George Mason University

GGS 300: Quantitative Methods for Geographical Analysis

Spring Semester 2022 (January 24 – May 18)

Hours: MW 10:30 – 11:20 AM (class);
Asynchronous material weekly
Location: EXPL 2310
Section/Credits: 002 / 3 credit hours
Teaching assistant: Colin Flynn

Instructor: Nathan Burtch
Email: nburtch@gmu.edu
Instructor office: EXPL 2413 / Zoom
Office hours: Tu 10AM – 12PM (via Zoom)
TA email: cflynn8@gmu.edu

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 quantitative 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.

Hybrid course: 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. Lectures are the live, in-person sessions of class on Monday and Wednesday, while labs will be asynchronous videos posted to Blackboard. See the end of the syllabus for a specific schedule. Labs will be structured as part of a 'flipped classroom,' in which students will be expected to watch recorded, instructor-led labs that teach R coding before class, allowing some of the in-person time to be devoted to examples and activities. This will allow the class to work together to practice and learn applying statistical methods to statistical questions.

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://uge.gmu.edu/mason-impact/, states that:

> Mason Impact prepares students to tackle significant global questions and challenges by investigating meaningful questions, engaging multiple perspectives, and creating new knowledge within the context of Undergraduate Research and Creative Activities, Civic Engagement, Entrepreneurship, and Global Activities.

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

Enrollment and repeat policy: This course follows the general Mason policy that an undergraduate course can be repeated for grade up to three times. Understand that each academic unit can have more restrictive limits on specific courses. Students that repeat the course must submit all newly completed work.

Course Materials

Required text:

McGrew, J.C. Jr., Lembo, A.J. Jr, and Monroe, C.B. (2014). *An introduction to statistical problem solving in geography*. 3rd ed. Waveland Press.
ISBN 13: 978-1-4786-1119-6

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) 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 Blackboard for you to complete.

Note: It is OK to use the 2nd edition, but there are a few differences in terms of chapter divisions/numbering and content. You can get this one if you'd like but keep in mind you will still be responsible for reading the correct chapters, knowing the content we cover in class, and answering reading quiz questions that are based upon the 3rd edition.

Required lab manual:
Burtch, N.R., and Finlayson, C. (2021). *Quantitative methods in geography: A lab manual*. Pressbooks. URL forthcoming.

The lab manual is an Open Educational Resource (OER), meaning it is freely available. The lab manual will provide examples and data for conducting statistical tests for the class in R.

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
Electronic Statistics Textbook:
http://www.statsoft.com/Textbook
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/. We will also use ArcGIS for some spatial statistical analysis.

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.

Many of the files we will use are very large! You are encouraged to have a USB flash drive or portable hard drive in order to store and access files. 16 GB of storage or more is preferable. You may also use the drive to install some of programs we use. Cloud storage is another option, either to keep all your files or to use as a common backup.

Online materials and email: This course will make extensive use of Blackboard at Mason. Asynchronous video labs will be posted to Blackboard, so ensure that you have an internet connection fast enough to stream video. Course materials such as assignments will be available only in electronic version on Blackboard. Also, students will be expected to submit assignments online through Blackboard. **Only Word document (.docx or .doc) or Adobe PDF (.pdf) file formats will be accepted,** with some exceptions. Grades will be posted on Blackboard as well. Make sure you are familiar and comfortable with the Blackboard interface.

Students are required to have a MasonLive/Email account, which will allow you access to Blackboard and lab computers. Please use this university email account when contacting the professor regarding this class; your professor will not respond to messages sent from a non-Mason email address. Students may also contact the professor through Microsoft Teams, 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 (40%): Labs will be associated with a homework assignment, which will be due generally on **Thursday 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 and possibly ArcGIS. 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 50 minutes to complete each midterm exam.

Final exam (25%): 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 Blackboard site and will consist of multiple choice questions based upon the reading due that day and some practice problems involving calculations, theory, or coding practice from the prior week. There will be eleven (11) quizzes overall, with the lowest quiz score dropped. Quizzes should be completed prior to the start of the week.

Lab viewing (5%): Most weeks will have an instructor-led lab included as a pre-recorded video on Blackboard. Lab videos should be viewed prior to the start of the week in order for students to have familiarity with statistical concepts in R that will be demonstrated in class. Statistics on viewing the recordings on Blackboard will be used to assess this item. In other words, there will be nothing to turn in to receive credit.

Grading scale:

Grade	*Percent Required*				*Assignment*	*Percentage of Total Grade*
A+	96 to 100	**C+**	76 to 79.9		Homework (11)	**40%**
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	**25%**
B+	86 to 89.9	**D**	60 to 69.9		Quizzes (11)	**10%**
B	83 to 85.9	**F**	<60		Lab views	**5%**
B-	80 to 82.9					

Note on attendance: Regular attendance is an expectation. Those that make a habit of missing class tend to do worse in this course than those that do attend. It is in your best interest to come to class and participate as attendance will lead to a better understanding of course concepts. Students are responsible for any announcement given by the instructor during class regardless of their personal attendance.

