George Mason University

GGS 300: Quantitative Methods for Geographical Analysis

Fall Semester 2024 (August 26 – December 18)

Class meeting: None (Asynchronous)
Class location: canvas.gmu.edu
Section/Credits: DL1 / 3 credit hours
Instructor office: EXPL 2413 / Zoom

Instructor: Nathan Burtch
Email: nburtch@gmu.edu
Office hours: T 11 AM – 12 PM (in person)
WF 11 AM – 12 PM (Zoom)

General Information

Classmate contact information:

Name	Email	Phone

Catalog description: Comprehensive introduction to quantitative methods in spatial analysis, with emphasis on solving geographical research problems. Topics include nature of spatial data; collection of spatial data; preparation of spatial data for mapping, geographic information systems, and statistical analysis; descriptive spatial statistics; areal sampling theory and methods; probability theory and distributions; hypothesis testing; correlation and regression; and areal and point pattern spatial statistics.

Course overview: This course is an introduction to quantitative methods for geographic and geoinformation sciences. Geographers and other environmental and social scientists use quantitative methods, such as statistics, to measure, describe, and make estimates about variables across the landscape for a variety of reasons, such as developing and testing hypotheses or to support decision making. Increasingly, large amounts of spatial data are being generated and used by all levels of government as well as by other private and public institutions. Thus, developing solid skills in statistical analysis should be a priority for any student in these fields.

The class covers the fundamentals of statistical analysis including data display, data description and summary, statistical inference and significance tests, analysis of variance, correlation, and regression. Concepts will be presented and developed through the use of real-world data sets that cover both the natural environment as well as the social environment.

This course consists of two closely related components: lectures and labs. In lectures, students will learn statistical theory and methods. In labs, students will apply these principles of statistics in 'hands-on' experience with real world datasets, using the software package R. Labs are instructor-led, allowing students to see how data is input, processed, and analyzed in order to answer statistical questions. Both lecture and lab will occur asynchronously in video recordings.

Online course: GGS 300 is presented as an asynchronous online course. "Asynchronous" means that there are no specific timed gatherings for this course (E.G.: we don't meet for lectures at specific times like in-classroom courses). Still, there will be specific due dates for graded work in the

course that you are expected to meet. It is incumbent upon each student to organize their time and work through materials in a timely and efficient manner.

The course has been designed in weekly segments (see the schedule at the end of the syllabus). Segments will be released in order in a prescribed manner. Students will not have access to the entirety of the course materials from the start; you will get the materials necessary for each week as the week approaches. This is done to ease logistical problems of students being at significantly different sections of the course. Please do not ask for advanced access to materials.

Target audience: This course is required for anyone majoring in geography and geoinformation science (both BS and BA GEOG degrees) and for the GIS minor. This course is appropriate for any student that wants to develop quantitative and technical skills, especially related to aspects of spatial data handling and analysis, such as those in GIS and remote sensing.

Applicable learning outcomes: Successful completion of this course will enable students to:

1. Articulate and refine a spatially-based question, problem, or challenge that is generally relevant and appropriate in scope
2. Choose an appropriate statistical methodology for scholarly inquiry
3. Understand characteristics and concepts of quantitative spatial data and statistical methods
4. Create basic graphic representations of data
5. Understand how hypothesis testing can be used to investigate meaningful questions
6. Understand basic concepts and skills in using R statistical coding and software

Mason Impact: This course has been designated as a Mason Impact course. The structure of this course utilizes the goals of the Mason Impact program as noted in the program's mission statement. The mission statement of Mason Impact, as noted at https://provost.gmu.edu/academics/undergraduate-education/mason-impact, states that:

> The Mason Impact program prepares students to tackle significant global questions and challenges by investigating meaningful questions, engaging multiple perspectives, and creating new knowledge.

Prerequisites: It is recommended that students have a minimum of 30 completed credits, generally including GGS 102 and 103.

Enrollment and repeat policy: GGS 300 follows the general Mason policy that an undergraduate course can be repeated for grade up to three times. Students that repeat the course must submit all newly completed work.

Course Materials

Required text:
Lembo, A.J. and J.C. McGrew. 2024. *An introduction to statistical problem solving in geography*. 4th ed. Waveland Press. ISBN 13: 978-1-4786-4946-5

The course textbook is available from various outlets in various forms. It is available through the bookstore or through your online provider of choice (Amazon, the publisher, etc.). The publisher website (https://waveland.com/browse.php?t=419&r=a%7C550) offers physical copies and an e-book through the VitalSource portal. The e-book version is the same as the hard copy, but there may be various short-term purchase options that are less expensive. In addition, there may be other readings posted on Canvas for you to complete.

