STAT 406: Statistical Methods for Spatial Data

Instructor: Petrutza C. Caragea

Course Outline and Information

• Meeting times: TTH 11-12:30 in Agronomy Hall, Room 2026

• Contact information: Office: 314 Snedecor Hall, Phone: 294-5582.
  email: pcaragea@iastate.edu
  Course URL: www.public.iastate.edu/~pcaragea/stat406
  Office hours: TTH after class and by appointment.

• Textbook: *Statistical Methods for Spatial Data Analysis*,
  by Oliver Schabenberger and Carol A. Gotway

• Computing: We will be using R: a language and environment for statistical computing. Use of this packages will be covered in the class. No prior experience with R is expected.

• Topics Outline:
  
  – **Introduction**: Geo-referenced data
  
  – **Part I: Geostatistical Analysis**:
    Exploratory Analysis.
    Estimation and prediction for spatial processes:
    Semivariograms and Covariance models;
    Kriging: simple, ordinary and universal.
    Stationary vs. Non-stationary spatial models.

  – **Part II: Lattice/Areal Data Analysis**:
    Exploratory data analysis;
    Spatial Autocorrelation and Spatial Regression Models.

  – **Part III: Spatial Point Processes**:
    Introduction, Historical Context;
    Locations of Events vs. Counts of Events;
    Testing for spatial randomness;
    Second-Order Properties of Point Patterns;
    Estimation of K- and L- functions;
    Clustering and Parent Processes.

  – **Part IV: Special Topics in Spatial Statistics**.
- **Textbook:** should be accessible to a student with a good foundation in statistical analysis. Some familiarity with concepts such as probability distributions, conditional expectation, maximum likelihood estimation is helpful.

- **Computation and Lab:** Depending on interest of the class and the background of students in computing, I will consider shifting part of the meeting time to a lab period. Alternatively, if there is less of a need for "hands-on" instruction in computation, I will spend regular lecture time at the beginning of the semester introducing basic computational tools. The primary language used will be R, which has the advantages that it is available at no cost and includes easily obtained modules that perform many of the basic computations needed for practical spatial data analysis.

- **Assignments and Final Project:** There will be regular assignments throughout the semester. These assignments will mostly require you to apply concepts taught in class to data various data sets, therefore mostly computational. However, each assignment has to contain your explanations as to what you have done, why, and, most importantly, what your conclusions are. You are encouraged to work in groups, but the write-up has to be done individually. A semester project will be required. Past experience has shown that some students wish to analyze data from their own graduate research or from related problems in their field of study. While these problems may result in excellent projects, it is also sometimes the case that they involve complications or issues that require modification of the fundamental methods covered in the course, or occasionally a more advanced approach is needed in total. If at all possible, we would like to have students enrolled in Statistics 506 available to consult on these problems. It is even possible that a project might be worked on jointly by students in 406 and 506, depending on the problem and if logistical considerations allow. Course grades will be based on the assignments, the final project and its presentation toward the end of the semester.

- **Class Examples:** Students will be asked to identify data sets of interest to them during the first two weeks of the semester. If at all possible, these data sets will incorporated into the set of examples to be used throughout the course. These examples may also serve to illustrate situations in which the basic practical approaches that form the core of Stat 406 are less than fully adequate for the problem under consideration, and more sophisticated methods need to be investigated.

- **The Special Topics** section will be decided on according to the main interest of students enrolled. Topics that might be considered include spatio-temporal processes, hierarchical models, marked point patterns...