

GEOG 531

Quantitative Methods in Geographic Research

Fall 2025

MW 3:55 – 5:10 PM

Callcott Social Science Center 302

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Student Support Hours: **M/W 2-3 pm** & by appointment

Academic Bulletin Description

Quantitative Methods in Geographic Research

Course Description

What is the distribution of a different phenomenon (such as disease cases, air pollution, political beliefs etc.) across space (and time)? Why does a particular spatial pattern exist, and what underlying spatial or ecological processes may be driving those patterns? How do we design a study or analysis that incorporates spatial thinking? Answering these questions needs to make use of quantitative methods (or statistical analysis) with geographic data. This course is for advanced undergraduates or graduate students in Geography and related disciplines who want to gain necessary spatial statistical analysis knowledge and skills for geographic research.

This course will deal with the nature of geographical data sets, and statistical measures and models commonly used by geographers to describe spatial variations and patterns, distributions, and relationships among geographical data. Each student will be given opportunities to apply these techniques to geographical datasets and questions (from a wide variety of domains spanning environmental, social, and health sciences) through hands-on lab exercises, homework assignments, and a student-driven final project. Additionally, students will also gain general insights on how to execute a sound quantitative research idea, including basics of study design, sampling, and scientific writing and communication, and gain experience with a popular coding language used in quantitative research.

Prerequisites

There are no prerequisites for this course. The course IS NOT about how to solve equations or learning how to code. However, any previous experience with GIS, or R (or another programming language) will be helpful. Knowledge of basic algebra will also be helpful for concepts in the second half of the course. As such, the course is designed to get you “up to speed” on these concepts through additional resources, tutorials, and labs.

Learning Outcomes

By the end of this course, students will be able to:

1. **Explain** core concepts in spatial thinking, spatial data structures, and the statistical foundations of geographic analysis.
2. **Apply** descriptive and inferential statistical techniques to explore spatial variations, distributions, and relationships in geographic data.
3. **Interpret** spatial patterns and **evaluate** possible underlying processes using spatial statistical models.
4. **Use** a statistical programming language (e.g., R) and GIS software to go through multiple steps of a quantitative geographic research project from data cleaning to statistical modeling.
5. **Communicate** spatial statistical results effectively through visualizations and written explanations.
6. **Integrate** spatial analysis into interdisciplinary research questions from environmental, social, and health sciences, among others.
7. **Produce** a final research product that synthesizes course concepts into an original, data-driven geographic analysis.

Course Materials

There are no required textbooks for this course. We will be using several openly available sources and reading materials that will be placed on blackboard.

All course will materials comply with copyright/fair use policies.

Technology Requirements

Lecture presentations, links to articles, assignments, and other course materials will be available on blackboard. To participate in learning activities and complete assignments, you will need access to a working computer, reliable Internet access and a USC email account, a current Internet browser, a word processing program, and reliable data storage for your work. Students will heavily use the R programming language and RStudio for this course, primarily through a cloud-based version called [Posit](#). Detailed instructions will be provided, and all software will also be available on computers in the class lab.

Course Policies and Procedures

Attendance Policy

Students are responsible for all material covered in class, including assignments, even if absent. To be respectful of your fellow classmates, please be ready for class at the scheduled time. Per University Policy, frequent absences and lateness will be penalized by the instructor. Students with more than **four unexcused** absences will have their final course letter grade dropped by one full grade (a “B” becomes a “C”, etc.). If you have an [excused absence](#) (<https://academicbulletins.sc.edu/undergraduate/policies-regulations/undergraduate-academic-regulations>), you should, at the first opportunity, notify me through a written request (email is acceptable) stating:

- The date(s) of absence
- The reason for absence. In some cases, documentation may be required. For additional information, please consult the [USC attendance policy](#).

Regardless of whether you have an excused or unexcused absence, you will be expected to complete a makeup assignment in either case. Makeup assignments and their instructions will be provided by the instructor.

In Class Smartphone and Computer Use Policy

Unless instructed, your electronic devices, other than your laptop should be placed on silent and should be put away in your pocket or bag. Lecture slides will be available on the course website before the class for you to print and take notes with a pen if you would like. If there is a serious need to leave your phone on vibrate (such as a family emergency), please let me know. If you happen to leave the class to accept a phone call, then I will have advance knowledge of the potential emergency.