Students that must miss classes because of religious observances or participation in University activities should provide documentation to the professor within the first two weeks of the course. Reasonable accommodations will be provided for work missed on those days. 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 assessed/graded items in this course (listed above) will be accepted past the ascribed due date until **May 17th**. Late penalties are assigned in a two-tiered system. Items turned in **within seven (7) days will result in a 25% deduction** for the item. Items **later that seven (7) days will result in a 50% deduction** for the item. This penalty begins 1 minute after the due date. Technical excuses ("computer system error", "didn't submit correctly on Blackboard", 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 cannot complete an assignment on time, it may be better to turn in partially completed work than nothing at all.

If you are ill or physically indisposed and cannot submit an item on time, you must notify the instructor beforehand for you to have a chance to make-up the item without late penalty. **Special dispensation is available for students with difficulties due to COVID-19 illness or quarantine**; please contact the instructor to make any special accommodations in this regard. **Make-up exams will be given only for University approved excused absences.** 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.

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/mason-honor-code/). 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.

Course materials and student privacy: All course materials posted to Blackboard 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. Some or all of our synchronous meetings in this class may be recorded to provide necessary information for students in this class. Recordings will be stored on Blackboard 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.**

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 memo from DS authorizing your accommodation is needed before any accommodation can be made. The memo 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: Mason President Gregory Washington has created the President's Task Force on Anti-Racism and Inclusive Excellence. Through a broad focus, the task force will help Mason become "a local, regional, and national beacon for the advancement of anti-racism, reconciliation, and healing." For President Washington's full statement, visit https://www2.gmu.edu/news/587381. Members of this classroom community must uphold Mason's core values of diversity and inclusion, and help 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 Compliance, Diversity, and Ethics (https://diversity.gmu.edu/) for training, resources, and to submit grievances. 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.
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> 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 Blackboard 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.

Safe return to campus: The COVID-19 pandemic has disrupted our lives. Administration at Mason has developed protocols outlined in the university Safe Return to Campus website (https://www2.gmu.edu/safe-return-campus). Students and faculty in face-to-face courses like this must follow these public health protocols, which include the **Mason COVID Health Check**. Students are expected to complete the COVID Health Check daily regardless of whether they will step foot on campus that day. The COVID Health Check uses a color code system; **only students with a "green" notification may come to class.** Those students with a "yellow" or "red" notification may not attend face-to-face class meetings. Faculty are allowed to ask you to show your "green" notification to be allowed in class.

Another component of Safe Return to Campus is wearing a facemask. **All Mason students, faculty, staff, and guests are required to wear a facemask in all indoor settings**, regardless of vaccination status. This means that while in class, students must wear an appropriate facemask that covers both the nose and mouth. Students can obtain a mask on campus at the HUB, Suite 2300.

Please familiarize yourself with other portions of the Safe Return to Campus protocols not mentioned above in order to be knowledgeable and safe on campus.

Sexual harassment, sexual misconduct, and interpersonal violence: *As a faculty member and designated "Responsible Employee," I am required to report all disclosures of sexual assault, interpersonal violence, and stalking to Mason's* Title IX Coordinator per university policy 1412. *If you wish to speak with someone confidentially, please contact the* Student Support and Advocacy Center *(703-380-1434),* Counseling and Psychological Services *(703-993-2380),* Student Health Services*, or* Mason's Title IX Coordinator *(703-993-8730; titleix@gmu.edu).*

University-wide closures and class cancellations/delays: There may be times during the semester in which George Mason University announces university-wide closures or delays. Should inclement weather or another emergency force Mason to close, causing our class to cancel meeting times, we will not meet. Check the Mason website and our own Blackboard site for updates. Other cancellations or delays to class will be announced via Blackboard by your professor. In the event that this course has missed meeting times, the course schedule, assignment deadlines, and other course alterations will be decided upon and announced via Blackboard and email by the professor. You are expected to stay abreast of any changes.

Use of electronic devices: Your professor encourages the use of devices that both aid your learning ability and do not distract from the learning of others. Except for mobile phones and audio/video recorders, you are free to use any electronic device that fulfills both of those conditions. All electronic devices should be muted or silenced. Please be respectful of the class and avoid use of social media during class which can distract both you and your classmates. You are expected to adhere to Mason's student code of conduct; disruptive behavior will result in classroom removal. Audio/video recording requires the consent of the professor.

