Geography 651
Spatial Statistics
Winter 2018

Instructor: Eunjung (Elle) Lim
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On-campus office hours: Thursdays 2-3 pm

Lecture: Online Wednesdays 5:30 – 8:00 pm
On campus 1166 LeFrak Hall
Online Thursdays 5:30 – 6:30pm
On campus 1166 LeFrak Hall
Website: http://elms.umd.edu
Lab: Online Thursdays 6:40 – 7:30 pm
TA : TBA

Course Description

This course is about quantitative analysis of spatial data. It is intended to provide a broad survey of various spatial statistic methods useful in environmental and social sciences. This course covers four broad topical areas: (1) point pattern analysis; (2) area data analysis; (3) continuous data analysis; (4) spatial sampling; and (5) multivariate spatial and temporal analysis. The course is a mix of theories, methods, and applications geared towards helping students: (1) develop an understanding of the important theoretical concepts in spatial statistical analysis; and (2) gain practical experience in applying spatial statistics to a variety of social and environmental problems using advanced statistical software.

Learning Outcomes

Upon completion of this course, students should be able to

- Understand concepts of homogenous (complete spatial randomness) and heterogeneous spatial process
- Understand concept of spatial autocorrelation
- Identify and interpret global and local spatial patterns of point and polygon data
- Understand the principals and practical applications of ordinary least square regression and spatial regression
- Understand and distinguish deterministic and stochastic spatial interpolation
- Understand the principals and practical applications of experimental semivariograms, semivarigoram models, kriging, and cross validation
- Understand the principals and practical applications of spatial sampling
- Understand the principals and practical applications of spatiotemporal pattern analysis
- Apply proper spatial analysis methods for their own research using various statistical software and interpret spatial analysis results

Prerequisites

Students are expected to have backgrounds in elementary statistics and introductory GIS.

Course Requirements and Grading

It is strongly encouraged to attend each lecture and actively participate in online discussion board as well as in class. Students are required to post a reply on the issue posted by the instructor. Lab assignments will be given on a weekly basis to help students gain practical experience to answer

specific problems. Students need to complete final projects with spatial data in their area of interest using various methods covered in this course. Final grades will be determined by the following items:

- Participation & Discussions 5%
- Weekly quizzes 5%
- Lab assignments 60%
- Final project 30%

Required Textbooks

This course will include many contents from several books and papers. There are four textbooks mainly referenced in the course. If you don't have any spatial statistic book, I recommend you get at least one book, Statistical Methods for Geography written by P. Rogerson which covers the subjects of Week1-6. Electronic versions of other books are listed below or will be posted on ELMS.

RP: Rogerson, P. (2014) Statistical Methods for Geography, 4th Edition. London, SAGE Publications.

RY: Rogerson, P. and I. Yamada (2008) *Statistical Detection and Surveillance of Geographic Clusters*, CRC Press.

IR: Issacks, E.H. and R. M. Srivastava Wong (1989) *An Introduction to Applied Geostatistics*, Oxford university press. Electronic version is available at ftp://shock.geomatics.ncku.edu.tw/array1/for_test/IsaaksBook.pdf

OU: O'Sullivan, D. and D. J. Unwin (2002 or 2010) *Geographic Information Analysis*, Wiley & Sons.

Recommended Textbooks & References

FB: Fotheringham, A. S., Brunsdon C. and Charlton M. (2000, 2002, 2004) *Quantitative geography:Perspectives on Spatial Data Analysis*, Sage Publications Ltd.

FR: Fotheringham, A. S.and Peter A. Rogerson (2009) *The SAGE Handbook of Spatial Analysis*, Sage Pblications Ltd.

SO: Stevens, D.L., and A.R. Olsen. 2004. "Spatially balanced sampling of natural resources."Journal of the American Statistical Association 99 (465): 262–278 http://www.epa.gov/nheerl/arm/documents/grts_asa.pdf

Make-up Policy

Assignments must be turned in by 11:59PM at which they are due. Late assignments will result in penalties unless prior arrangements are made with the instructor. If you have a documented disability and wish to discuss academic accommodations, please contact the instructor immediately. Students should not expect 'Incomplete' grade as they will be only given under extra-ordinary circumstances.

Academic Integrity

The University of Maryland, College Park, has a nationally recognized Code of Academic Integrity, administered by the Student Honor Council. This Code sets standards for academic integrity at Maryland for all undergraduate and graduate students. As a student, you are responsible for upholding these standards for this course. It is very important for you to be aware of the

consequences of cheating, fabrication, facilitation, and plagiarism. For more information on the Code of Academic Integrity or the Student Honor Council, please visit http://www.shc.umd.edu. Within our class, students may work together to review class notes and home assignments. However, assignments must be done individually. Each student must turn in his or her own work, from his or her own computer. Any discussion or problem solution must be his or her alone, without assistance from any other person.

Disabilities and Religion
Any student with a disability is encouraged to meet with the instructor privately during the first week of class to discuss accommodations. I will make every effort to accommodate students who are registered with the Disability Support Services (DSS) Office and provide a DSS accommodation form. Please refer to the Online Undergraduate Catalog Policy on Religious Observance.

Sustainability
In an effort to promote greater understanding of sustainability among students, faculty, and staff at the University of Maryland, this course has been adapted to include discussion about larger sustainability issues, such as global climate change, food security, and systems modeling. Visit the University of Maryland's office of sustainability at: http://www.sustainability.umd.edu/.

