

# **GEOG 407/507: Spatial Analysis and Modeling**

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**Lectures:** T/TH, 12:30-1:45; 206 McClure Hall

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## **Course Description**

This course will introduce the basic spatial analytic methods used by both human and physical geographers and increasingly used in other social and environmental science fields. We will introduce the special nature of spatially arranged data that geographers are concerned with, discuss some of unique problems that arise with such data, and explore the solutions that geographers and others have developed in response to these challenges. Along the way, we will also introduce the R statistical software package which is widely used by your contemporaries (and workforce competitors). This course will further your ability to become an effective researcher when using spatial data while also providing a foundation for more advanced courses in spatial statistical analysis.

## **Learning Outcomes**

The main objectives for this course are for you to:

- understand the basic descriptive and inferential spatial analyses used in Geography;
- learn how to identify an appropriate spatial analytic technique for specific research questions in Geography;
- correctly perform and interpret the spatial analysis technique you have selected;
- recognize the challenges and opportunities involved in working with spatially organized data;
- develop or extend your skills in data preparation/handling within R.

## **Required Text and Readings**

There is but one required text for the class. We will use it extensively.

- Brunsdon, C. , and Comber, L. 2015. *An Introduction to R for Spatial Analysis and Mapping*. Sage. (ISBN 13: 978-1-4462-7295-4)

We will use other materials in the class, mostly research articles. These will be made available to you as needed.

## **Recommended Texts**

We are going to introduce the R software package which beginners may find a bit tricky to use at first. Although we will go over the basics of R in class, these are helpful R guidebooks for beginners.

- Zuur, A., E. N. Ieno, and E. Meesters. 2009. *A Beginner's Guide to R (Use R! Series)*. Springer. (ISBN 13: 978-0-387-93836-3)
- Dennis, B. 2013. *The R Student Companion*. CRC Press. (ISBN 13: 978-1-4398-7540-7)

These texts are helpful introductions to statistics and are very useful as references (I refer to them often in my own research).

- Burt, J. E., G. M. Barber, and D. L. Rigby. 2009. *Elementary Statistics for Geographers, Third Edition*. Guilford Press. (ISBN 13: 978-1-5723-0484-0)
- Dalgaard, P. 2008. *Introductory Statistics with R. 2<sup>nd</sup> edition*. Springer. (ISBN 13: 978-0-3877-9053-4)

For those that wish to go further with spatial analysis in R, I also recommend the books listed below.

- Ward, M. D., and K. S. Gleditsch. 2008. *Spatial Regression Models: Quantitative Applications in the Social Sciences, Volume 155*. SAGE Publications. (ISBN 13: 978-1-4129-5415-0)
- Bivand, R. S., E. Pebesma, and V. Gómez-Rubio. 2013. *Applied Spatial Data Analysis with R, 2<sup>nd</sup> Ed. (Use R! Series)*. Springer. (ISBN 13: 978-1-4614-7618-4)

## **Your Responsibilities**

**This course is lecture- and activity-based.** Our lecture meetings will consist of me reviewing material and demonstrating techniques. However, we will also engage group discussion, lab activities, and exercises that explore the concepts and ideas in the readings. **This course is demanding and I expect that you will come to class prepared.** You are responsible for knowing all the course material including the assigned readings. Further, you are expected to work with the assigned readings and other materials before coming to class. Take notes on what you read and bring questions to class.

**The nature of this class means that consistent attendance is necessary to succeed.** After the second unapproved absence, you will receive a 5% deduction to your final grade for each additional absence. Coming to class means more than just being present. I expect you to arrive on time, stay for the duration, and to be attentive. I have no patience for talking, texting, tweeting, instagramming, yik-yakking, live blogging, or snoring during class, and will not accept these or other kinds of disruptive behaviors. As such, **cell/smart phones should be silenced in the classroom. Laptops and tablets are permitted with the condition that they are used appropriately in the classroom.**

**You must also actively participate in the course** beyond simply turning up on time. Participating means: being engaged, asking questions, offering examples, and responding to my questions and activities.

