

PubH 8472
Spatial Biostatistics
Spring 2017

Credits:	3
Meeting Days:	Monday and Wednesday
Meeting Time:	11:15AM – 12:30PM
Meeting Place:	Moos 2-116
Instructor:	Lin Zhang, PhD, Xiaoyue Zhao (TA)
Office Address:	A430 Mayo Bldg, MMC 303, 420 Delaware St S.E., Minneapolis MN 55455
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Office Hours:	Lin: Friday 3:00PM-5:00PM, or by appointment; Xiaoyue: Tuesday 10:30AM – 12:30PM; held in TA Room Mayo A446.

I. Course Description

In the context of public health, the necessity of understanding the tools developed for analyzing spatially-referenced data, and its application to bio-statistical problems cannot be stressed more. This course introduces basics of spatial data, statistical model development, their fitting, inferential methods, summary and interpretation. The course covers a blend of theory, applications and software related to three major types of spatial data: geo-statistical (point level), areal (block level) and point processes. The major emphasis is on *hierarchical model building* with an emphasis on Bayesian methods, however related classical (frequentist) tools will also be discussed. Statistical software packages designed to analyze spatial data (like R) will be illustrated through examples.

II. Course Prerequisites

Stat 5101-02, Stat 8101-02, some experience using R software, or permission from the Instructor. PubH 7440/8431 (Bayesian methods), Stat 8311 (Linear Models) are highly recommended.

III. Course Goals and Objectives

Upon successful completion, the student will be able to:

- Understand the nature of spatial data, why such data merit special analysis techniques.

- Learn the theoretical basics of spatial processes, their use in parameter estimation, testing of hypothesis, inference, etc.
- Implement solutions and fit models using both classical and Bayesian methods. Learn the functions available in the R packages *geoR* and *spBayes*, and the *GeoBUGS* tools within the WinBUGS package for Bayesian implementation.

IV. Methods of Instruction and Work Expectations

Primarily through in-class lectures and presentations, but will also include relevant hands-on sessions to demonstrate relevant computer programming (using *geoR*, *spBayes*, WinBUGS packages) in the classroom. All teaching materials, homeworks, etc will be posted in the Moodle course webpage located at: <https://ay16.moodle.umn.edu/course/view.php?id=8415>

Students are expected to attend the lectures (twice a week) and computer lab sessions, complete assigned homework, midterm exam and the finals.

V. Course Text and Readings

The only required textbook for this course is the recently published **second edition** of the book '*Hierarchical Modeling and Analysis for Spatial Data*', by Sudipto Banerjee, Bradley P. Carlin and Alan E. Gelfand, (henceforth referred to as BCG). Other readings/notes will appear in the course website. E-mails will be sent out periodically to the whole class regarding any course-related information.

VI. Course Outline/Weekly Schedule

Week 1: Introduction, types of spatial data, fundamentals of cartography. BCG Chap 1

Week 2: Point-referenced data (geostatistics) basics: stationarity, isotropy, variograms. BCG Chap 2

Week 3: EDA methods, classical estimation and prediction, kriging. BCG Chap 2

Week 4: Areal data (lattice) basics: Markov Random field, CAR/SAR. BCG Chap 3

Week 5: Basics of Bayesian inference: point & interval estimation, testing, MCMC computation, basic modeling using WinBUGS. BCG Chap 4

Week 6: Hierarchical modeling for univariate data: spatial process models. BCG Chap 5

Week 7: Bayesian kriging, areal data models, disease mapping. BCG Chap 5

Week 8: Review (by TA); **Midterm Exam**

Week 9: SPRING BREAK, No class

Week 10: Spatial misalignment: point and block levPel modeling. BCG Chap 6

Week 11: Multivariate spatial modeling: separable point level models. BCG Chap 7

Week 12: Co-regionalization models, areal data (MCAR) models. BCG Chap 7

Week 13: Spatio-temporal modeling: point and block level (with alignment) BCG Chap 8

Week 14: Spatio-temporal modeling: Without alignment. BCG Chap 8

Week 15: Special methods: spatial survival (frailty and cure rate models). BCG Chap 9

Week 16: Spatially varying co-efficients, spatial CDFs, wombling. BCG Chap 9

Week 17: Student project presentations, and Finals.

