:
Impacts of discrepancy between measurement and estimation scales; examples of the effects of scale, accounting for scale discrepancies with analytical techniques, numerical techniques for addressing scale issues (block kriging, averaging techniques).

Application of Analysis of Uncertainty:
Concepts of probability of exceeding a threshold value and probability mapping, incorporation of spatial uncertainty into predicted outcomes of physical processes and human activities; creating probability maps through estimation versus simulation