ENVR 468 / ENST 468
Advanced Functions of temporal GIS

Fall 2009, 3 semester hours, Monday Wednesday 03:30PM-04:45PM
Room MC 2305 (McGavran-Greensberg building, room 2305)

Instructor: Marc Serre

Course description:

The course focuses on the development of environmental Geostatistics and its application in temporal Geographical Information Systems (TGIS). TGIS describe environmental, epidemiological, economic, and social phenomena distributed across space and time. The course introduces the arcGIS software to query and manipulate geographic data, it provides the concepts and mathematical framework of space/time Geostatistics necessary to map environmental contaminants across space and time, and it leads to a real-world TGIS project where students analyze their own data, following a comprehensive example using EPA and USGS freshwater contaminant data across an entire state (e.g. physical, microbial and biological environmental water quality contaminants in New Jersey and North Carolina), as well as an example using an infectious disease (e.g. STDs and HIV prevalence across North Carolina).

The course starts with a 4 to 5 weeks review of basic GIS consisting in intensive computer labs on the ESRI ArcGIS software. Prior knowledge of GIS is highly recommended, but not required. Lessons from these ArcGIS computer labs is tested in a homework where students research and display maps of their own space/time environmental data using basic ArcGIS functions (see Graph 1). In the remainder of the course we then switch to using the BMEGUI software developed especially for this course for the advanced visualization and spatiotemporal geostatistical analysis of space/time data. The use of BMEGUI is tested in the remaining homework of the course, and culminates in an individual final project.

The concepts and mathematical formulation of spatiotemporal Geostatistics are progressively introduced throughout the course. We start with the concept of space/time distance. We then rapidly review multivariate calculus (derivatives and integrals) and basic statistics (probability density function, or pdf, and expected value) of random variables. Multivariate calculus is a pre-requirement for this course, and prior introductory statistics or probability courses are recommended, but not required. Using this foundation in multivariate calculus and basic statistics, we then cover the theory of spatiotemporal Geostatistics, which include 1) bivariate pdf and conditional probabilities, 2) variability in space and time and covariance function, 3) spatial and spatiotemporal random fields and 4) spatiotemporal estimation and uncertainty assessment. The
The concepts of the Bayesian Maximum Entropy (BME) method is presented, which provides a powerful framework for space/time mapping, and leads to the classical kriging methods as special cases.

The application consists of a real-world mapping TGIS project. Using skills acquired in basic GIS (i.e. arcGIS), and in advanced TGIS (i.e. BMEGUI) each students research a space/time dataset of concern for society, s/he formulates the space/time mapping problem, and s/he uses concepts and mathematical tools together with the BME method of space/time Geostatistics to provide a realistic representation of the field over space and time.

**Textbook recommended:**


**Prerequisite:**

Students must have had Calculus of Functions of One Variables (Calc I and II), as well as Calculus of Functions of Several Variables (MATH 233 or equivalent), and Linear Algebra (MATH 547 or equivalent). An introductory course in Statistics or Probability is useful, but not required. Additionally, knowledge of GIS (from beginner to expert) is highly recommended, but not required.

**Philosophy and grading:**

The students should learn the concepts, and not use the tools as a black box. They will be graded on solving conceptual problems rather than just applying the programs. The students will do homework’s, and a project, which will count for the final grade as follow:

- Homework 50%
- Student-defined project 50%