Final Project write-up due in Mid May

VII. Evaluation and Grading

Your final grade will be based upon Homework assignments (40%), mid-term (20%) and the final project (40%).

The homework problems will test your theory and application skills and will be drawn mostly from the book (BCG), and occasionally from elsewhere. They will be posted on the course webpage throughout the semester (as appropriate), and generally due 1 week from the date it was assigned. You are allowed to work together, contact the instructor or the TA for questions during office hours, but they should be written independently. NO COPYING each other's work. For data analysis type homework/exam, you must provide a neat report describing your models, methods, interpretations, etc. Submit a concise report, and not just pages of computer output. If homework is overdue, 30% earned points will be deducted. PRIOR NOTIFICATION is necessary (via. e-mail) if you are unable to submit the homework timely (maybe due to sickness, or some emergency). Homework solutions will be discussed in class.

Currently, there is no provision for a make-up mid-term. Please notify me of any issue latest by mid-February, and we can re-adjust the date.

The final project will involve preparing a short paper (about 5-10 pages, preferably using Tex) and a presentation (20 minutes) on an assigned topic. I would assign each one of you with a topic around first week of April. You need to work independently on that, no discussions.

Although you can submit your homework using any text editor, however, using the Tex software is highly recommended. Handwritten submissions are allowed, but they need to be legible.

The final grade will be assigned as follows:

90-100%: **A**; 85-89%: **A-**; 80-84%: **B+**; 75-79%: **B**; 70-74%: **B-**; 60-69%: **C**; < 60%: **F**

Course Evaluation

The SPH will collect student course evaluations electronically using a software system called CoursEval: www.sph.umn.edu/courseval. The system will send email notifications to students when they can access and complete their course evaluations. Students who complete their course evaluations promptly will be able to access their final grades just as soon as the faculty member renders the grade in SPHGrades: www.sph.umn.edu/grades. All students will have access to their final grades through OneStop two weeks after the last day of the semester regardless of whether they completed their course evaluation or not. Student feedback on course content and faculty teaching skills are an important means for improving our work. Please take the time to complete a course evaluation for each of the courses for which you are registered.

Incomplete Grades

A grade of incomplete "I" shall be assigned at the discretion of the instructor when, due to extraordinary circumstances (e.g., documented illness or hospitalization, death in family, etc.), the student was prevented from completing the work of the course on time. The assignment of an "I" requires that a contract be initiated and completed by the student before the last official day of class, and signed by both the student and instructor. If an incomplete is deemed appropriate by the instructor, the student in consultation with the instructor, will specify the time and manner in which the student will complete course requirements. Extension for completion of the work will not exceed one year (or earlier if designated by the student's college). For more information and to initiate an incomplete contract, students should go to SPHGrades at: www.sph.umn.edu/grades.

University of Minnesota Uniform Grading and Transcript Policy

A link to the policy can be found at onestop.umn.edu.

VIII. Other Course Information and Policies

Grade Option Change (if applicable)

For full-semester courses, students may change their grade option, if applicable, through the second week of the semester. Grade option change deadlines for other terms (i.e. summer and half-semester courses) can be found at onestop.umn.edu.

Course Withdrawal

Students should refer to the Refund and Drop/Add Deadlines for the particular term at onestop.umn.edu for information and deadlines for withdrawing from a course. As a courtesy, students should notify their instructor and, if applicable, advisor of their intent to withdraw.

Students wishing to withdraw from a course after the noted final deadline for a particular term must contact the School of Public Health Office of Admissions and Student Resources at sph-ssc@umn.edu for further information.

