George Mason University

# GGS 300: Quantitative Methods for Geographical Analysis

Spring Semester 2019 (Jan 22 – May 15)

**Hours:** TuTh 1:30 PM – 2:45 PM
**Location:** EXPL 2312
**Website:** https://mymason.gmu.edu
**Sect/Credits:** 001 / 3 credit hours

**Instructor**: Nathan Burtch
**Email:** nburtch@gmu.edu
**Instructor office:** EXPL 2413
**Office hours:** TuWe 3:00 – 4:45 PM

## General Information

**Classmate contact information:**

| Name | Email | Phone |
|---|---|---|
| | | |
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**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.

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. In general, lectures will occur on Tuesdays, while labs will be scheduled on Thursdays. See the schedule at the end of the syllabus for a specific schedule. Labs will be instructor-led, allowing the entire class to work together to practice and learn applying statistical methods to statistical questions. Occasionally the lab session will begin with overflow lecture materials from the previous session. Both lecture and lab will occur in the same classroom (EXPL 2312).

**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. Understand the characteristics of quantitative data
2. Understand important theoretical concepts in statistical methods
3. Analyze geographical data through the application of statistics
4. Use geostatistical methods to sample data
5. Create basic graphic representations of data
6. Understand hypothesis testing
7. Understand basic concepts and skills in using R statistical coding and software

**Scholarly Inquiry:** This course has been designated as a Scholarly Inquiry course. This intermediate level *Students as Scholars* course is designed so that students learn statistical techniques to describe and infer information about geographically-situated data. In learning quantitative approaches, students will discover approaches that can not only answer questions, but can be used to refine research questions in order to produce novel questions, ideas, and hypotheses. In particular, students will:

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. Identify relevant ethical issues and demonstrate attention to addressing ethical principles in scholarly inquiry
4. Communicate research-based knowledge through writing, presenting data analysis, and employing proper statistical techniques to geographic information

**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 text book 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 eBook through the VitalSource portal. The eBook 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 and knowing the content we cover in class.

**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.

**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 .

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. You can also make use of the GMU Virtual Computing Lab (https://www.vcl.gmu.edu/).

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. 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.

## Grading

**Homework/labs (40%):** Most weeks will have an instructor-led lab on Thursdays. Labs will be associated with a homework assignment, which will be due two weeks later before the Thursday class starts (1:30 PM). 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 ArcGIS. All R code used will need to be included with the homework submission. There will be ten (10) homework assignments overall.

**Midterm Exam (15% each, 30% total):** There will be two midterm exams for this course. The midterms will (most probably) 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 75 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.

**Quizzes (10%):** Most weeks before the Tuesday class begins, a quiz will be due. Generally quizzes will be available for one week prior to the due date. 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 ten (10) quizzes overall.

**Grading scale:**

| ***Grades*** | ***Percentage Required*** | ***Grades*** | ***Percentage Required*** | ***Assignment*** | ***Percentage of Total Grade*** |
|---|---|---|---|---|---|
| **A+** | 96 to 100 | **C+** | 76 to 79.9 | Homework (10) | **40%** |
| **A** | 93 to 95.9 | **C** | 73 to 75.9 | Midterms (2) | **30%** |
| **A-** | 90 to 92.9 | **C-** | 70 to 72.9 | Final Exam | **20%** |
| **B+** | 86 to 89.9 | **D** | 60 to 69.9 | Quizzes (10) | **10%** |
| **B** | 83 to 85.9 | **F** | <60 | | |
| **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 is to have one of these excused absences on a day in which an assignment is due that the student submit the assignment early.

**Make-up and late assignment policies:** Assignment due dates are explicitly stated. Assignments will be accepted up to 7 days after the due date. **Each day late for the assignment will result in a 10% deduction for the assignment.** In other words, an assignment handed in one day late can earn a maximum of 90%. 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.**

Quizzes are due before most Tuesday classes begin. You may answer the questions as early as you like (generally they will be available a week in advance), but they are not accepted after the Tuesday class begins. Should some extenuating circumstances arise, please discuss potential options with your professor.

If you are ill or physically indisposed and cannot submit your assignment on time, you must notify the instructor before class for you to have a chance to make up the assignment. 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. If you cannot complete the assignment on time, it can sometimes be better to turn in partially completed work than nothing at all.

## 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.

**Disability statement:** This course is in compliance 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.

**Mason diversity statement:** *From https://stearnscenter.gmu.edu/professional-development/mason-diversity-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.

**Mason policy on 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; cde@gmu.edu).

**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. With the exception of 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.

**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.

**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; many times you will find the proper solution by giving yourself an hour or two to problem solve!

Please also make use of the office hours listed at the top of this document. Generally, issues can be clarified quickly in person.

## GGS 300 Course Schedule

| Dates | | Lecture Topics | Reading | Due |
|---|---|---|---|---|
| Week 1 | Jan 22 | Introduction and data basics | | |
| | Jan 24 | Data basics and geographic data | Ch 1, 2 | |
| Week 2 | Jan 29 | Descriptive statistics | Ch 3 | Q 1 |
| | Jan 31 | Lab 1: Plotting and R basics | | |
| Week 3 | Feb 5 | Descriptive spatial statistics | Ch 4 | Q 2 |
| | Feb 7 | Lab 2: Descriptive statistics | | |
| Week 4 | Feb 12 | Probability | Ch 5, 6 | Q 3 |
| | Feb 14 | Lab 3: Probability | | HW 1 |
| Week 5 | Feb 19 | Data sampling and sampling design | Ch 7 | |
| | Feb 21 | **Midterm 1** | | HW 2 |
| Week 6 | Feb 26 | Estimation in sampling | Ch 8 | Q 4 |
| | Feb 28 | Lab 4: Sampling | | HW 3 |
| Week 7 | Mar 5 | Inferential statistics and hypothesis testing | Ch 9 | Q 5 |
| | Mar 7 | Lab 5: One sample tests | | |
| Week 8 | Mar 12 | *Spring Break – no class* | | |
| | Mar 14 | *Spring Break – no class* | | |
| Week 9 | Mar 19 | Inferential statistics: Two sample tests | Ch 10 | Q 6 |
| | Mar 21 | Lab 6: Two sample tests | | HW 4 |
| Week 10 | Mar 26 | Analysis of variance: Multiple sample tests | Ch 11 | Q 7 |
| | Mar 28 | Lab 7: ANOVA | | HW 5 |
| Week 11 | Apr 2 | Categorical difference tests | Ch 12 | |
| | Apr 4 | **Midterm 2** | | HW 6 |
| Week 12 | Apr 9 | Correlation | Ch 16 | Q 8 |
| | Apr 11 | Lab 8: Categorical difference and correlation | | HW 7 |
| Week 13 | Apr 16 | Inferential spatial statistics | Ch 13, 14, 15 | Q 9 |
| | Apr 18 | Lab 9: Inferential spatial statistics | | |
| Week 14 | Apr 23 | Regression | Ch 17 | Q 10 |
| | Apr 25 | Lab 10: Regression | | HW 8 |
| Week 15 | Apr 30 | Multivariate regression and GWR | Ch 18 | |
| | May 2 | Course review | | HW 9 |
| Week 16 | May 9 | *Finals week – no class* | | HW 10 |
| | May 14 | **Final Exam: Tuesday, May 14, 1:30 – 4:15 PM** | | |

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