Optional texts: *An Introduction to R,* available for free as a pdf from http://www.r-project.org/ in the Manuals section. The Books section also contains a multitude of links that may assist you. There are a number of introductory statistics web sites that are very good and may help you considerably in your understanding by providing a different perspective. Three that are recommended are:

Statistics at Square 1:
http://www.bmj.com/about-bmj/resources-readers/publications/statistics-square-one
Online Statistics Education: https://www.onlinestatbook.com/2/index.html
Simple R: Using R for Introductory Statistics
http://www.math.csi.cuny.edu/Statistics/R/simpleR/index.html

Further readings, if any, will be announced in class or by e-mail.

GGS computer lab and virtual computing: The lab in EXPL 2102 is open 24 hours for you to use. Registration in a GGS class should automatically grant you access. Please contact ggsit@gmu.edu to report issues.

Mason provides access to Mason Labs virtual computing through your web browser. In order to access it, you will need to install both a Mason VPN (https://its.gmu.edu/service/virtual-private-network-vpn/) and the Citrix Workspace app (https://www.citrix.com/products/receiver.html). After logging into the VPN, you can then access https://mymasonapps.gmu.edu/ using your Mason directory ID. Once inside, you will be able to access Mason Labs and have a virtual connection to a Mason lab computer with some specialized software. You can connect to the Microsoft One Drive cloud storage that each Mason student has or connect to local storage drives.

Software, hardware, and data: The main required software for this class is **R.** R is the open source, freeware version of Splus, one of the most powerful and versatile statistical packages, and is available for free download for use on PC, Mac, UNIX and Linux environments. If you have a laptop or home computer you can download R for free from here: http://www.r-project.org/.

This class will be using **'R-Studio'** as an interface to R. You should install R-Studio after installing R. R-Studio is available for Windows, Mac and Linux at http://www.rstudio.com/ide/download/desktop. Directions on installing the software will be given during the first week of the course.

You are encouraged to have viable storage for your data and assignments. This may be your local machine hard drive, a USB flash drive/portable hard drive, or cloud storage (like Microsoft One Drive). Think about backing up data periodically through the semester!

It is recommended that students have the technological bandwidth to stream data; students should have regular, reliable access to a computer with an updated operating system and a stable broadband

Internet connection (consistent 1.5 Mbps or higher download and upload speed; you can use https://www.speedtest.net/ to check the speed of your connection).

Online materials and email: This course will make extensive use of Canvas at Mason. Course materials such as assignments and tests will be available only in electronic version on Canvas. Students are expected to submit assignments online through Canvas. **Only Word document (.docx or .doc) or Adobe PDF (.pdf) file formats will be accepted,** unless otherwise noted in the assignment. Grades will be posted on Canvas as well. Make sure you are familiar and comfortable with the Canvas interface.

Students are required to have a Mason NetID and associated @gmu.edu email account, which will allow you access to Canvas and lab computers. Please use this university email account when contacting the professor regarding this class; as explained in the Administrative section below, the course professor will not respond to messages sent from a non-Mason email address. Students may also use Microsoft Teams to communicate with the professor, although students should not expect instant responses from these direct chats; in other words, Teams is not a 24/7 direct support line for the class.

Grading

Homework (35%): Labs will be associated with a homework assignment, which will be due generally on **Wednesday at 11:59 PM** of the following week. Please view the calendar at the end of the syllabus to see the schedule of assignments. These assignments are designed to apply the quantitative theories discussed in class in a hands-on environment. Work will typically be completed with R. All R code used will need to be included with the homework submission. There will be eleven (11) homework assignments overall.

Midterm exam (10% each, 20% total): There will be two midterm exams for this course. The midterms will be a mix of multiple choice, fill-in-the-blank, calculations, and short answer questions covering topics from lecture and readings. Midterm exams are not cumulative, but keep in mind that quantitative methods are essentially by definition cumulative. You will be given 60 minutes to complete each midterm exam.

Final exam (20%): The final will be roughly the same format as the midterms but will cover all material learned during the course. Though cumulative, the last topics of the course, not covered on prior midterms, will have priority. You will be given 120 minutes (2 hours) to complete the final exam.

Quizzes (10%): Most weeks will have a quiz. These quizzes will be hosted on the Canvas site and will consist of multiple-choice questions based upon the reading due that week and potentially practice problems involving calculations, theory, or coding practice from the prior week. There will be twelve (12) quizzes overall, with the lowest quiz score dropped. Quizzes should be completed by the end of the week (Sunday).

