



Instructor		Course Details	
<b>Name:</b>	Wade Tinkham	<b>Term:</b>	Fall 2018
<b>Office:</b>	Forestry 126E	<b>Lecture/Lab Days:</b>	Tue & Thu
<b>E-Mail:</b>	<a href="mailto:Wade.Tinkham@colostate.edu">Wade.Tinkham@colostate.edu</a>	<b>Lecture/Lab Meeting Hours:</b>	9:00 - 10:40
<b>Office Hours:</b>	MW 10:30-12:00 or by appointment	<b>Lecture/Lab Location:</b>	Engineering B3

### Course Overview

Spatial statistics refers to statistical methods designed to analyze spatially referenced data (i.e. data with known X and Y coordinates). When used to analyze spatially referenced data, conventional statistical methods may lead to incorrect conclusions, or are simply unable to answer spatially informed questions. For example, conventional statistical methods cannot be used to answer questions about spatial patterns - and the underlying causes of these patterns - present in the dataset. This course will introduce a variety of statistical methods (loosely termed Spatial Statistics) specifically design to analyze spatially referenced data and ask spatially informed questions. We will also discuss important concepts and concerns to consider when analyzing spatial data.

### Course Goals and Objectives

This class is designed to teach you the basics of analyzing spatially referenced data with spatial statistics. This will be achieved through a combination of lectures and hands on lab exercises using a variety of software packages. We will primarily use the statistics software R. The ArcMap GIS software will also be used in limited situations. You will also spend a significant portion of class time developing, conducting, and writing up an applied spatial statistics analysis problem.

The purpose of the laboratory exercises is to provide you with hands-on experience analyzing and interpreting spatially referenced data. Information covered in the lectures will directly support the laboratory exercises, and class periods will often be a mix of lecture and lab.

### Course Prerequisites

ST301 (Introduction to Statistics)

### Useful Texts

- Bailey, T.C. and A.C. Gatrell. 1995. Interactive Spatial Data Analysis. Longmans Scientific and Technical. ISBN: 0582244935.
- Bivand, R., E.J. Pebesma, and V. Gomez-Rubio. 2013. Applied Spatial Data Analysis with R. Springer, New York, USA. ISBN: 1461476178.
- Isaaks, E.H. and R.M. Srivastava. 1989. An Introduction to Applied Geostatistics. Oxford University Press, New York, USA. ISBN: 0195050134.

### Other References

- James, G., D. Witten, T. Hastie, and R. Tibshirani. 2017. An Introduction to Statistical Learning: with Applications in R. Springer, New York, NY, USA. ISBN: 978-1-4614-7138-7.
- Ward, M.D. and K.S. Gleditsch. 2008. Spatial Regression Models. Thousand Oaks, CA: Sage.
- Adrian Baddeley, A. 2010. Analyzing spatial point patterns in R. CSIRO and University of Western Australia. <http://www.csiro.au/resources/pfl6h>

### Library & Research Help

The CSU Libraries Help Desk provides basic research and technical assistance either in person at Morgan Library or by phone at 970-491-1841. Virtual assistance is also available via the Libraries' Ask Us chat and email services

(<http://lib.colostate.edu/help/ask-us>). Jocelyn Boice is the librarian supporting the Forest and Rangeland Stewardship Department and this course. Contact her for in-depth assistance at: [jocelyn.boice@colostate.edu](mailto:jocelyn.boice@colostate.edu) / 970-491-3882.

### **Important Dates to Remember**

Extended Outline: Fri, Sept 28  
First Draft: Fri, Nov 2  
Peer-Reviews: Fri, Nov 9  
Final Report: Fri, Dec 7  
Final Presentation: Tue, Dec 4 & Thu, Dec 6

A complete schedule is available at the end of the syllabus.

### **Grading**

***There are no exams in this course.*** Grades will be based upon the completion of individual laboratory exercises (20% of the grade), successful completion of exercises associated with the development and completion of an independent research project involving the selection, processing, analysis, and interpretation of spatial data with spatial statistics (55% of the grade), presentations associated with your final project (15% of the grade), and presenting a paper and participating in discussion (10% of the grade). If you are using spatial data for your thesis project, you are encouraged to use those data. If you do not have access to appropriate datasets, the instructor will provide you with a dataset and will aid in the selection of an appropriate application/research question. Your goal is to complete the project and hand in a final report, in manuscript form (grading rubric is included below), by the end of the semester. You should strive to produce a final report that is worthy of peer review in a scientific journal of your choice. Taking an applied research project from the design and analysis stage through to a manuscript describing and disseminating the findings is a useful endeavor for all graduate students (and motivated undergraduate students) to undertake. ***Discuss project ideas with the instructor ASAP; a project must be clearly identified within the first three weeks of class.***

### **Basis for Final Grade**

<b>Assessment</b>	<b>Contribution</b>
Lab Exercises	40 Points (20%)
Paper Presentation	10 Points (5%)
Extended Outline	10 Points (5%)
First Draft	20 Points (10%)
Peer Reviews	10 Points (5%)
Final Report	70 Points (35%)
Final Presentation	30 Points (15%)
Participation in Discussions	10 Points (5%)

Letter grade assignment will be based on: A: 200-180, B: 179-160, C: 159-140, D: 139-120, F: < 120 points.