**No late assignments will be accepted. None. I'm not kidding.** Exceptions to this strictly enforced policy are made for students that are representing the university at some official or sanctioned function or for a documented medical or family emergency. **An emergency is something sudden, drastic, and unforeseen.** If you have scheduled events coming up, such as weddings, family reunions, job interviews, etc., plan ahead and hand in the assignment early!

**No cheating or plagiarism will be tolerated!** Your written work must be independently produced and must not display cross-over or direct similarity with the work of a classmate or another author. Any cheating or plagiarism will result in a zero for the assignment and maybe even the course. See <http://www.wpacouncil.org/node/9> if you're unsure about what constitutes plagiarism. **Seriously, if you turn in something that's not your own writing, you'll get a zero on it.**

**If you need course adaptations or accommodations because of a disability, if you have emergency medical information to share with me, or if you need special arrangements in case the building must be evacuated, please inform me as soon as possible.** At the University of Idaho, reasonable accommodations are available for students who have documented temporary or permanent disabilities. All accommodations must be approved through Disability Support Services which is located in the Idaho Commons Building, Room 306 (<http://www.uidaho.edu/studentaffairs/asap/dss>).

### **Firearms Policy (this is not satire)**

The University of Idaho bans firearms from its property with only limited exceptions. One exception applies to persons who hold a valid Idaho enhanced concealed carry license, provided those firearms remain concealed at all times. If an enhanced concealed carry license holder's firearm is displayed, other than in necessary self-defense, it is a violation of University policy. Please contact local law enforcement (call 911) to report firearms on University property.

The University of Idaho's leadership remains committed to maintaining a safe work, living and learning environment on campus and will not tolerate any threatening use of firearms or any other weapons. While authorized license holders may be at ease carrying a loaded firearm, **please be aware that many people are not familiar with handguns and are uncomfortable in their presence. Especially me.**

## **Course Assignments**

Your performance in this course will be assessed through the following activities. More information about the assignments will be offered during the semester.

**Exams:** Two take-home exams will be given that focus on the assigned readings and other materials. The exams emphasize conceptual understanding and application through a mix of short answer and R-based questions. The best preparation for the exams will be to complete all assigned readings, attend all lectures, work through all the assigned exercises, and engage in all class discussions.

**Lab Exercises:** You will be assigned lab exercises that reinforce the readings and lecture materials. These involve using R to carry out specific spatial analytic techniques on datasets provided by me. These labs are your primary opportunity to gain proficiency with actually doing spatial analysis (as opposed to just reading about them). As such, the labs are central to your ability to expand your skills. More information about the labs will be provided during class.

**Article review (507 students only):** You are expected to write one research article review. You will select an article yourself that employs spatial analysis. You must prepare a brief written review of the article. Reviews should be a critical evaluation of the research methods used in the article and presentations should stimulate discussions that provide insight into how spatial analytic methods are used in the scientific literature. The review must be no more than three pages double-spaced and will follow a format provided during class.

**Final project (research poster):** The capstone assignment of the course is for you to perform an original spatial analysis on a topic of your choice and to summarize/present your efforts using a research poster. Your analysis can involve 1) attempting to replicate someone else's published findings using the same data and techniques, 2) performing a new type of analysis on existing data that has already been used for publication, or 3) conducting new research on new data (collected/organized by you or others). Whichever option you choose, you will submit a formal proposal to me about your topic no later than the beginning of March. Once approved, you will conduct your analysis and summarize your results in a conference-quality research poster. At the end of the semester, you will give a 5 minute 'lightning talk' about your poster to the class. More details about the poster will be provided during class.

**Participation:** Active participation in class is essential to succeed in this course. In class we will actively engage with the ideas presented in assigned materials and you are expected to contribute to our activities and discussions with questions and thoughtful and informed reactions.

### **Grading Criteria**

Your grade will be determined on the percentage of points you receive for the required assignments and exams. Your final grade will be calculated using the following breakdown:

#### GEOG 407

Exams	30% (15% each)
Lab exercises	40% (8% each)
Research poster	25% (Proposal 5%, Poster 15%, Presentation 5%)
Participation	5%

#### GEOG 507

Exams	20% (10% each)
Lab exercises	40% (8% each)
Article review	10%
Research poster	25% (Proposal 5%, Poster 15%, Presentation 5%)
Participation	5%

The final grades will be assigned according to the following system:

A	90-100%
B	80-89%
C	70-79%
D	60-69%
F	anything below 60%

## Course Calendar

All dates and materials are subject to change.