Lab viewing (5%): Most weeks will have an instructor-led lab included as a pre-recorded video on Canvas. Lab videos should be viewed by the end of the week (Sunday), but viewing earlier will allow more time to have familiarity with statistical concepts in R. Each lab video will have an embedded

single-question quiz; answering the quiz question will demonstrate that you viewed the lab video.

Activities (10%): Each week there will be an activity, with most of the activities including posting in the course discussion board. Activities are intended to broaden connections of quantitative methods/thinking to the real world and provide classmate interaction in this asynchronous course. Details for each activity will be posted weekly.

Grading scale:

Grade	***Percent Required***				***Assignment***	***Percentage of Total Grade***
A+	96 to 100	**C+**	76 to 79.9		Homework (11)	**35%**
A	93 to 95.9	**C**	73 to 75.9		Midterms (2)	**20%**
A-	90 to 92.9	**C-**	70 to 72.9		Final Exam	**20%**
B+	86 to 89.9	**D**	60 to 69.9		Quizzes (12)	**10%**
B	83 to 85.9	**F**	<60		Lab views (12)	**5%**
B-	80 to 82.9				Activities (14)	**10%**

Note on attendance: As an asynchronous course, attendance is not necessary. Please ensure that you check your email and monitor Canvas announcements; students are responsible for any announcement given by the instructor via electronic means. Students should compare the course schedule at the end of this syllabus with dates of religious observances or participation in University activities. Provide the professor with documentation during the first two weeks of the course; reasonable accommodation will be provided. In general, it is expected that if a student has one of these excused absences on a day in which an assignment is due that the student submits the assignment early.

Make-up and late assignment policies: Due dates are explicitly stated. All graded items that are turned in for assessment in this course (listed above) will be accepted past the ascribed due date until **December 13th**. Late penalties are assigned in a two-tiered system. Items turned in **within seven (7) days will result in a 10% deduction** for the item. Items **later than seven (7) days will result in a 25% deduction** for the item. This penalty begins 1 minute after the due date. Technical excuses ("computer system error", "didn't submit correctly on Canvas", etc.) will not be accepted as reasons for late work. You are expected to start the work early. **Never underestimate the time you will spend on the assignments.**

If you are ill or physically indisposed and cannot submit work on time, you must notify the instructor beforehand for you to have a chance to make up the work without late penalty. This policy may seem strict, but it is in your best interest to turn in everything on time to avoid falling irrecoverably behind. Please contact the instructor if you are struggling and you will receive aid as best as the instructor can provide.

Incomplete policy: Students may request an incomplete for this course if they (a) currently have a 75% grade based on submitted coursework and relative weighting; (b) have completed at least 50% of coursework materials; (c) cannot complete scheduled coursework for a cause beyond reasonable control; and (d) submit an Incomplete Grade Contract with the professor. In general, students have until the 9th week of the following full semester to complete their work (unless it is the student's final semester). All incomplete work will be assigned late penalties as outlined in this syllabus.

Administrative

Academic integrity: *The following statement is adapted from the Stearns Center for Teaching and Learning.* No grade is important enough to justify academic misconduct. The integrity of the University community is affected by the individual choices made by each of us. Mason has an Honor Code, which you can read fully at the Office for Academic Integrity (https://oai.gmu.edu/full-honor-code-document/). The Honor Code Pledge reads as follows:

> To promote a stronger sense of mutual responsibility, respect, trust, and fairness among all members of the George Mason University Community and with the desire for greater academic and personal achievement, we, the student members of the university community, have set for this Honor Code: Student Members of the George Mason University community pledge not to cheat, plagiarize, steal, or lie in matters related to academic work.

The Mason Honor Code defines cheating, plagiarism, stealing, and lying. It is expected that you understand these definitions. If you have any doubts about what constitutes cheating, plagiarism, stealing, or lying in the academic context, please see your professor. **Acts of academic dishonesty in this course may be penalized with failure of either the work in question or the entire course.**

While collaboration and group learning is encouraged in this course, each student **absolutely must** turn in their own work, from their own computer, and any discussion must be theirs alone, and not attributable to another person or group, *except where noted* (for example, quoting authors as a small portion of your scholarly work). This also applies to online sources; you cannot copy the words of anyone else for any graded part of this course. It is not enough to exchange a few synonyms within a sentence! You must write, summarize, and analyze with your own words and ideas. **Student use of Generative-AI models or tools must also conform to the Honor Code.**