Online Learning
This is an online course with occasional in-person experiences. We will meet online at the announced time for a live audio/video lecture. The lecture will be archived for anyone who absolutely must miss the class, but I encourage you to login at the appointed time so that you can ask questions.

Our class will meet within Blackboard, the university's online learning system. Go to http://elms.umd.edu to access the course. After you login, our course will be listed in the right column under My Courses. Click on the course link to access the course.

Short videos that illustrate how to use the online learning system are available on the course page. Click the Tutorials button on the left sidebar to access the tutorials.

Software Requirements for this course
- ArcGIS 10.3 are required to install on your computer. Spatial Statistics and Geostatistical Analyst in ArcMap will be used in the labs. If you didn't get an ArcGIS 10.3 license code from the department, contact with Kristin Bergery (kbergery@umd.edu).
- SPSS is software package used for statistical analysis. It is not a spatial statistic software package but can be used to apply classical statistics which is the basis of spatial statistics. Student can download free 1 year licensed SPSS software from http://terpware.umd.edu/Windows/title/1880
- This course introduces and use Free Spatial Statistical Software such as CrimeSat, GeoSurveillance, GeoDa, etc. The installation details will be provided during the class.

All students must have a UMD TerpConnect (used to be Glue) account to obtain permissions to access the software in the computer labs on campus (LeFrak 1136 1137) and on VMWare virtual

computers. You can access virtual computers remotely through VMWare Client View. VMWare View Client tutorial (MPS_ViewTutorial-VMWare.pdf) will be posted on ELMS.

Hardware Requirement for this course

You may use either a PC or a Macintosh computer to access ELMS. Whichever you choose, it must be equipped with the following hardware:

- Headset (including headphones and microphone)
- Webcam (optional)

You will also need the following plug-ins (be sure you have the latest versions):

- Adobe Flash Player

Support for Online Learning

This method of taking classes is undoubtedly new to some of you, so we have a few tools to make life easier for you.

Email

Both TA and instructor will always be available by email. Use the email link in the sidebar to send us emails at any time. We will try to answer within 24 hours and probably much sooner.

Online office hours

We will have office hours in a Live Classroom each week. The times will be posted in the Announcements. Use the link in the sidebar to access office hours.

On campus office hours

We will post times when we will be available on campus for face-to-face office hours. The TAs will have lab office hours on periodic Saturday mornings.

Online Discussion & Chat rooms

We have created places for you to visit with your classmates. Share everything from discussions about the course material to what you did last weekend. I will look in from time to time but I probably won't respond to anything posted.

Course Schedule

This is a tentative schedule and may be adjusted to suit our class. Changes will be announced and posted on Blackboard.

Dates	Topics	Reading	Assignment
Nov 29	Overview of spatial statistics Review of elementary statistics • Probability concepts • Probability distributions • Sampling theory	RP Ch 1, 2, 3, 4	Lab1 Out
Nov 30	Review of elementary statistics • Hypothesis test	RP Ch 5	
Dec 6	Spatial process: Complete Spatial Randomness Issues in analyzing spatial data	RP 2.6 RP Ch 8.2	Lab 1 Due Lab2 Out

	Point pattern analysis • Descriptive measures of point pattern • Density-based measures of point pattern	OU Ch 2.2, 2.3, 4, 5,6	
Dec 7	Point pattern analysis • Distance-based measures of point pattern	RP 10.1 10.2 OU Ch 6	
Dec 13	Cluster detection analysis	RY Ch 5 OU Ch 6.7	Lab 2 Due Lab3 Out
Dec 14	CrimeSat		
Dec 20	Spatial autocorrelation	RP Ch 10.3 10.4 OU Ch 7	Lab3 Due Lab4 Out
Dec 21	Useful GIS Data Resources		Final Project Topic Discussion Out
	Winter Break Dec 23, 2017 – Jan 1, 2018		
Jan 3	OLS Regression Logistic Regression Spatial Regression	RP Ch 8 9 11.3	Lab 4 Due Lab5 Out Final Project Topic Discussion Due:
Jan 4	Geographic Weighted Regression (GWR)	RP Ch 11.4	
Jan 10	Factor Analysis Principal Component Analysis Spatial interpolation • Deterministic approach • Stochastic (Geostatistical) approach	RP 12 OU Ch 8 IR Ch 7	Lab 5 Due Lab 6 Out Proposal Out
Jan 11	Stochastic spatial interpolation • Describing spatial variation	OU Ch 9 IR Ch 7	
Jan 17	Stochastic spatial interpolation • Modeling varigram • Kriging	IR Ch 7 12 15	Lab 6 Due Lab7 Out
Jan 18	Spatial interpolation • Kriging • Effects of variogram parameters on kriging	IR Ch 15 16	
Jan 24	Spatial interpolation • Empirical Bayesian Kriging • Areal Interpolation	IR Ch 16	Lab 7 Due
Jan 25	Spatial Sampling	SO	Proposal Due
Jan 31	Spatio-temporal data analysis	RY 6 7	
Feb 1	Spatio-temporal data analysis	RY 7 8 9	Optional Lab 8
Feb 7	Spatio-temporal data analysis		
Feb 8	Review of applications of spatial statistics		

Feb 14	Independent Study		Lab 8 & Project Due: Feb 16