Late Work Policy

All assignments will be posted on the course website with detailed instructions including the due dates. All assignments must be submitted electronically prior to the due date/time. Unless you have an [excused absence](#) or have a previous agreement with me, late submissions will be penalized 10% for each day overdue.

Academic Integrity

From *Academic Responsibility – The Honor Code* (STAF 6.25): “It is the responsibility of every student at the University of South Carolina to adhere steadfastly to truthfulness and to avoid dishonesty in connection with any academic program. A student who violates, or assists another in violating the Honor Code, will be subject to university sanctions.” Students who engage in this type of behavior will receive, at a minimum, a “0” (zero) for the work in question and risk failure for the course. Other sanctions may also be pursued.

Plagiarism

Using the words or ideas of another as if they were one’s own is a serious form of academic dishonesty. If another person’s complete sentence, syntax, key words, or the specific or unique ideas and information are used, one must give that person credit through proper citation.

Generative Artificial Intelligence (AI) Policy

Generative AI tools such as ChatGPT, Gemini, Claude etc. should not be used in the completion of course assignments unless the instructor specifically authorizes their use. You will be informed as to when and how these tools may be used, along with guidance for attribution if/as needed. Any use of generative AI tools outside of these parameters constitutes plagiarism and will be treated as such.

Class Conduct

Professionalism will be expected at all times. Because the university classroom is a place designed for the free exchange of ideas, we must show respect for one another in all circumstances. We will show respect for one another by exhibiting patience and courtesy in our exchanges. Appropriate language and restraint from verbal attacks upon those whose perspectives differ from your own is a minimum requirement. Courtesy and kindness are the norm for those who participate in my class.

Course Assignments and Grading

General Assignment Information

- All coursework (e.g., assignments, projects) and rubrics will be available on blackboard.
- All assignments will be due, and all exams administered on the day indicated on the course schedule.
- All checkpoint assessments and exercises will be posted and submitted on blackboard.
- All in-class labs will be administered in class.

Evaluation

Final grades in this course will be assigned based on the performance on attendance and participation, lab exercises, homework assignments and your final project.

1) Attendance and Participation (100 points)

Class meetings will include lecture, discussion, and applied activities that require active engagement and participation. Participation scores will be evaluated via contributions made to class discussions and attendance in class.

2) Lab Exercises (100 points)

Class meetings every week will also consist of various active In-class Lab exercises. During class meetings, the instructor will conduct a tutorial that highlights the week's core concepts in 'action'. Building on those tutorials, students will complete an in-class lab exercise for submission at the end of class.

4) Homework Assignments (600 points, 200 each)

Students will be asked to complete 3 structured homework assignments throughout different points of the semester. The purpose of these assignments is to help you apply techniques and

concepts learned in class to major contemporary real world data sets. These are individual assignments and will be assessed based on completion and a grading rubric that will be distributed by the instructor.

5) Final Project Report/Paper (200 points)

Undergraduate Students ONLY: Undergraduate students are required to submit a short Final Project Report. The final project is an opportunity for students to apply concepts learned in class to a dataset or research problem of their choice. The instructor will provide detailed requirements and rubrics for project reports. In addition, students will also have the opportunity to develop their ideas throughout the semester. Please discuss this with the instructor early in the semester about your topic for the final project.

Graduate Students ONLY: Graduate students are required to submit a Final Project Paper. In contrast to a short report, graduate students will submit a paper in a journal-style format of their choice. You will get feedback from the instructor and your classmates to improve your papers for the final submission. The instructor will provide detailed requirements and rubrics for the paper. In addition, students will also have the opportunity to develop their ideas throughout the semester. Please discuss this with the instructor early in the semester about your topic for the final project paper.

Grading Scale

All graded assignments will be returned to you on Blackboard. You are strongly encouraged to check your grades regularly. A final letter grade will be assigned based on percentages.

Assignment Weights	Points
Attendance	100
Lab Participation	100
Homework Assignments	600
Final Project Report/Paper	200
Total	1000

Grading Scale

900 - 1000 = A

850 - 899 = B+

800 - 849 = B

750 - 799 = C+

700 - 749 = C

650 - 699 = D+

600 - 649 = D

0 - 599 = F

Course Schedule

The instructor reserves the right to make changes to this schedule; students will be informed in advance where practical.