Course materials and student privacy: All course materials posted to Canvas or other course sites are private; by federal law, any materials that identify specific students (via their name, voice, or image) **must not be shared** with anyone not enrolled in this class. Video recordings of class meetings that include audio or visual information from other students are private and must not be shared. Live video conference meetings (e.g. Collaborate or Zoom) that include audio or visual information from other students must be viewed privately and not shared with others in your household. Recordings will be stored on Canvas and will only be accessible to students taking this course during this semester. **Sharing of instructor-created materials** (lectures, notes, videos, assignments, exams, etc.) to others not currently enrolled in this specific section of this class, **including to public or private online "study" sites, is considered a violation of Mason's Honor Code.**

Student privacy is governed by the Family Educational Rights and Privacy Act (FERPA). In addition to the privacy concerns outlined above, FERPA dictates how communication between students and faculty can occur electronically. Students must use their Mason email accounts to discuss anything pertaining to their enrollment in this course. I will not answer questions from non-Mason email addresses pertaining to this class.

Disability statement: This course complies with Mason policies for students with disabilities. Students with disabilities are encouraged to register with Disability Services (DS). DS can be contacted by phone at (703) 993-2474, or in person at SUB I Suite 2500, or online by the link at the end of this section. Students who suspect that they have a disability, temporary or permanent, but do not have documentation are encouraged to contact DS for advice on how to obtain appropriate evaluation. A faculty contact sheet from DS authorizing your accommodation is needed before any accommodation can be made. The faculty contact sheet should be furnished to the professor preferably within the first two weeks of class or as soon as an accommodation is made. Please visit https://ds.gmu.edu/ for more information.

Diversity, non-discrimination, and anti-racism: This course, as a part of George Mason's community, promotes and upholds Mason's core values of diversity and inclusion. Members of this class should seek to maintain a learning environment of respect across identity, status, origin, and ability. Being inclusive and anti-racist is an active, conscious practice involving self-reflection.

Mason's non-discrimination policy can be read at https://universitypolicy.gmu.edu/policies/non-discrimination-policy/. Please utilize the office of Diversity, Equity, and Inclusion (DEI, https://diversity.gmu.edu/) for training, resources, and to submit incidence reports. The following is a short portion of the Mason Diversity Statement; visit https://stearnscenter.gmu.edu/knowledge-center/general-teaching-resources/mason-diversity-statement/ to read the full statement:

> George Mason University promotes a living and learning environment for outstanding growth and productivity among its students, faculty and staff. Through its curriculum, programs, policies, procedures, services and resources, Mason strives to maintain a quality environment for work, study and personal growth.
>
> An emphasis upon diversity and inclusion throughout the campus community is essential to achieve these goals. Diversity is broadly defined to include such characteristics as, but not limited to, race, ethnicity, gender, religion, age, disability, and sexual orientation. Diversity also entails different viewpoints, philosophies, and perspectives. Attention to these aspects of diversity will help promote a culture of inclusion and belonging, and an environment where diverse opinions, backgrounds and practices have the opportunity to be voiced, heard and respected.

Gender identity, pronoun use, and proper address: Students are welcome to share their chosen name and gender pronouns with the instructor and discuss how the instructor can best address you in class and via email. As well, students should be aware that they can use Mason-provided tools to update their chosen name and pronouns; these changes will appear in Canvas class sites among other places. See https://registrar.gmu.edu/updating-chosen-name-pronouns/ for more information. Your instructor uses *he/him/his* pronouns. When addressing your instructor in writing or verbally, please use "Dr. Burtch" or "Prof. Burtch." The surname 'Burtch' is pronounced the same as 'birch.'

Instructor availability: Please do not hesitate to contact your instructor if you have questions about course topics or assignments. Your instructor will do his best to answer all weekday emails within 24 hours, and weekend emails within 48 hours. Should you not receive a response within that time frame, you may send a gentle reminder via email. Do try to avoid last-minute emails, as your instructor may not have email accessible immediately before deadlines. It is generally a good practice to avoid sending an email at the first sign of trouble with an assignment; often you will find the

proper solution by giving yourself an hour or two to problem solve! Please make use of the office hours listed at the top of this document. Generally, issues can be clarified quickly in person or in a live online chat.

Sexual harassment, sexual misconduct, and interpersonal violence: *The following statement is adapted from the Stearns Center for Teaching and Learning.* George Mason is a place for faculty, staff, and students to learn, live, and work. As such, Mason is committed to providing all of us this place that we call campus that is free of discrimination, sexual harassment, sexual misconduct, and other acts of interpersonal violence. All members of this campus are encouraged to seek support in cases of discrimination, sexual harassment/misconduct, or interpersonal violence. University Policy 1202 provides information on the reporting process and resources available. Resources are also linked below.

