Course Information for
STAT:6530 "Environmental and Spatial Statistics"

Fall 2024

Instructor

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Course Format

The course will meet in 51 SH at 2:30 – 3:20 pm MWF.

Office Hours

Conducted in person from 1:00 – 3:00 pm Tuesdays and 2:00 – 3:00 pm Thursdays, or by appointment.

Department Information

Department of Statistics and Actuarial Science, 241 Schaeffer Hall, Phone 335-2082

Department Executive Officer

Professor Kung-Sik Chan, 241 SH, Phone 335-0712, E-mail kung-sik-chan@uiowa.edu

Textbook

Several different printed sources of information will be used in this course. First, for approximately the first two-thirds of the course, readings will be assigned from the required textbook, *Spatial Linear Models for Environmental Data* by Dale L. Zimmerman and Jay M. Ver Hoef (CRC Press). For the remainder of the course, additional readings will be assigned from other sources, some that are online and some that are not. Professor Zimmerman will provide source material for those additional readings on the course ICON page.

In addition, lecture notes (partially incomplete) will be posted on the course ICON page. Notes for each week will be posted by 6 pm on Sundays.

Course Prerequisites

STAT:3200 (or equivalent) and STAT:3101 (or equivalent).

Course Objectives

To learn some of the most important methods for explicitly accounting for space in the statistical analysis of data, especially environmental data. In addition to learning the methods, it is our goal to learn when and why they are appropriate, what the underlying assumptions are, and how to implement the methods using various statistical software packages. With rare exceptions, we will not be concerned with deriving the methods using statistical theory, but we will occasionally use statistical theory to obtain statistical properties of the methods.

Students taking this course are mainly of two types: (1) Statistics/Biostatistics M.S. and Ph.D. students, who have had courses more advanced than the prerequisites for this course; (2) Graduate students from Geography, Civil Engineering, and other fields who barely have

(or in some cases simply don't have) the course prerequisites. This course is primarily for students of the first type, but we try to accommodate students of the second type. The course objectives differ slightly for the two groups: the first group needs a theoretical understanding of the statistical methodology, while the second does not. Accordingly, the course content includes some theory, but homework and exam problems requiring more advanced theory will be assigned to only the first group; those problems will be replaced with more applied problems for the second group.

Major Topics Covered

- Spatial data and inference objectives
- Trends, variability, covariance, correlation, and semivariance
- Covariance and semivariance matrices, and functions, for spatial data
- Exploratory spatial data analysis
- Ordinary least squares regression methods for continuous spatial data
- Generalized least squares regression methods for continuous spatial data
- Geostatistical models, including parametric covariance functions and semivariograms
- Models for areal data, including parametric spatial SAR and CAR models
- Estimation of covariance and semivariogram parameters, and trend parameters
- Kriging (spatial prediction)
- Non-Euclidean geostatistics (river networks and the globe)
- Spatial regression modeling of discrete and categorical data
- Methods for sampling environmental populations
- Spatial point pattern analysis: univariate
- Spatial point pattern analysis: multivariate

Computing

Substantial computing will be necessary to complete many homework assignments and the final project. Our software of choice will be `R`. Instructions on its use will be provided in class. In particular, we will make extensive use of the packages `gstat`, `geoR`, and `spmodel`.

Homework

Written homework assignments are an essential component of the course. Assignments will be given approximately every 10 days, except around the times of exams or projects. Completed assignments should be turned in, either physically or electronically (as a pdf attachment to an email to Dr. Z), by the beginning of class on the day they are due. Note: If you write your solutions by hand and then scan them, please ensure that your scanned document is

readable before submitting it! Unless prior arrangements are made, homework turned in late will receive a score no higher than 50%. You may work on homework problems together, but outright plagiarism is prohibited. Each student must write up their own work.

Some assignments will involve the analysis of data using a computer. Any computer output you wish to include with your homework should be fully labeled and annotated, and should be integrated with other parts of the homework by electronically cutting and pasting.

Some homework assignments may include some problems assigned only to Stats/Biostat graduate students, and other problems assigned only to non-Stats/Biostats graduate students. Every effort is made to "equalize" these assignments in terms of the work involved.

Attendance

Attendance at lectures and participation in discussions are expected. Coming late to class, leaving early, or failing to attend class often will lower your grade.

Midterm Exams

Two evening midterm exams will be given on the following dates: 6:30–8:00 pm, October 10 and November 14. Both exams will be held in 118 MLH. These exams will be "closed-book" but a formula sheet will be provided by Dr. Z. As with homeworks, some exam problems may be assigned only to Statistics graduate students and others only to non-Statistics graduate students.

Final Project

In lieu of a final exam, a final project will be assigned in early November, which is due by the final exam time assigned to our course. (We won't have an in-class final exam.) This project will either be: (a) a complete, in-depth analysis of a spatial dataset (possibly one that you are working with in your research), or (b) a written report on a spatial statistics topic not covered in the course. Each student will propose their project topic to Dr. Z by mid-November, and must be approved in advance by Dr. Z.

Grading

- Homework and Attendance, 30%
- Midterm Exams, 50% (25% each)
- Final Project, 20%

Plus-minus grading will be used.