Day	Date	Topic	Activities
W	20-Aug	<ul style="list-style-type: none">• Class Introduction	<ul style="list-style-type: none">• Introduction to R, Rstudio and Posit Cloud
M	25-Aug	<ul style="list-style-type: none">• Geographic Data: Characteristics and concepts• Descriptive spatial statistics	<ul style="list-style-type: none">• Introduction to Tidyverse• Importing and reading spatial data in R
W	27-Aug		
M 1-Sep Labor Day (No Classes)			
W	3-Sep	<ul style="list-style-type: none">• Basics of probability• Discrete and continuous probability distributions	<ul style="list-style-type: none">• Reproducibility and Replicability• Literate Programming using Quarto
M	8-Sep	<ul style="list-style-type: none">• Introduction to sampling and sampling methods• Confidence intervals• Types of study designs	<ul style="list-style-type: none">• HW 1: Descriptive Problem solving in Geography
W	10-Sep		
M	15-Sep	<ul style="list-style-type: none">• Exploratory spatial data analysis• Basics of Data visualization	<ul style="list-style-type: none">• Visualizing Geographic Data
W	17-Sep		
M	22-Sep	<ul style="list-style-type: none">• Hypothesis testing• Correlation• Measuring univariate and bivariate associations	<ul style="list-style-type: none">• Visualizing Multivariate relationships
W	24-Sep		

Day	Date	Topic	Activities
M	29-Sep	<ul style="list-style-type: none">Point pattern analysisArea pattern analysis	<ul style="list-style-type: none">HW2: Exploratory Spatial Data Analysis
W	1-Oct		
M	6-Oct	<ul style="list-style-type: none">Causation vs Correlation	<ul style="list-style-type: none">Introduction to Directed Acyclic Graphs
W	8-Oct	<ul style="list-style-type: none">Introduction to regression	
M	13-Oct	<ul style="list-style-type: none">Ordinary Least squares regression	<ul style="list-style-type: none">Regression modeling and diagnostics
W	15-Oct		
M	20-Oct	<ul style="list-style-type: none">Generalized Linear Regression	<ul style="list-style-type: none">Interpreting and visualizing regression results
W	22-Oct	<ul style="list-style-type: none">Hierarchical regression modeling	
M	27-Oct	<ul style="list-style-type: none">Spatial and Temporal regression	<ul style="list-style-type: none">Examining spatial and temporal dependency in data
W	29-Oct		
M	3-Nov	<ul style="list-style-type: none">Geographically (and temporally) Weighted Regression	<ul style="list-style-type: none">HW3: Inferential Statistics
W	5-Nov		
M	10-Nov	<ul style="list-style-type: none">Dimensionality reduction in Spatial Data	<ul style="list-style-type: none">Communicating quantitative results and findings
W	12-Nov	<ul style="list-style-type: none">Unsupervised Clustering AnalysisSupervised Clustering Analysis	
M	17-Nov	<ul style="list-style-type: none">Guest Lectures – Spatial analysis in action	<ul style="list-style-type: none">Final Project practice
W	19-Nov		
MW 24-26 Nov Thanksgiving Break (No Classes)			
M	01-Dec		

Day	Date	Topic	Activities
W	03-Dec	<ul style="list-style-type: none"> Prediction and Forecasting Course wrap-up 	<ul style="list-style-type: none"> Final Project practice
M	8-Dec	Final Project Paper Due by 4:00 pm	

Academic Success

Your instructor is committed to helping you achieve the best in this course. Below is a list of valuable support resources available at USC. Please reach out to me for assistance in accessing any of these support services.

Disability Services

The [Student Disability Resource Center](http://www.sa.sc.edu/sds/) (SDRC) (<http://www.sa.sc.edu/sds/>) empowers students to manage challenges and limitations imposed by disabilities. In order to receive reasonable accommodations from me, you must be registered with the Student Disability Resource Center (1705 College Street, Close-Hipp Suite 102, Columbia, SC 29208, 803-777-6142). Any student with a documented disability should contact the SDRC to make arrangements for appropriate accommodations. Once registered, students with disabilities are encouraged to contact me (within the first week of the semester) to discuss the logistics of any accommodations needed to fulfill course requirements.

