# GGS 560: Quantitative Methods (online)
# Fall, 2022

Instructor: *David Wong, Professor*
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Virtual Office/Meeting Room: https://gmu.zoom.us/j/4701770761
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**Class time**: Virtual, but assume the class starts on ***Mondays*** of the week
Course delivery platform: Mason Blackboard (Bb) System https://mymasonportal.gmu.edu/
All course and learning activities are conducted on Bb

**Office Hours**: Thursdays, 3 - 4 pm (in person) or by appointments (virtual, request via email)

## Text Books:

- **Required**: Burt, James E., Gerald M. Barber, and David L. Rigby, 3 edition, 2009: *Elementary Statistics for Geographers,* Guilford Press, New York, New York. (ISBN-10: 1572304847, ISBN-13: 9781572304840).

- **Recommended**: Wong, D. W. S. and J. Lee, 2005: *Statistical Analysis of Geographic Information with ArcView GIS and ArcGIS*, Wiley, Hoboken, New Jersey. (ISBN-10: 0471468991; ISBN-13: 9780471468998)

**GMU Catalog Entry:**

**GGS 560 - Quantitative Methods (Credits: 3)**
Survey of quantitative methods commonly used in geographic research. Emphasizes spatial analysis techniques.

**Prerequisites:** Previous course work in statistics, GGS 310 or 550. [GGS 310 should be GGS 300.]

**Goals and Objectives:**

To introduce basic descriptive statistics, inferential statistics, and specially the statistical analysis of spatial data. Both understanding and the implementation of the corresponding analysis methods will be covered.

**Learning Outcomes:**

After successful completion of this course,

1. Students will understand basic spatial data analysis methods;
2. Students will be able to analyze given general data sets and to compute descriptive measures;
3. Students will be able to draw conclusions based on data and inferential statistics.

**Computing Requirements:** 1) refer to Bb about Technology Requirements. 2) No specific statistical package/tool will be required for assignments in this course. No programming is necessary. A hand calculator with standard algebraic functions (not statistical functions) may be useful. Microsoft Excel with Excel Analysis ToolPak will be heavily used for instruction purpose and assignments.

GIS (ArcMap/ArcPro) is also needed for some of assignments. However, it is open for students to choose other statistical tools. Please also note that the assignments will be distributed in .7z (zipped). If you need, you can check Mason ITS site at https://its.gmu.edu/service/software-listing-7-zip/ for installing it on your computer.

**Prerequisite Skills:** A good comprehension of algebra and basic trigonometry and familiar with Microsoft Excel and ArcGIS. Basic calculus is helpful but not required.

## Other references:


Devore, Jay L., 2004, "*Probability and Statistics for Engineering and the Sciences,"* 6th Ed. Brooks/Cole Publishing Co. (ISBN-10: 0006210171; ISBN-13: 978-0006210177).

Rogerson, Peter A., 2006, "Statistical Methods for Geography: A Student's Guide." January 2006, Sage Publications, London. (ISBN: 1412907950).

Jobson, J. D., 1991, "Applied Multivariate Data Analysis," Springer, New York. (ISBN-10: 0387976604; ISBN-13: 9780387976600).

Goodchild, Michael F., 1986, "Spatial Autocorrelation," Geo Books, Norwich. (ISBN-10: 0860942236; ISBN-13: 9780860942238).

de Smith, M., M. F. Goodchild, and P. Longley 2012. *Geospatial Analysis*. (http://www.spatialanalysisonline.com/).

Cliff, A.D. and J. K. Ord, 1973, "Spatial Autocorrelation," Pion, London. (ISBN-10: 0850860369; ISBN-13: 9780850860368).

Moran, P. A. P., 1950, "Notes on Continuous Stochastic Phenomena," *Biometrika*, Vol. 37, No. 1/2 (Jun., 1950), pp. 17-23.


## Grading Policy:

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|---|---|
| 13 Homework Assignments: | 80% |
| Comprehensive Exercise | 20% |
| Total | 100% (**Letter grades based on absolute/relative numbers)** |

- Late submissions will be penalized 5% for each day, and will not be graded after two weeks.
- Distribution of the total final scores at the end of the course will be used to determine the final grades using a "sliding scale" (curved) (letter grades will not be given to individual assignments).
- Students with the highest total scores will receive an A. Average (mean) scores will be assigned to A- or B+. Scores "significantly" lower than the rest of the class **may** be assigned to a failing grade.
- All materials submitted to meet the evaluation criteria should be completed in accordance with the student Honor Code (University Catalog).

**The followings are university wide required information from Office of the Provost:**

**UNIVERSITY POLICIES**

- **University Catalog:** The University Catalog, http://catalog.gmu.edu, is the central resource for university policies affecting student, faculty, and staff conduct in university academic affairs. Other policies are available at http://universitypolicy.gmu.edu/. All members of the university community are responsible for knowing and following established policies.