GGS 300 Course Schedule

Week	Day	Lecture/Lab Topic	Coursework
Unit 1: Data, descriptive statistics, and probability			
Week 1	Mon 1-24 – Wed 1-26	Introduction to quantitative methods 1.1. Course overview 1.2. Statistics 1.3. Statistics in geoinformation science 1.4. Graphical data display	**Read** Chapter 1
	Async. Material	Lab: Installing R	
Week 2	Mon 1-31 – Wed 2-2	Data basics and geographic data 2.1. Dimensions of data 2.2. Levels of measurement 2.3. Characteristics of a data set	**Read** Chapter 2 **Reading Quiz 1**
	Async. Material	Lab 1: Basic R and plotting Homework 1 released	
Week 3	Mon 2-7 – Wed 2-9	Descriptive statistics 3.1. Concepts of descriptive statistics 3.2. Measures of central tendency 3.3. Measures of dispersion 3.4. Measures of shape	**Read** Chapter 3 **Reading Quiz 2** **Homework 1**
	Async. Material	Lab 2: Descriptive statistics Homework 2 released	
Week 4	Mon 2-14 – Wed 2-16	Descriptive spatial statistics 4.1. Concepts of descriptive spatial statistics 4.2. Spatial measures of central tendency 4.3. Spatial measures of dispersion	**Read** Chapter 4 **Reading Quiz 3** **Homework 2**
	Async. Material	Lab 3: Descriptive spatial statistics Homework 3 released	
Week 5	Mon 2-21 – Wed 2-23	Probability 5.1. Basic probability 5.2. Binomial distribution 5.3. Poisson distribution 5.4. Normal distribution 5.5. Probability mapping	**Read** Chapter 5, 6 **Reading Quiz 4** **Homework 3**
	Async. Material	Lab 4: Probability Homework 4 released	
Unit 2: Sampling and inferential tests of difference			
Week 6	Mon 2-28 – Wed 3-2	Data sampling 6.1. Sampling concepts 6.2. Sampling methods 6.3. Sampling design	**Read** Chapter 7 **Homework 4**
	Async. Material	**Midterm 1** - Due Wed 3-2	

Week	Day	Lecture/Lab Topic	Coursework
Week 7	Mon 3-7 – Wed 3-9	Estimation in sampling 7.1. Concepts in estimation 7.2. Central limit theorem 7.3. Confidence intervals 7.4. Sample size estimation	**Read** Chapter 8 **Reading Quiz 5**
	Async. Material	Lab 5: Sampling Homework 5 released	
Spring Recess	Mon 3-14 – Wed 3-16	*Spring Recess – No class*	
Week 8	Mon 3-21 – Wed 3-23	Inferential statistics and hypothesis testing 8.1. Hypothesis testing 8.2. One sample tests 8.3. Issues in inferential testing	**Read** Chapter 9 **Reading Quiz 6** **Homework 5**
	Async. Material	Lab 6: One sample tests Homework 6 released	
Week 9	Mon 3-28 – Wed 3-30	Inferential statistics: Two sample tests 9.1. Concepts of two sample tests 9.2. Two independent sample tests 9.3. Matched pair tests	**Read** Chapter 10 **Reading Quiz 7** **Homework 6**
	Async. Material	Lab 7: Two sample tests Homework 7 released	
Week 10	Mon 4-4 – Wed 4-6	Analysis of variance: Multiple sample tests 10.1. Concepts of three or more samples 10.2. Analysis of variance 10.3. Kruskal-Wallis	**Read** Chapter 11 **Reading Quiz 8** **Homework 7**
	Async. Material	Lab 8: Multiple sample tests Homework 8 released	
Unit 3: Inferential tests of relationships			
Week 11	Mon 4-11 – Wed 4-13	Categorical difference tests 11.1. Goodness-of-fit 11.2. Contingency analysis	**Read** Chapter 12 **Homework 8**
	Async. Material	**Midterm 2** - Due Wed 4-13	
Week 12	Mon 4-18 – Wed 4-20	Inferential spatial statistics 12.1. Concepts of inferential spatial statistics 12.2. Point pattern analysis 12.3. Area pattern analysis	**Read** Chapter 13, 14, 15 **Reading Quiz 9**
	Async. Material	Lab 9: Inferential spatial statistics Homework 9 released	
Week 13	Mon 4-25 – Wed 4-27	Correlation 13.1. The nature of correlation 13.2. Correlation tests	**Read** Chapter 16 **Reading Quiz 10** **Homework 9**
	Async. Material	Lab 10: Correlation and categorical difference Homework 10 released	

Week	Day	Lecture/Lab Topic	Coursework
Week 14	Mon 5-2 – Wed 5-4	Regression 14.1. Simple linear regression 14.2. Bivariate regression analysis 14.3. Residual analysis 14.4. Multivariate regression 14.5. Geographically weighted regression	**Read** Chapter 17, 18 **Reading Quiz 11** **Homework 10**
	Async. Material	Lab 11: Regression Homework 11 released	
Finals Week	Wed 5-11	**Final exam** 10:30 AM – 1:15 PM	**Homework 11** - Due Thu 5-12

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