Students should be aware of **faculty's duty of mandatory reporting**. As a faculty member, I am designated as a "Non-Confidential Employee," and must report all disclosures of sexual assault, sexual harassment, interpersonal violence, stalking, sexual exploitation, complicity, and retaliation to Mason's Title IX Coordinator per University Policy 1202 (linked above). If you wish to speak with someone confidentially, please contact one of Mason's confidential resources, such as the Student Support and Advocacy Center (SSAC) at (703) 993-3686 or Counseling and Psychological Services (CAPS) at (703) 993-2380. You may also seek assistance or support measures from Mason's Title IX Coordinator by calling (703) 993-8730 or via email at titleix@gmu.edu.

University-wide closures and class cancellations/delays: There may be times during the term in which George Mason University announces university-wide closures or delays. As an asynchronous online course, in general these cancellations should not delay our course. However, there may be times in which university-wide closures or delays will affect Canvas availability or the ability to submit coursework. In these situations, your professor will make an announcement via Canvas and/or email. Check the Mason website and our own Canvas site for updates. Other cancellations or delays to class will be announced via Canvas by your professor. In the event that this course is in some way interrupted, the course schedule, assignment deadlines, and other course alterations will be decided upon and announced via Canvas and email by the professor. You are expected to stay abreast of any changes.

GGS 300 Course Schedule

Dates	Lecture/Lab Topic	Coursework
Unit 1: Data, descriptive statistics, and probability		
Week 0 Aug 26 – Sep 1	Introduction to quantitative methods Lab 0: Installing R	**Read** Ch 1 **Quiz 1** **Activity 0**
Week 1 Sep 2 – Sep 8	Data basics and geographic data Lab 1: Basic R and plotting	**Read** Ch 2 **Quiz 2** **Activity 1**
Week 2 Sep 9 – Sep 15	Descriptive statistics Lab 2: Descriptive statistics	**Read** Ch 3 **Quiz 3** **Activity 2** **Homework 1**
Week 3 Sep 16 – Sep 22	Descriptive spatial statistics Lab 3: Descriptive spatial statistics	**Read** Ch 4 **Quiz 4** **Activity 3** **Homework 2**
Week 4 Sep 23 – Sep 29	Probability Lab 4: Probability	**Read** Ch 5, 6 **Quiz 5** **Activity 4** **Homework 3**
Unit 2: Sampling and inferential tests of difference		
Week 5 Sep 30 – Oct 6	Data sampling **Midterm 1**	**Read** Ch 7 **Activity 5** **Homework 4**
Week 6 Oct 7 – Oct 13	Estimation in sampling Lab 5: Sampling	**Read** Ch 8 **Quiz 6** **Activity 6**
Week 7 Oct 14 – Oct 20	Inferential statistics and hypothesis testing Lab 6: One sample tests	**Read** Ch 9 **Quiz 7** **Activity 7** **Homework 5**
Week 8 Oct 21 – Oct 27	Inferential statistics: Two sample tests Lab 7: Two sample tests	**Read** Ch 10 **Quiz 8** **Activity 8** **Homework 6**
Week 9 Oct 28 – Nov 3	Analysis of variance: Multiple sample tests Lab 8: Multiple sample tests	**Read** Ch 11, 19 **Quiz 9** **Activity 9** **Homework 7**
Unit 3: Inferential tests of relationships		
Week 10 Nov 4 – Nov 10	Categorical difference tests **Midterm 2**	**Read** Ch 12 **Activity 10** **Homework 8**
Week 11 Nov 11 – Nov 17	Inferential spatial statistics Lab 9: Inferential spatial statistics	**Read** Ch 13, 14, 15 **Quiz 10** **Activity 11**
Week 12 Nov 18 – Nov 24	Correlation Lab 10: Correlation & categorical difference	**Read** Ch 16 **Quiz 11** **Activity 12** **Homework 9**
Thanksgiving Nov 25 – Dec 1	*Thanksgiving Break – No class*	
Week 13 Dec 2 – Dec 8	Regression Lab 11: Regression	**Read** Ch 17, 18, 20 **Quiz 12** **Activity 13** **Homework 10**
Finals Week Dec 13	**Final exam** Due Friday, Dec. 13 by 11:59 PM	**Homework 11** - Due Wed 12-11

Note: The GGS 300 course schedule is tentative and is subject to revision by the instructor