- **Sexual Harassment*:*** 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) or *Counseling and Psychological Services* (703-993-2380). You may also seek assistance from *Mason's Title IX Coordinator* (703-993-8730; *titleix@gmu.edu*).
- **Academic Integrity:** GMU is an Honor Code (http://oai.gmu.edu/mason-honor-code/) university. Please see the University Catalog for a full description of the code and the honor committee process. The principle of academic integrity is taken very seriously and violations are treated gravely. What does academic integrity mean in this course? Essentially this: when you are responsible for a task, you will perform that task. When you rely on someone else's work in an aspect of the performance of that task, you will give full credit in the proper, accepted form. Another aspect of academic integrity is the free play of ideas. Vigorous discussion and debate are encouraged in this course, with the firm expectation that all aspects of the class will be conducted with civility and respect for differing ideas, perspectives, and traditions. When in doubt (of any kind) please ask for guidance and clarification.
- **Mason Email Accounts:** Students must use their Mason email account to receive important University information, including communications related to this class. I will not respond to messages sent from or send messages to a non-Mason email address. See http://your-netid.gmu.edu for more information on Mason Email System.
- **Office of Disability Services:** If you are a student with a disability and you need academic accommodations, please see me and contact the Office of Disability Services (ODS) at 993-2474. All academic accommodations must be arranged through the ODS, http://ods.gmu.edu.
- **Diversity and Inclusion**: Mason, an intentionally inclusive community, promotes and maintains an equitable and just work and learning environment. We welcome and value individuals and their differences including race, economic status, gender expression and identity, sex, sexual orientation, ethnicity, national origin, first language, religion, age, and disability.

**OTHER USEFUL CAMPUS RESOURCES:**

- WRITING CENTER: A114 Robinson Hall; (703) 993-1200; http://writingcenter.gmu.edu
- UNIVERSITY LIBRARIES "Ask a Librarian." http://library.gmu.edu/ask
- Counseling and Psychological Services (CAPS): (703) 993-2380; http://caps.gmu.edu

**Tentative Course Schedule** (may be adjusted during the semester. Last modified on August 3, 2022):

Week 1: Introduction
- Syllabus
- Introduction to quantitative methods
- Math notations
- Reading Assignment: Chapter 1 (Burt if not stated); Appendix 3a

Week 2: Univariate Data Display and Description
- Distribution display (histograms)
- Central tendency
- Dispersion
- Higher order moments
- Reading Assignment: Sections 2.1, 2.2 (up to Page 62), 3.1-3.3

Week 3: Probability Theory
- Random variables
- Probabilities
- Distributions: uniform, and binominal
- Reading Assignment: Sections 5.1-5.3 (Page 228); Appendix 5a

Week 4: Probability Theory (Continued)
- Poisson distribution
- Normal distribution
- Sampling
- Reading Assignment: Sections 5.3 (Page 228)-5.4; Appendix 5b

Week 5: Basis for Inferential Statistics
- Central Limit Theorem
- Point estimations
- Interval estimations (Confidence Interval)
- Reading Assignment: Chapter 6 (mainly Section 6.5); Chapters 7
- Reading Assignment: Sections 8.1 to 8.3

Week 6: Hypothesis Testing
- Method and elements of hypothesis testing
- Specific tests: Mean test against a fixed value
- Reading Assignment: Chapters 8

Week 7: Hypothesis Testing (Continued)
- Specific tests: Two mean test and testing of variance
- Reading Assignment: Chapters 9

Week 8: Correlations Analysis
- For interval/ratio data
- For ordinal data
- For nominal data (dependence, chi-square test)
- Reading Assignment: Chapters 4 (4.1-4.3), Pages 486-487, Section 10.5

Week 9: Linear Regression
- Simple linear bivariate regression
- Reading Assignment: Section 4.4, 12.2-3, 13.1

Week 10: Linear Regression (Continued)
- Multiple linear regression
- Collinearity and diagnostics

Week 11: Spatial Data (Point) Description
- Spatial data
- Spatial central tendency
- Spatial dispersion
- MAUP
- Standard deviational ellipse
    - ArcGIS toolbox
    - Applications
- Reading Assignment: Sections 2.4, 3.5 (point data parts only); Appendix 3b and Wong & Lee: Sections 5.3.2

Week 12: Point Pattern Analysis
- Quadrat analysis (Kolmogorov-Smirnov test)
- Nearest neighbor statistics
- K-Function
- Reading Assignment: Section 14.1; Pages 141-142, 401-405; Wong & Lee: Sections 6.1-6.4

Week 13: Spatial Autocorrelation, Part I
- Measures for spatial autocorrelation
- Concept for spatial autocorrelation
- Spatial weights matrices
- Joint count statistics (for nominal data)
- Reading Assignment: Section 14.2; Wong & Lee: Sections 6.5, 8.1-8.6, 8.11

Week 14: Thanksgiving (short week)
Spatial Autocorrelation, Part II
- Moran's I
- G-statistic
- Local Indicators of Spatial Association (LISA)
    - Local Moran's I
    - Local G-statistic
- Reading Assignment: Section 14.2-3; Wong & Lee: Sections 8.7-8.10

Week 15: Comprehensive Exercise