Student Conduct Code

The University seeks an environment that promotes academic achievement and integrity, that is protective of free inquiry, and that serves the educational mission of the University. Similarly, the University seeks a community that is free from violence, threats, and intimidation; that is respectful of the rights, opportunities, and welfare of students, faculty, staff, and guests of the University; and that does not threaten the physical or mental health or safety of members of the University community.

As a student at the University you are expected adhere to Board of Regents Policy: *Student Conduct Code*. To review the Student Conduct Code, please see:

http://regents.umn.edu/sites/default/files/policies/Student_Conduct_Code.pdf.

Note that the conduct code specifically addresses disruptive classroom conduct, which means "engaging in behavior that substantially or repeatedly interrupts either the instructor's ability to teach or student learning. The classroom extends to any setting where a student is engaged in work toward academic credit or satisfaction of program-based requirements or related activities."

Use of Personal Electronic Devices in the Classroom

Using personal electronic devices in the classroom setting can hinder instruction and learning, not only for the student using the device but also for other students in the class. To this end, the University establishes the right of each faculty member to determine if and how personal electronic devices are allowed to be used in the classroom. For complete information, please reference:

<http://policy.umn.edu/Policies/Education/Education/STUDENTRESP.html>.

Scholastic Dishonesty

You are expected to do your own academic work and cite sources as necessary. Failing to do so is scholastic dishonesty. Scholastic dishonesty means plagiarizing; cheating on assignments or examinations; engaging in unauthorized collaboration on academic work; taking, acquiring, or using test materials without faculty permission; submitting false or incomplete records of academic achievement; acting alone or in cooperation with another to falsify records or to obtain dishonestly grades, honors, awards, or professional endorsement; altering, forging, or misusing a University academic record; or fabricating or falsifying data, research procedures, or data analysis. (Student Conduct Code:

http://regents.umn.edu/sites/default/files/policies/Student_Conduct_Code.pdf) If it is determined that a student has cheated, he or she may be given an "F" or an "N" for the course, and may face additional sanctions from the University. For additional information, please see:

<http://policy.umn.edu/Policies/Education/Education/INSTRUCTORRESP.html>.

The Office for Student Conduct and Academic Integrity has compiled a useful list of Frequently Asked Questions pertaining to scholastic dishonesty: <http://www1.umn.edu/oscai/integrity/student/index.html>. If you have additional questions, please clarify with your instructor for the course. Your instructor can respond to your specific questions regarding what would constitute scholastic dishonesty in the context of a particular class-e.g., whether collaboration on assignments is permitted, requirements and methods for citing sources, if electronic aids are permitted or prohibited during an exam.

Makeup Work for Legitimate Absences

Students will not be penalized for absence during the semester due to unavoidable or legitimate circumstances. Such circumstances include verified illness, participation in intercollegiate athletic events, subpoenas, jury duty, military service, bereavement, and religious observances. Such circumstances do not include voting in local, state, or national elections. For complete information, please see: <http://policy.umn.edu/Policies/Education/Education/MAKEUPWORK.html>.

Appropriate Student Use of Class Notes and Course Materials

Taking notes is a means of recording information but more importantly of personally absorbing and integrating the educational experience. However, broadly disseminating class notes beyond the classroom community or accepting compensation for taking and distributing classroom notes undermines instructor interests in their intellectual work product while not substantially furthering instructor and student interests in effective learning. Such actions violate shared norms and standards of the academic community. For additional information, please see: <http://policy.umn.edu/Policies/Education/Education/STUDENTRESP.html>.

Sexual Harassment

"Sexual harassment" means unwelcome sexual advances, requests for sexual favors, and/or other verbal or physical conduct of a sexual nature. Such conduct has the purpose or effect of unreasonably interfering with an individual's work or academic performance or creating an intimidating, hostile, or offensive working or academic environment in any University activity or program. Such behavior is not acceptable in the University setting. For additional information, please consult Board of Regents Policy: <http://regents.umn.edu/sites/default/files/policies/SexHarassment.pdf>

Equity, Diversity, Equal Opportunity, and Affirmative Action

The University will provide equal access to and opportunity in its programs and facilities, without regard to race, color, creed, religion, national origin, gender, age, marital status, disability, public assistance status, veteran status, sexual orientation, gender identity, or gender expression. For more information, please consult Board of Regents Policy: http://regents.umn.edu/sites/default/files/policies/Equity_Diversity_EO_AA.pdf.