Student Success Center

In partnership with USC faculty, the [Student Success Center](https://sc.edu/about/offices_and_divisions/student_success_center/index.php) (SSC) (https://sc.edu/about/offices_and_divisions/student_success_center/index.php) offers a number of programs to help you better understand your course material and to support your path to success. SSC programs are facilitated by professional staff, graduate students, and trained undergraduate peer leaders who have previously excelled in their courses. Resources available to you in this course may include:

- **Peer Tutoring:** You can make a one-on-one appointment with a [Peer Tutor](http://www.sc.edu/success) (www.sc.edu/success). Drop-in Tutoring and Online Tutoring may also be available for this course. Visit their website for a full schedule of times, locations, and courses.
- **Supplemental Instruction (SI):** SI Leaders are assigned to specific sections of courses and hold three weekly study sessions. Sessions focus on the most difficult content being covered in class. The SI Session schedule is posted through the SSC website each week and will also be communicated in class by the SI Leader.
- **Peer Writing:** Improve your college-level writing skills by bringing writing assignments from any of your classes to a Peer Writing Tutor. Similar to Tutoring, you can visit the website to make an appointment, and to view the full schedule of available drop-in hours and locations.
- **Success Consultations:** In Success Consultations, SSC staff assist you in developing study skills, setting goals, and connecting to a variety of campus resources. Throughout the semester, I may communicate with the Student Success Center regarding your progress,

which indicates your instructor is concerned about your progress in this course. If contacted by the Student Success Center, please schedule a Success Consultation right away. Referrals are not punitive, and any information shared by your professor is confidential and subject to FERPA privacy laws. Student Success Center services are offered to all USC undergraduates at no additional cost. Please call 803-777-1000, visit www.sc.edu/success, or come to the Student Success Center in the Thomas Cooper Library (Mezzanine Level) to check schedules and make appointments.

Writing Center

This course has many writing assignments. The University [Writing Center](http://artsandsciences.sc.edu/write/university-writing-center) (<http://artsandsciences.sc.edu/write/university-writing-center>) is an important resource you should use! It's open to help any USC student needing assistance with a writing project at any stage of development. The main Writing Center is in Byrnes 703.

University Library Resources

[University Libraries Resources](http://sc.edu/libraries) (sc.edu/libraries)

- University Libraries has access to books, articles, subject specific resources, citation help, and more. If you are not sure where to start, assistance is available at [Ask a Librarian!](https://sc.edu/libraries/ask) (<https://sc.edu/libraries/ask>).
- Remember that if you use anything that is not your own writing or media (quotes from books, articles, interviews, websites, movies – everything) you must cite the source in MLA (or other appropriate and approved) format.

Counseling Services

The University offers [Counseling and crisis services](https://sc.edu/about/offices_and_divisions/student_health_services/medical-services/counseling-and-psychiatry/index.php) (https://sc.edu/about/offices_and_divisions/student_health_services/medical-services/counseling-and-psychiatry/index.php) as well as outreach services, self-help, and frequently asked questions.

Mental Health

If stress is impacting you or getting in the way of your ability to do your schoolwork, maintain relationships, eat, sleep, or enjoy yourself, then please reach out to any of USC's mental health resources. Most of these services are offered at no cost as they are covered by the Student Health Services tuition fee. For all available mental health resources, check out [Student Health Services Mental Health](https://www.sc.edu/about/offices_and_divisions/health_services/mental-health/index.php) (https://www.sc.edu/about/offices_and_divisions/health_services/mental-health/index.php) and the quick reference list below.

