GGS 560: Quantitative Methods

Instructor: Ruixin Yang
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Time & Place: fully online, asynchronous but assuming it is a Friday 4:30-7:10pm class for schedule purpose.

Office Hours: by appointment via email (Zoom Meeting: https://gmu.zoom.us/j/4655943637)

Text Books:

- **Required**: Burt, James E. , David L. Rigby, Gerald M. Barber, 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 or permission of instructor.

Goals and Objectives (Course Overview):

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, compute descriptive measures, and establish relationship between variables;
3. Students will be able to draw conclusions based on data and inferential statistics.

Course Web Site: Canvas, the University's enterprise learning management system at https://canvas.gmu.edu/ (or https://lms.gmu.edu/). You must use the system for accessing course materials/assignments and for the final project submission.

Computing Requirements: 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 (ArcGIS) 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 the 7-Zip software on your computer if you do not have a ZIP foftware.

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.
- Rogerson, Peter A., 2006, "Statistical Methods for Geography: A Student's Guide." 2006, Sage Publications, London.
- Jobson, J. D., 1991, "Applied Multivariate Data Analysis," Springer, New York.
- Goodchild, Michael F., 1986, "Spatial Autocorrelation," Geo Books, Norwich.
- 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.
- Moran, P. A. P., 1950, "Notes on Continuous Stochastic Phenomena," *Biometrika*, Vol. 37, No. 1/2 (Jun., 1950), pp. 17-23.

Grading Policy:

Homework Assignments:	65% (weekly up to HW13; another HW14 optional)
Project	35%
Total	100% (**Letter grades based on absolute and relative numbers)**

Notes on Assignments:

- If multiple files are involved, 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 the software on your computer.
- Assignments should be submitted only through the Assignment submission section of the LMS system - DO NOT email assignments directly to the instructor.
- It is expected that your submission will be in either PDF or Word format.
- Please make sure you have a backup of all the materials you submit.
- Please make sure to put your name with your assignment, and use your name or other identification information for your file names such as <yourLastName>_<firstName>_GGS560HW<#>.<xxx>.
- If more than one file is submitted, you should submit a single **ZIP** file (such as the .7z) containing all the assignment files. In that case, it is strongly suggested that you put all the files into a folder and name the folder with your identity.
- The grace time is the noon of the following day after the due day (Saturdays). Submission after the grace time may result in losing of points, 10% per day for the first two days. No grading for submission later more than 2 days.
- Different weights may be applied to assignments in the final points calculation (unlikely).
- Rubrics for assignments and the final projects will be provided separately.

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.

- **Generative-AI (GenAI) Tools:** Use of GenAI tools will sometimes be in alignment with the learning outcomes for this course. It is expected that the GenAI for this course is very limited. If used, one should follow the fundamental principles of the Academic Standards. This includes being honest about the use of these tools for submitted work and including citations when using the work of others, whether individual people or Generative-AI tools. When meeting the outcome requires original human action, creativity or knowledge, AI tool use would not align with the stated course goals.
- **Campus Closure or Emergency Class Cancellation/Adjustment Policy**: If the campus closes, or if the class meeting needs to be canceled or adjusted due to weather, students should check the university announcement. If the class meeting needs to be canceled or adjusted due to other reasons, an announcement should be sent out via Canvas for updates on how to continue learning and for information about any changes to events or assignments.
- **Mason Email Accounts:** Students must use their MasonLive 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 about the course following the university policy. See http://masonlive.gmu.edu for more information on Mason Email System.
- **Communication Policy**: The preferred individual communication mechanism with me is email. However, for this course, I will check the CANVAS on daily basis and try to respond on posted questions (the "Ask the Instructor" thread in the Discussion Board). For email communications, I will try to respond in one business day (24 hours or a little more) during weekdays and 1-2 days during weekends. Please include "GGS 560" in your subject line to start a new email.
- **Full Mason** Common Course Policies**.**

OTHER USEFUL CAMPUS RESOURCES:

- WRITING CENTER: Johnson Center, Room 227E;
  Phone: 703-993-1200; Email: wcenter@gmu.edu; 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
- UNIVERSITY CALENDAR: Details regarding the current Academic Calendar. Calendars | Office of the University Registrar | George Mason University (gmu.edu)

Tentative Course Schedule (will be adjusted during the semester. Last modified on August 24, 2025):
Please consider this as a list of course contents instead of schedule. All efforts will be made to cover as many topics below as possible.

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
- Project Topic due (9/12)
- 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
- Correlations (nominal, ordinal and interval/ratio)
- Simple linear bivariate regression
- Project outline due (10/24)
- Reading Assignment: Section 4.4, 12.2-3, 13.1

Week 10: Linear Regression (Continued); Spatial Data (Point) Description
- Multiple linear regression
- Spatial data
- Spatial central tendency

Week 11: Spatial Data (Point) Description (Continued); Point Pattern Analysis?
- 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
- Reading Assignment: Section 14.1; Pages 141-142, 401-405; Wong & Lee: Sections 6.1-6.4

Week 13: Point Pattern Analysis (Continued); Spatial Autocorrelation, Part I
- K-Function (continued from last lecture)
- 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: Spatial Autocorrelation, Part I (Continued) and 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: **Final Exam Week: (12/12)**
- Project due
- All late HW assignments for consideration due