Disability Accommodations

The University of Minnesota is committed to providing equitable access to learning opportunities for all students. Disability Services (DS) is the campus office that collaborates with students who have disabilities to provide and/or arrange reasonable accommodations.

If you have, or think you may have, a disability (e.g., mental health, attentional, learning, chronic health, sensory, or physical), please contact DS at 612-626-1333 to arrange a confidential discussion regarding equitable access and reasonable accommodations.

If you are registered with DS and have a current letter requesting reasonable accommodations, please contact your instructor as early in the semester as possible to discuss how the accommodations will be applied in the course.

For more information, please see the DS website, <https://diversity.umn.edu/disability/>.

Mental Health and Stress Management

As a student you may experience a range of issues that can cause barriers to learning, such as strained relationships, increased anxiety, alcohol/drug problems, feeling down, difficulty concentrating and/or lack of motivation. These mental health concerns or stressful events may lead to diminished academic performance and may reduce your ability to participate in daily activities. University of Minnesota services are available to assist you. You can learn more about the broad range of confidential mental health services available on campus via the Student Mental Health Website: <http://www.mentalhealth.umn.edu>.

The Office of Student Affairs at the University of Minnesota

The Office for Student Affairs provides services, programs, and facilities that advance student success, inspire students to make life-long positive contributions to society, promote an inclusive environment, and enrich the University of Minnesota community.

Units within the Office for Student Affairs include, the Aurora Center for Advocacy & Education, Boynton Health Service, Central Career Initiatives (CCE, CDes, CFANS), Leadership Education and Development

–Undergraduate Programs (LEAD-UP), the Office for Fraternity and Sorority Life, the Office for Student Conduct and Academic Integrity, the Office for Student Engagement, the Parent Program, Recreational Sports, Student and Community Relations, the Student Conflict Resolution Center, the Student Parent HELP Center, Student Unions & Activities, University Counseling & Consulting Services, and University Student Legal Service.

For more information, please see the Office of Student Affairs at <http://www.osa.umn.edu/index.html>.

Academic Freedom and Responsibility: for courses that do not involve students in research

Academic freedom is a cornerstone of the University. Within the scope and content of the course as defined by the instructor, it includes the freedom to discuss relevant matters in the classroom. Along with this freedom comes responsibility. Students are encouraged to develop the capacity for critical judgment and to engage in a sustained and independent search for truth. Students are free to take reasoned exception to the views offered in any course of study and to reserve judgment about matters of opinion, but they are responsible for learning the content of any course of study for which they are enrolled.*

Reports of concerns about academic freedom are taken seriously, and there are individuals and offices available for help. Contact the instructor, the Department Chair, your adviser, the associate dean of the college, or the Vice Provost for Faculty and Academic Affairs in the Office of the Provost.

OR:

Academic Freedom and Responsibility, for courses that involve students in research

Academic freedom is a cornerstone of the University. Within the scope and content of the course as defined by the instructor, it includes the freedom to discuss relevant matters in the classroom and conduct relevant research. Along with this freedom comes responsibility. Students are encouraged to develop the capacity for critical judgment and to engage in a sustained and independent search for truth. Students are free to take reasoned exception to the views offered in any course of study and to reserve judgment about matters of opinion, but they are responsible for learning the content of any course of study for which they are enrolled.* When conducting research, pertinent institutional approvals must be obtained and the research must be consistent with University policies.

Reports of concerns about academic freedom are taken seriously, and there are individuals and offices available for help. Contact the instructor, the Department Chair, your adviser, the associate dean of the college, or the Vice Provost for Faculty and Academic Affairs in the Office of the Provost.

* Language adapted from the American Association of University Professors "Joint Statement on Rights and Freedoms of Students".

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