SYLLABUS & COURSE INFORMATION

SCHOOL OF PUBLIC HEALTH
UNIVERSITY OF MINNESOTA

PUBH 8472

Spatial Biostatistics
Spring 2019

COURSE & CONTACT INFORMATION

Credits: 3
Meeting Day(s): Monday and Wednesday
Meeting Time: 11:15AM – 12:30PM
Meeting Place: Moos 2-118

Instructor: Lin Zhang, PhD, Roland Brown (TA)
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Office Phone: 612-624-0624
Fax: 612-626-0660
Office Hours: Lin: Monday 3:00PM-5:00PM, or by appointment;
Roland: Tuesday & Thursday 10:00AM – 11:00AM; held in TA Room Mayo A446
Office Location: A430 Mayo Bldg, MMC 303, 420 Delaware St S.E., Minneapolis MN 55455

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.

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.

COURSE GOALS & 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.

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 canvas course webpage located at: https://canvas.umn.edu/courses/100264
Students are expected to attend the lectures (twice a week) and computer lab sessions, complete assigned homework, midterm exam and the finals.

COURSE TEXT & 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.

COURSE OUTLINE/WEEKLY SCHEDULE

Week	Topic	Readings
Week 1 1/23	• Introduction, types of spatial data, fundamentals of cartography	• BCG Chapter 1
Week 2 1/28, 1/30	• Point-referenced data (geostatistics) basics	• BCG Chapter 2
Week 3 2/4, 2/6	• EDA methods, classical estimation and prediction	• BCG Chapter 2
Week 4 2/11, 2/13	• Areal data (lattice) basics	• BCG Chapter 3
Week 5 2/18, 2/20	• Basics of Bayesian inference	• BCG Chapter 4
Week 6 2/25, 2/27	• Hierarchical modeling for univariate data: spatial process models	• BCG Chapter 5
Week 7 3/4, 3/6	• Areal data modeling and disease mapping	• BCG Chapter 5
Week 8 3/11, 3/13	• Review and Midterm Exam	•
Week 9 3/18, 3/20	• Spring break	•
Week 10 3/25, 3/27	• Spatial misalignment: point and block level modeling	• BCG Chapter 6
Week 11 4/1, 4/3	• Multivariate spatial modeling: separable point level models	• BCG Chapter 7
Week 12 4/8, 4/10	• Co-regionalization models, areal data (MCAR) models	• BCG Chapter 7
Week 13 4/15, 4/17	• Spatio-temporal modeling	• BCG Chapter 8
Week 14 4/22, 4/24	• Large scale spatial modeling; Nonstationary spatial modeling	• Supplement Materials
Week 15 4/29, 5/1	• Student project presentation	•
Week 16 5/11	• Final Project write-up due	•

SPH AND UNIVERSITY POLICIES & RESOURCES

The School of Public Health maintains up-to-date information about resources available to students, as well as formal course policies, on our website at www.sph.umn.edu/student-policies/. Students are expected to read and understand all policy information available at this link and are encouraged to make use of the resources available.

The University of Minnesota has official policies, including but not limited to the following:

- Grade definitions
- Scholastic dishonesty
- Makeup work for legitimate absences
- Student conduct code
- Sexual harassment, sexual assault, stalking and relationship violence
- Equity, diversity, equal employment opportunity, and affirmative action
- Disability services
- Academic freedom and responsibility

Resources available for students include:

- Confidential mental health services
- Disability accommodations
- Housing and financial instability resources
- Technology help
- Academic support

EVALUATION & 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.

Grading Scale
The University uses plus and minus grading on a 4.000 cumulative grade point scale in accordance with the following, and you can expect the grade lines to be drawn as follows:

% In Class	Grade	GPA
93 - 100%	A	4.000
90 - 92%	A-	3.667
87 - 89%	B+	3.333
83 - 86%	B	3.000
80 - 82%	B-	2.667
77 - 79%	C+	2.333
73 - 76%	C	2.000
70 - 72%	C-	1.667
67 - 69%	D+	1.333
63 - 66%	D	1.000
< 62%	F	

- A = achievement that is outstanding relative to the level necessary to meet course requirements.
- B = achievement that is significantly above the level necessary to meet course requirements.
- C = achievement that meets the course requirements in every respect.
- D = achievement that is worthy of credit even though it fails to meet fully the course requirements.
- F = failure because work was either (1) completed but at a level of achievement that is not worthy of credit or (2) was not completed and there was no agreement between the instructor and the student that the student would be awarded an I (Incomplete).
- S = achievement that is satisfactory, which is equivalent to a C- or better
- N = achievement that is not satisfactory and signifies that the work was either 1) completed but at a level that is not worthy of credit, or 2) not completed and there was no agreement between the instructor and student that the student would receive an I (Incomplete).

Evaluation/Grading Policy	Evaluation/Grading Policy Description
Scholastic Dishonesty, Plagiarism, Cheating, etc.	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 (As defined in the Student Conduct Code). For additional information, please see https://z.umn.edu/dishonesty The Office for Student Conduct and Academic Integrity has compiled a useful list of Frequently Asked Questions pertaining to scholastic dishonesty: https://z.umn.edu/integrity. If you have additional questions, please clarify with your instructor. 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. Indiana University offers a clear description of plagiarism and an online quiz to check your understanding (http://z.umn.edu/iuplagiarism).
Late Assignments	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).
Attendance Requirements	Students are expected to attend class. If you need to miss a class, please discuss this with the instructor, in advance whenever possible.
Extra Credit	None.

CEPH COMPETENCIES

Competency	Learning Objectives	Assessment Strategies
1. Apply epidemiological methods to the breadth of settings and situations in public health practice.	When given a specific research context, recognize which spatial statistical method is appropriate to address the scientific or public health question for the given data set. Carry out diagnostics to assess whether the assumptions of the method hold for the given data set.	Homework assignments and the final project will cover this learning objective.
2. Select quantitative and qualitative data collection methods appropriate for a given health context.	Distinguish among the different types of data (e.g., point-referenced, areal) that may be collected. Create new variables from given variables (e.g., aggregate of point-reference data to areal data) and investigate whether transformations of a variable are needed to satisfy modeling assumptions or aid interpretation.	Homework assignments and the final project will cover this learning objective.
3. Analyze quantitative and qualitative data using biostatistics, informatics, computer-based programming and software.	Understand the nature of spatial data, why such data merit special analysis techniques. Plan and implement a data analysis that is specific to the evaluation of a stated scientific/public health hypothesis and appropriate for the type of data being analyzed. Learn the appropriate softwares (eg., R packages geoR and spBayes, GeoBUGS tools within the WinBUGS) for spatial data analysis.	Homework assignments and the final project will cover this learning objective.

4. Interpret results of data analysis for public health research, policy or practice.	Interpret the results of your data analysis within the context of the stated hypothesis and the scientific/public health relevance.	Homework assignments and the final project will cover this learning objective.
11. Select methods to evaluate public health programs or policies.	Decide upon research hypotheses for a dataset that involves public health programs or policies, design an analysis plan appropriate for the research questions, implement that analysis plan, interpret the results, and describe the entire study in a research summary report.	Students may choose to conduct a spatial data analysis what involves public health programs for their final project; the project would then cover these learning objectives.
19. Communicate audience-appropriate public health content, both in writing and through oral presentation.	Be aware of the need to assess your audience's scientific and statistical backgrounds and public health research interests; practice tailoring your written communications to those backgrounds and interests.	The final project will cover this learning objective through the crafting of the language used within background, methods, results, public health/clinical relevance, and discussion.