Week	Dates	Topics	Readings	R programming practice	Labs/Assignments
1	Jan 11	Course Intro	Syllabus		
2	Jan 16, 18	Working with R R basics, data types and classes, basic plots	Reg: Brunsdon & Comber Ch1 and Ch2, Miller 2004 "Tobler's First Law and Spatial Analysis" Recommended: Dalgaard Ch. 1-4	B&C: Ch 2 self-test questions Dalgaard: Ch 1-4 exercises	Lab 0: Getting started with R
3	Jan 23, 25	What is spatial data? Types of spatial data, spatial data properties	Reg: Hairing 2003 Ch1 and Ch2 Recommended: Anselin, L. 1989, "What is Special About Spatial Data?" NCGIA Tech Paper 89-4.	B&C: examples pp 36-46	Lab 1: Spatial data handling in R (due Feb 1)
4	Jan 30, Feb 1	Working with spatial data Mapping in R, basic descriptive attribute analyses	Reg: B&C Ch. 3 Recommended: B&C Ch4; Brewer 2006 Basic Mapping Principles for Visualizing Data	B&C: Ch 3 self-test questions	
5	Feb 6, 8	GIS functions in R Using R as a GIS, working with vectors and rasters	Reg: B&C Ch. 5 Recommended: Câmara et al. 2006 GIS and spatial analysis: A primer	B&C: Ch 5 examples and self-test questions	Article Summary due Feb. 8

6	Feb 13, 15	<b>Point patterns I</b> Spatial randomness, event clustering, density estimation	<u>Reg:</u> B&C Ch 6  Recommended: Baddeley and Turner 2005 spatstat An R Package for Analyzing Spatial Point Patterns	B&C: Ch 6 examples and self-test questions	Lab 2: Point pattern analysis in R (due Feb 27)
7	Feb 20, 22	<b>Point patterns II</b> Interpolation and kriging	<u>Reg:</u> B&C Ch 6  Recommended: Gatrell et al. 1996 Spatial Point Pattern Analysis	B&C: Ch 6 examples and self-test questions	
8	Feb 27, Mar 1	<b>Exam 1</b>			Poster proposals due March 1
9	Mar 6, 8	<b>Lattice analysis I</b> Spatial attributes, spatial autocorrelation, spatial weights	<u>Reg:</u> B&C Ch 7, Ward & Gleditsch, Ch 1  Recommended: Dark 2004 Biogeography of invasive plants – a spatial regression analysis	B&C: Ch 7 examples and self-test questions	Lab 3: Global Spatial Autocorrelation in R (due Mar 20)
10	Mar 13, 15	<b>NO CLASS – Spring Break</b>			
11	Mar 20, 22	<b>Lattice analysis II</b> Spatial regression models in R	<u>Reg:</u> B&C Ch 7, Ward & Gleditsch, Ch 2-3  Recommended: Anselin 2002 Issues in specification and interpretation of spatial regression models	B&C: Ch 7 examples and self-test questions	Lab 4: Spatial regression in R (due Apr 3)

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12	Mar 27, 29	Localized analysis I LISA/Local Moran's I, Getis & Ord G	Req: B&C Ch 8 Recommended: Anselin 1995 Local Indicators of Spatial Association	B&C: Ch 8 examples and self-test questions	
13	Apr 3, 5	Localized analysis II Geographically weighted regression	Req: B&C Ch 8 Recommended: Fotheringham, Brunsdon, & Charlton Ch 1	B&C: Ch 8 examples and self-test questions	Lab 5: GWR in R (due Apr 18)
14	Apr 10, 12	Away for AAG Meeting Work on posters			
15	Apr 17, 19	Exam 2			
16	Apr 24, 26	Work on posters			
17	May 1, 3	Work on posters			
18	May 7-11	FINALS WEEK			Poster presentations (date & time TBD)