### **Expectations**

It is important that you attend all lectures and labs and be on time for both. Each lecture and lab will build on knowledge and skills presented in previous sessions. If you fall behind it is very difficult to catch up due to the extensive technical vocabulary and the software skills needed to perform the analyses in the lab exercises as well as your independent project.

Math and statistical skills are a prerequisite for this class. You need to be able to do algebraic calculations as easily as you can add and subtract, as well as calculate a mean, standard deviation, variance and correlation and be able to interpret the output.

You will also need to be (or become) familiar with the R statistics package. We will spend a short amount of lab time learning the basics of R; however, we will quickly transition into more advanced R techniques. If you are unfamiliar with the package I can recommended useful tutorials the will teach you the basics.

### **Discussion Paper Presentations**

Spatial Statistics can be applied to support a huge diversity of interesting problems and questions in the ecological, geological, and social sciences, among others. To help characterize the diversity of these applications each of you will present a scientific paper that uses Spatial Statistics in support of an applied science question. We will have roughly 7-

10 paper discussions throughout the semester (see schedule). The presentations should be approximately 15 minutes long with additional time slotted for discussion. Your presentation should outline the paper for why the study was conducted, how the study was conducted, and the outcomes of the study, along with this you should be sure to try and address anything that might be confusing within the article. You will each work independently to select an appropriate paper (I will help if you like) and provide it to the class so each of us can read it prior to the discussion.

### **Final Report Guidelines**

The final reports will be graded for content, writing, and logical flow. Guidelines to help you with formatting your manuscript are described below:

*Abstract (4 points):* A **concise** overview of the entire research project. This should include a description of the general problem or research question, a **brief** overview of the specific methods you employed, key results, and a **brief** description of your conclusions. **Less than 300 words.**

*Introduction (8 points):* Begins with a **brief** problem statement, transitioning into a brief description of what research has already been done, and closes with a brief description of your objectives and or hypotheses. The purpose of the introduction is get the reader excited about your work (why is this research important and how is it going to save the world?). **4-6 paragraphs.**

*Methods (10 points):* The purpose of the methods section is to provide the geeky, technical details of you project. This includes **brief** descriptions (separated out by subheadings) of the study area, field data, and remote sensing data collection protocols, as well as a description and explanation of the statistical analysis methods you employed. **2-4 paragraphs.**

*Results (12 points):* A **very brief** description of your results. Do not explain or justify the results here. This is simply a statement of what the statistics and analyses reports. If hypotheses were stated, did you find evidence to support them? **2-4 paragraphs.**

*Discussion (16 points):* An **in-depth** explanation and interpretation of your results. What do your results mean in the context of the problem statement? Did you find what you expected? Why or Why not? How do your results compare with previous published work (look at the literature and cite other studies)? Point out any limitations of your approach and suggest how future research could improve upon what you did. **4-8 paragraphs.**

*Conclusions (10 points):* A **brief** reiteration of what you did, your overall objectives, your hypotheses, and what you found. Be sure to describe the overall significance of your research to the scientific and/or management communities. What is the take home message? **2-3 paragraphs.**

*Technical Writing (10 points):* Use of scientific literature to support writing. All maps, graphics, and tables are neat and necessary to understand the study. Proper grammar and punctuation is used to assist the reader in understanding the study and its outcomes.

### **Course Policies**

#### **Late Work Policy**

All late assignments will receive a **20% deduction** in credit for one week, after which the late assignment will not be accepted for credit. Students must notify the instructors at least 1 week before missing an assignment, report, quiz, or exam, or they will not be allowed to make it up.

#### **Professionalism Policy**

Per university policy and classroom etiquette; mobile phones and electronic devices **must be silenced** during all classroom and lab sessions. Those not heeding this rule will be asked to leave the classroom/lab immediately so as to not disrupt the learning environment. Please arrive on time for all class meetings. Students who habitually disturb the class by talking, arriving late, *etc.*, and have been warned may suffer a reduction in their final class grade. When emailing the instructor or TA, please do so in a professional manner by including a salutation, complete sentences, and your full name, CSU ID, and the course number in your email.