- Wellness Coaching can help you improve in areas related to emotional and physical well-being (e.g., sleep, resiliency, balanced eating and more) – schedule an appointment at (803) 777-6518 or on [MyHealthSpace](https://myhealthspace.ushs.sc.edu/login_dualauthentication.aspx) (https://myhealthspace.ushs.sc.edu/login_dualauthentication.aspx)

- Access virtual self-help modules via [Therapy Assistance Online \(TAO\)](https://us.taoconnect.org/register) (<https://us.taoconnect.org/register>) – see [TAO registration instructions](https://www.sc.edu/about/offices_and_divisions/health_services/medical-services/counseling-and-psychiatry/online-support/index.php) (https://www.sc.edu/about/offices_and_divisions/health_services/medical-services/counseling-and-psychiatry/online-support/index.php).
- Access additional articles and videos on health and wellness topics on the Wellness Hub, [thriveatcarolina.com](https://www.thriveatcarolina.com), or by downloading the [CampusWell](https://www.campuswell.com/) (<https://www.campuswell.com/>) app and searching for University of South Carolina.
- Counseling & Psychiatry offers individual and group counseling and psychiatric services – schedule an appointment at (803) 777-5223 or on [MyHealthSpace](https://myhealthspace.ushs.sc.edu/login_dualauthentication.aspx) (https://myhealthspace.ushs.sc.edu/login_dualauthentication.aspx).
- Access the 24-hr Mental Health Support Line at (833) 664-2854.
- Access an anonymous [mental health screening program](https://www.uscscreening.org/welcome.cfm?access=website) (<https://www.uscscreening.org/welcome.cfm?access=website>).

Interpersonal Violence

Interpersonal violence - including sexual harassment, relationship violence, sexual assault, and stalking - is prohibited at USC. Faculty, staff, and administrators encourage anyone experiencing interpersonal violence to speak with someone, so they can get the necessary support and USC can respond appropriately. If you or someone you know has been or is currently impacted by interpersonal violence, you can find the appropriate resources at the [Sexual Assault and Violence Intervention & Prevention](https://sc.edu/safety/interpersonal-violence/index.php) (SAVIP) (<https://sc.edu/safety/interpersonal-violence/index.php>) website.

As faculty, I must report all incidents of interpersonal violence and sexual misconduct, and thus cannot guarantee confidentiality. Please know that you can seek [confidential resources](https://sc.edu/safety/interpersonal-violence/index.php) (<https://sc.edu/safety/interpersonal-violence/index.php>). If you want to make a formal report, you can [report here](https://cm.maxient.com/reportingform.php?UnivofSouthCarolina&layout_id=25) (https://cm.maxient.com/reportingform.php?UnivofSouthCarolina&layout_id=25) or contact the institution's Title IX Coordinator, or one of the Deputy Title IX Coordinators listed on the SAVIP website. You can also file a police report by contacting USC Police at 803-777-4215.

Diversity and Inclusion

The university is committed to a campus environment that is inclusive, safe, and respectful for all persons, and one that fully embraces the Carolinian Creed. To that end, all course activities will be conducted in an atmosphere of friendly participation and interaction among colleagues, recognizing and appreciating the unique experiences, background, and point of view each student brings. You are expected at all times to apply the highest academic standards to this course and to treat others with dignity and respect.

Diversity, Ethics, and the Carolinian Creed

This course works to foster a climate free of harassment and discrimination, and it values the contributions of all forms of **diversity**. The decision to enter university and pursue advanced study is a choice that entails commitment to personal **ethics** expressed in the [Carolinian Creed](https://sc.edu/about/offices_and_divisions/student_affairs/our_initiatives/involvement_and_) (https://sc.edu/about/offices_and_divisions/student_affairs/our_initiatives/involvement_and_

eadership/carolinian_creed/index.php): “I will discourage bigotry, while striving to learn from differences in people, ideas and opinions.” Likewise, the [Student Code of Conduct](http://www.sc.edu/policies/ppm/staf626.pdf) (STAF 6.26: <http://www.sc.edu/policies/ppm/staf626.pdf>) stresses, “The University of South Carolina strives to maintain an educational community that fosters the development of students who are ethical, civil and responsible persons.”

Title IX and Gendered Pronouns

This course affirms equality and respect for all gendered identities and expressions. Please don’t hesitate to correct me regarding your preferred gender pronoun and/or name if different from what is indicated on the official class roster. Likewise, I am committed to nurturing an environment free from discrimination and harassment. Consistent with Title IX policy, please be aware that I as a responsible employee am obligated to report information that you provide to me about a situation involving discrimination, sexual harassment, or assault.