Classroom Environment

Activities in class which are unacceptable are (1) prolonged conversation with a fellow student, (2) the use of cell phones, and (3) the use of laptops/tablets etc. to do things unrelated to the course. Please remember to switch your cell phones to silent mode and put them away before class starts.

Absences and Attendance

Students are responsible for attending class and for contributing to the learning environment

of a course. Coming late to class, leaving early, or failing to attend class often will lower your grade. Students are also responsible for knowing their course absence policies, which will vary by instructor. All absence policies, however, must uphold the UI policy related to student illness, mandatory religious obligations, including Holy Day obligations, military service obligations, unavoidable circumstances or University authorized activities Students may use the CLAS absence form to aid communication with the instructor who will decide if the absence is excused or unexcused. The form is on ICON in the top banner under "Student Tools." More information is at https://clas.uiowa.edu/students/handbook/attendance-absences.

Academic Integrity

All undergraduates enrolled in courses offered by CLAS have, in essence, agreed to the College's Code of Academic Honesty. Misconduct is reported to the College, resulting in suspension or other sanctions, with sanctions communicated with the student through UI email. Visit this page for information: (https://clas.uiowa.edu/students/handbook/academic-fraud-honor-code).

Accommodations for Disabilities

UI is committed to an educational experience that is accessible to all students. A student may request academic accommodations for a disability (such as mental health, attention, learning, vision, and physical or health-related condition) by registering with Student Disability Services (SDS). The student is then responsible for discussing specific accommodations with the instructor. More information is at https://sds.studentlife.uiowa.edu/.

Administrative Home of the Course

The College of Liberal Arts and Sciences (CLAS) is the administrative home of this course and governs its add/drop deadlines, the second-grade-only option, and related policies. Other colleges may have different policies. CLAS policies may be found here:
https://clas.uiowa.edu/students/handbook.

Class Behavioral Expectations

Students are expected to comply with University policies regarding appropriate classroom behavior as outlined in the Code of Student Life. This includes the policies and procedures that all students have agreed to regarding the Steps Forward for Fall 2020 in response to the COVID-19 pandemic. Particularly, all students are required to wear a face covering when in a UI building, including a classroom. In addition, the density of seats in classrooms has been reduced; in some instances, this will allow 6 feet or more between students while other cases, it may be less. Regardless, wearing a face covering and maintaining as much distance as possible are vital to slowing the spread of COVID19. In the event that a student disrupts the classroom environment through their failure to comply with the reasonable directive of an instructor or the University, the instructor has the authority to ask that the student immediately leave the space for the remainder of the class period. Additionally, the instructor is asked to report the incident to the Office of Student Accountability for the possibility of additional follow-up. Students who need a temporary alternative learning arrangement related to COVID-19 expectations should contact Student Disability Services arrangements/; +1 319 335-1462) 2 (https://sds.studentlife.uiowa.edu/fall-2020/covid-19-temporary-learning- arrangements/.

Class Recordings: Privacy and Sharing
Some sessions of a course could be recorded or live-streamed. Such a recording or streaming will only be available to students registered for the course. These recordings are the intellectual property of the faculty, and they may not be shared or reproduced without the explicit written consent of the faculty member. Students may not share these sessions with those not in the class; likewise, students may not upload recordings to any other online environment. Doing so is a breach of the Code of Student Conduct and, in some cases, a violation of the Federal Education Rights and Privacy Act (FERPA).

Communication and the Required Use of UI Email
Students are responsible for official correspondences sent to the UI email address (uiowa.edu) and must use this address for all communication within UI (Operations Manual, III.15.2).

Complaints
Students with a complaint about an academic issue should first visit with the instructor or course supervisor and then with the Chair of the department or program offering the course; students may next bring the issue to the College of Liberal Arts and Sciences; see this page for more information: https://clas.uiowa.edu/students/handbook/student-rights-responsibilities.

Final Examination Policies
The final exam schedule is announced around the fifth week of classes; students are responsible for knowing the date, time, and location of a final exam. Students should not make travel plans until knowing this information. No exams of any kind are allowed the week before finals with very few exceptions made (for labs, ESL and some world language courses, and off-cycle courses): https://registrar.uiowa.edu/final-examination-scheduling-policies.

Nondiscrimination in the Classroom The University of Iowa is committed to making the classroom a respectful and inclusive space for people of all gender, sexual, racial, religious, and other identities. Toward this goal, students are invited in MyUI to optionally share the names and pronouns they would like their instructors and advisors to use to address them. The University of Iowa prohibits discrimination and harassment against individuals on the basis of race, class, gender, sexual orientation, national origin, and other identity categories set forth in the University's Human Rights policy. For more information, contact the Office of Equal Opportunity and Diversity (https://diversity.uiowa.edu/eod; +1 319 335-0705 or (diversity.uiowa.edu).

Sexual Harassment
Sexual harassment subverts the mission of the University and threatens the well-being of students, faculty, and staff. All members of the UI community must uphold the UI mission and contribute to a safe environment that enhances learning. Incidents of sexual harassment must be reported immediately. For assistance, please see https://osmrc.uiowa.edu/.