#### **Academic Integrity**

The Department of Forest and Rangeland Stewardship takes academic integrity seriously. At minimum, academic integrity means that no one will use another's work as their own. The CSU writing center defines plagiarism this way:

Plagiarism is the unauthorized or unacknowledged use of another person's academic or scholarly work. Done on purpose, it is cheating. Done accidentally, it is no less serious. Regardless of how it occurs, plagiarism is a theft of intellectual property and a violation of an ironclad rule demanding "credit be given where credit is due."

Source: (Writing Guides: Understanding Plagiarism. <http://writing.colostate.edu/guides/guide.cfm?guideid=17>)

If you plagiarize in your work you could lose credit for the plagiarized work, fail the assignment, or fail the course. Each instance of plagiarism, classroom cheating, and other types of academic dishonesty will be addressed according to the principles published in the CSU General Catalog (under "Academic Integrity/Misconduct:

<http://catalog.colostate.edu/general-catalog/policies/students-responsibilities/> .)

Of course, academic integrity means more than just avoiding plagiarism. It also involves doing your own reading and studying. It includes regular class attendance, careful consideration of all class materials, and engagement with the class and your fellow students. Academic integrity lies at the core of our common goal: to create an intellectually honest and rigorous community. Because academic integrity, and the personal and social integrity of which academic integrity is an integral part, is so central to our mission as students, teachers, scholars, and citizens, we will ask to you sign the CSU Honor Pledge as part of completing all of our major assignments. While you will not be required to sign the honor pledge, we will ask each of you to write and sign the following statement on your papers and exams:

"I have not given, received, or used any unauthorized assistance."

### **Grades of "Incomplete"**

Per university policy, an instructor may assign temporary grade of Incomplete to a student who demonstrates that he or she could not complete the requirements of the course due to circumstances beyond the student's control and not reasonably foreseeable. A student must be passing a course at the time that an Incomplete is requested unless the instructor determines that there are extenuating circumstances to assign an Incomplete to a student who is not passing the course. When an instructor assigns an Incomplete, he or she shall specify in writing using the Department Incomplete Grade Form the requirements the student shall fulfill to complete the course as well as the reasons for granting an Incomplete when the student is not passing the course. The instructor shall retain a copy of this statement in his or her grade records and provide copies to the student and the department head or his or her designee. (Section I.6 of the Academic Faculty and Administrative Professional Manual)

### **Disability Access**

Colorado State University is committed to providing reasonable accommodations for all persons with disabilities. Students with disabilities who need accommodations must first contact Resources for Disabled Students before requesting accommodations from the professor. Resources for Disabled Students (RDS; <http://rds.colostate.edu/home>) is located in room 100 of the General Services Building. Their phone is (970) 491-6385 (V/TDD). Students who need accommodations in this course must contact the professor at the beginning of the semester to discuss needed accommodations.

### **Attendance Policy**

Students must inform the instructors prior to any anticipated absence and take the initiative to make up missed work in a timely fashion. In the event of a conflict in regard to this policy, individuals may appeal using established University procedures. University-sanctioned activities include competitions, events and professional meetings in which students are officially representing the institution. Appropriate sanctioned activities include:

- a. Intercollegiate athletics;
- b. Collegiate club sports and competitions;
- c. Conferences and workshops recognized by the University not related to academics;
- d. Commitments on behalf of the University (ASCSU, band, etc.); and
- e. Professional activities recognized by the University related to academics.

Department heads or their designated representatives must approve sanctioned professional and departmental activities. Other sanctioned activities must be approved by the appropriate program director on record with the Division of Student Affairs offices or the Department of Athletics.

### **Religious Accommodation**

Participation in official University activities, e.g., an out-of-town athletic event, or special religious observances may provide a legitimate reason for an excused absence. The student is responsible for discussing this with the instructor at the beginning of the semester.

### **Title IX Information**

CSU's Student Sexual Harassment and Violence policy, following national guidance from the Office of Civil Rights, requires that faculty follow CSU policy as a "mandatory reporter" of any personal disclosure of sexual harassment, abuse, and/or violence related experiences or incidents shared with the faculty member in person, via email, and/or in classroom papers or homework exercises. These disclosures include but are not limited to reports of personal relational abuse, relational/domestic violence, and stalking. While faculty are often able to help students locate appropriate channels of assistance on campus (e.g., see the CSU Health Network link below), disclosure by the student to the faculty member requires that the faculty member inform appropriate CSU channels to help ensure that the student's safety and welfare is being addressed, even if the student requests that the disclosure not be shared.

