SIE 512 SPATIAL ANALYSIS

Instructor: Kate Beard
Tues and Thurs: 2:00 - 3:15 Boardman Room 336
Course webpage: http://umaine.edu/computingcoursesonline/512/
3 credits

Course objective:
This course introduces techniques for the statistical analysis of spatial data. The course will cover characterization of spatial data, and techniques for visualizing, exploring and modeling spatial data distributed as point patterns, continuous data, and area or lattice data, and methods and problems in spatial data sampling. Students will become familiar with methods for identifying, describing, modeling and testing spatial patterns in observed data. Students will gain skills in using R for applied spatial data analysis.

Students will be responsible for completing several lab exercises, one paper, a midterm exam and a final project. Prerequisites: an introductory statistics course.

Course outline
Issues in analyzing spatial data
General concepts in spatial data analysis
Methods for point pattern analysis
Methods for spatially continuous data analysis
Methods for area data analysis
Sampling spatial populations

Class Sessions

- *On-campus Students*: Tues and Thursday, 2:00 – 3:15 Tues & Thurs, Room 326 Boardman Hall
- *Live Broadcast*: Available through Zoom. Online students may view and participate in the live sessions but are not required to do so.
- *Archived Broadcasts*: Links to the class broadcasts are made available at the end of each day through the *Lectures and Assignments* link for this course.
- *Audio Chat:* Distance students can view the lectures at any time of their choosing during the week. A *discussion session* can be arranged to discuss questions or lab issues.

Supplementary Readings:

- Bivand R, Pebesma E, and Gomez-Rubio V 2008. Applied Spatial Data Analysis with R
- Stephenson, D.B. 2003. Notes on Statistical Concepts in Environmental Science.
- Baddeley, A. 2008 Analyzing Spatial Point Patterns in R

Additional references:

- Banerjee, S., Carlin, B. & Gelfand, A. 2014 Hierarchical Modeling and Analysis for Spatial Data. Chapman and Hall/CRC Press
- Cressie, N. 1993. Statistics for Spatial Data. Revised ed. John Wiley & Sons, New York.
- Diggle, P. Statistical Analysis of Spatial Point Patterns. London: Academic Press.
- Goovaerts, P. Geostatistics for Natural Resource Evaluation. Oxford University Press.
- Isaaks, E., and R. Srivastava. 1989. An Introduction to Applied Geostatistics. Oxford University Press, New York.
- Plant, R. 2012. Spatial Data Analysis in Ecology and Agriculture using R. CRC Press.
- Schabenberger, O. and Gotway, C. 2004. Statistical Methods for Spatial Analysis. Chapman and Hall/CRC Press

Lab exercises:

Most lab exercises will be done using R open source statistical software. RStudio is an open source integrated development environment (IDE) for R which is recommend as it supports syntax checking, direct code execution, and tools for plotting, history, and debugging. R Studio runs on Windows, Mac and Linux and is easy to install. The download site is here.

We will also use Geoda, open source software from the Spatial Analysis Lab, from the University of Chicago available from their download site here.

Lab assignments are due weekly and must be turned in on the day they are due. Labs will be completed as R Markdown documents.

- **Resources for R**
  http://rspatial.org/intr/index.html
- http://cran.r-project.org/web/views/Spatial.html
- **Spatial Point Pattern Analysis resources for R**
- http://spatstat.org/

- **Geostatistics resources for R**
  http://www.leg.ufpr.br/geoR/geoRdoc/geoRintro.pdf

Papers:

One short review paper is required. For this paper assignment students will review a journal article that describes a spatial analysis method from one of the topic areas covered by the course (e.g point patterns, continuous data, area data, or sampling). Review papers should be approximately 3 pages in length.

Midterm:

There will be a take home midterm exam distributed the third or fourth week of October.

Final Projects:

Students must complete a final project using analysis techniques learned in the course of the class. A one-page description of your proposed project is due Nov 2 for presentation in class or for distance students as a video. Final presentations of projects will be scheduled during final exam week. There are two options for the final project:

- Implement a spatial analysis technique. For this option, any programming or scripting language can be used to code an analysis method.
- Carry out spatial analysis on a data set of your choice. For this option, the objective will be to select a data set of your choice, use exploratory techniques to examine the data, and develop a hypothesis or set of hypotheses concerning the data and test these using techniques discussed in class. Any software of your choice can be used to perform the analysis. Many spatial data sets are now available on the web but they can take some work to prepare for analysis. You should not leave planning for this project until the eleventh hour.

Grading

- Lab Assignments – 30%
- Midterm Exam – 25%
- Journal Article review paper – 15%
- Final project and presentation – 30%

Important Notices

- Important Disability Notice
- Copyright Notice for Materials Accessible through this Website

E. Instructor Office Hours & Discussions

- For one-on-one discussions with the instructor, E-mail **kate.beard@maine.edu**.
- **On-campus Students**: Email me to schedule appointments in person.
- **Distance Students** For student questions and discussion we will use Zoom. Contact me to schedule a time for Zoom meeting to discuss lecture or lab questions you may have.

If you wish to request an accommodation for a disability, please contact Ann Smith, Coordinator of Services for Students with Disabilities (Onward Building, 1-2319) as early as possible in the semester.

Sample Class outline

	Topics	**Readings**
3 Sept	Course Overview	Stephenson 2-4
5 Sept	RStudio and R markdown	RBasicsTutorial
Lab1	Basic graphics in R	
10 Sept	Overview of Statistical Concepts	Stephenson 7
12 Sept	Overview of Statistical Concepts	Stephenson 7
Lab 2	Regression Models in R	
17 Sept	Overview of Statistical Concepts	
19 Sept	Issues in Spatial Analysis	
Lab 3	First and second order effects	

24 Sept	Introductory Methods in Point Processes	Baddley
26 Sept	Introductory Methods in Point Processes	Baddley
Lab 4	Point pattern exploratory analysis	
1 Oct	Introductory Methods in Point Processes	Baddley
3 Oct	Introductory Methods in Point Processes	Baddley
Lab 5	Point pattern analysis	
8 Oct	Multivariate Point Processes	Baddley
10 Oct	Multivariate Point Processes	Baddley
Lab 6	Point pattern analysis	
15 Oct	Fall Break – No Class	Baddley
17 Oct	Geostatistical Data Analysis	
22 Oct	Geostatistical Data Analysis	
24 Oct	Geostatistical Data Analysis	
Lab 7	Geostatistical Data Methods	
29 Oct	Geostatistical Data Analysis	Midterm Exam
31 Oct	Geostatistical Data Analysis	
Lab 8	Geostatistical Data Methods	
5 Nov	Area Data Analysis	
7 Nov	Area Data Analysis	Project Proposals
Lab 9	Area data exploratory methods	
12 Nov	Area Data Analysis	
14 Nov	Area Data Analysis	
Lab 10	Area Data Modeling	
19 Nov	Local Statistics for Area Analysis	Anselin:LISA
21 Nov	Geographically Weighted Regression	Fotheringham et al
Lab	Final Projects	
26 Nov	Area Data Analysis	Text Chapter 8
28 Nov	Thanksgiving Break	
3 Dec	Sampling Design	VerHoeff, 2002, Haining: Chap 5
5 Dec	Sampling Design	Haining: Chap 5
Lab	Final Projects	
10 Dec	Sampling Design	Haining: Chap 5
12 Dec	Sampling Design	Oliver and Webster
Lab	Final Projects	