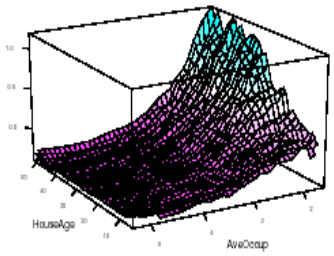
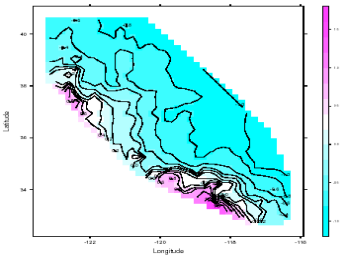
UNH: Dept. of Mathematics & Statistics:

Fall 2013



MATH 944

Spatial Statistics



MW 11:10am - 12:30pm Kingsbury N134

CRN 16113

Description

Spatial Statistics is the study of models and methods for the analysis of data that is collected in space. Most often space means the 2-dimensional geographic space (geospatial) or a 3- dimensional space (atmosphere, ocean, subterranean). Space can also be the two or three-dimensional image space of image analysis. Classical statistical theory is based on the cross-sectional paradigm of independently sampled data. In spatial statistics observations in close spatial proximity tend to be correlated, leading to much more complicated stochastic models than in classical statistics.

In this course we will discuss methods for three types of spatial data:

(1) Point referenced data (or continuous space). These include so-called geostatistical methods of correlation structure (or variogram) estimation, and spatial interpolation, typically from a spatially irregular set of locations to a regular grid.
(2) Areal data, or so-called lattices, such as in county averages, remote sensing grids, image analysis. Here we construct a graph of the neighbor relations which the model fitting is based on. We discuss Markov random field models and similar spatial autoregressions.
(3) Spatial point patterns. Here the variable of interest is the location of a certain event, such as location of trees, location of incidence of a rare disease, etc. The goal is to estimate / describe patterns of intensity of points: clustering, inhibition, non-homogeneity, etc.

Types (1) and (2) may be embedded in a regression set-up and for this we will also discuss the modern methods of Bayesian hierarchical modeling and analysis that have been most successful in this context. As a by-product, students will learn a bit of Bayesian statistics and related modern computational methodologies, such as simulation – based inference, Gibbs sampling, and Markov chain Monte Carlo (MCMC) methods. However a more comprehensive introduction to these topics is provided in MATH 941: Bayesian Statistics.

We may also (time permitting) discuss issues and methods related to spatial misalignment (or modified areal unit problem), multivariable spatial data (coregionalization) and spatial-temporal data.

Course Organization

Instructor: Ernst Linder, 603 - 862 - 2687 , N321B Kingsbury Hall
elinder@unh.edu

Office Hours: M/W 2:30 – 4 or by appointment

Text: **Applied Spatial Statistics (for Public Health Data).** Lance Waller and Carol Gotway. Wiley , 2004 ISBN 978-0-471-38771-8

Software: We will be using the following software
R and various of its R-packages (freeware – open source)
Possibly we will also use the **OpenBugs** for performing Bayesian analysis.

Introduction to R Course: If you have never seen or used R before I recommend you take the 1-credit course MATH 796.01 / 896.01: Statistical Computing: Introduction to R. W: 6:40 – 8 pm MUB DL, first half of the semester. Although I will provide many scripts as part of the course notes, there will not be enough time in this course to go over all the details.

Prerequisites: 1) Knowledge of intermediate statistics: Distributions, discrete and continuous random variables, transformation of variables (calculus based!), bivariate and multivariate normal distribution.
2) Working knowledge of linear regression and analysis of variance.
3) Basic linear algebra: Vectors and matrices, linear spaces, matrix multiplication, inverse of a matrix, positive definiteness. Matrix-vector notation for linear regression and ANOVA.

Homework: Homework assignments will be given on a regular basis. Assignments will require computer-based calculations. Use of software will be explained throughout the course, especially via sample scripts. There are many on-line resources on R, and Winbugs.

Final Exam: A comprehensive final take-home exam will be assigned during the last week of classes. For this exam students will be asked to perform several in-depth analyses of spatial data.

Grade: Homework 70 %, Final Exam: 30 %

Distance Learning:

This course is delivered *synchronously* on-line using ***Blackboard-Collaborate***. You can find it in "Tools" on Blackboard under this course's section. Simply click on the scheduled class when you try to participate in a class, or click on a specific recording. Collaborate provides a fully interactive platform for course delivery and student participation. It is therefore expected that students attend the class either in person in the classroom, or, virtually from a computer ***during the scheduled class time***. While the classes are recorded for replay at a later point in time, it is not acceptable for students to never attend class when it is scheduled and simply peruse the recording later. The recordings are to be used for replay in cases where parts of the lecture were not clearly understood the first time. Students who anticipate having time conflicts with the scheduled classes need to inform the instructor of their planned absence from the live class.
It is also expected that students who attend the class from a distance have the necessary equipment that allows them to fully participate in the course, in particular a microphone (a laptop mic tends to be sufficient). Collaborate works for PCs and Macs.
Loudspeakers/Microphone setup: You should configure the audio before each Collaborate session using ***Audio Wizard***. We highly recommend the use of a USB headset, so that you can simultaneously speak while you receive sound from the classroom. If you use a laptop built-in microphone, even if it has noise-cancelling capabilities, we would still recommend that you use earphones (i.e. turn the loudspeakers off) for better interactivity. In this case however make sure that you work in a quiet room. ***Careful: If you have microphone and loudspeakers turned on at the same time it can produce echoes and loud background noises for the entire class.***