For counseling support and assistance, please see the CSU Health Network, which includes a variety of counseling services that can be accessed at: <http://www.health.colostate.edu/>. And, the Sexual Assault Victim Assistance Team is a confidential resource for students that does not have a reporting requirement and that can be of great help to students who have experienced sexual assault. The web address is <http://www.wgac.colostate.edu/need-help-support>.

Source: <http://oeo.colostate.edu/title-ix-sexual-assault>

### **Non-Discrimination Statement**

Colorado State University does not discriminate on the basis of race, age, creed, color, religion, national origin or ancestry, sex, gender, disability, veteran status, genetic information, sexual orientation, gender identity or expression, or pregnancy. The University complies with the Civil Rights Act of 1964, as amended, related Executive Orders 11246 and 11375, Title IX of the Education Amendments Act of 1972, Sections 503 and 504 of the Rehabilitation Act of 1973, Section 402 of the Vietnam Era Veterans' Readjustment Assistance Act of 1974, as amended, the Age Discrimination in Employment Act of 1967, as amended, The Pregnancy Discrimination Act of 1978, Americans with Disabilities Act of 1990, the Civil Rights Act of 1991, the ADA Amendments Act of 2008, the Genetic Information Nondiscrimination Act of 2008, and all civil rights laws of the State of Colorado. Accordingly, equal opportunity of employment and admission shall be extended to all persons. The University shall promote equal opportunity and treatment in employment through a positive and continuing affirmative action program for ethnic minorities, women, persons with disabilities, and veterans. The Office of Equal Opportunity is located in 101 Student Services. Source: <http://oeo.colostate.edu/non-discrimination-statement>

## Course Schedule

*All dates are tentative depending on the pace of the class.*

	Lecture Topics	Readings	Labs
<b>Week 1</b> (Aug 20-24)	Overview of Spatial Statistics Introduction to the R Environment	Fortin et al. Isaaks handout	Lab Exercise 1
<b>Week 2</b> (Aug 27-31)	Basics of spatial statistics I – Issues in spatial data analysis Basics of spatial statistics II - Types of spatial data and their analysis First- and second-order effects	ISDA Chapter 1	Lab Exercise 2 R for spatial data analysis (ASDAR Chapters 1-6)
<b>Week 3</b> (Sept 3-7)	No Class meeting on the 3 <sup>rd</sup> – Work with R tutorials		Work with R tutorials (ASDAR Chapters 1-6)
<b>Week 4</b> (Sept 10-14)	No Class or Lab		
<b>Week 5</b> (Sept 17-21)	Analysis of point patterns I – Complete spatial randomness, Quadrat analysis Kernel estimation	ISDA Chapter 3	Lab Exercise 3
<b>Week 6</b> (Sept 24-28)	Analysis of point patterns II - Nearest neighbor distance K-function	ISDA Chapters 3 & 4 Paper presentation	Lab Exercise 4 Extended Outline of Project – With potential citations – Due Sept 28
<b>Week 7</b> (Oct 1-5)	No Class or Lab		
<b>Week 8</b> (Oct 8-12)	Analysis of point patterns III – Marked point patterns	ISDA Chapter 4 Paper presentation	Lab Exercise 5
<b>Week 9</b> (Oct 15-19)	Analysis of spatially continuous data I - Moving average, Voronoi tessellation, Covariogram, and variogram	ISDA Chapter 5 Paper presentation	Introduction to geostatistical analysis in R – the gstat package
<b>Week 10</b> (Oct 22-26)	Analysis of spatially continuous data II - Kriging (spatial interpolation)	ISDA Chapter 5 & 6 Paper presentation	Geostatistical analysis in R – the gstat package
<b>Week 11</b> (Oct 29-Nov 2)	Analysis of areal data I - Scales of spatial pattern analysis, Proximity measures, and Spatial autocorrelation	ISDA Chapter 7 Paper presentation	Draft of Project – Due Nov 2
<b>Week 12</b> (Nov 5-9)	Analysis of areal data II - Moran’s I statistic, Geary’s c statistic Analysis of areal data III - Anselin’s LISA	ISDA Chapter 7 & 8 Paper presentation	Peer-Review of Project – Due Nov 9
<b>Week 13</b> (Nov 12-16)	Analysis of areal data IV - Getis and Ord’s G statistics and Bayesian estimation	ISDA Chapter 8 Paper presentation	
(Nov 19-23)	Thanksgiving Break		
<b>Week 14</b> (Nov 26-31)	Spatial regression - Simultaneous autoregressive model Geographically weighted regression	Paper presentation	
<b>Week 15</b> (Dec 3-7)	Presentations of final projects		Final Report – Due Dec 7

*All assignments are due at the start of class unless otherwise stated on Canvas.*