GGS 560: Quantitative Methods

Instructor: Ruixin Yang
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Grayed out words are not applicable in the current semester.

Time & Place: Wednesday, 4:30 pm-7:10 pm, Exploratory Hall 2312 (fully online, asynchronous but assuming it is a Wednesday class for schedule purpose)

Office Hours: Thursdays, 2:30 pm-4:00 pm and/or by appointment (office phone: 703-993-3615; 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, GGS 310 or 550. Actually, 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, 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: Mason Blackboard System at mymason.gmu.edu. You must be familiar with 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 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:

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

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.
- **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** (from Mason Stearns Center for Teaching and Learning): Mason is an Honor Code university; please see the Office for Academic Integrity for a full description of the code and

the honor committee process. Three fundamental principles to follow at all times are that: (1) all work submitted be your own, as defined by the assignment; (2) when you use the work, the words, or the ideas of others, including fellow students or online sites, you give full credit through accurate citations; and (3) if you are uncertain about the ground rules on a particular assignment or exam, ask for clarification. No grade is important enough to justify academic misconduct.

- **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 Honor Code. 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.
- **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. See http://masonlive.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.
- **Name and Pronoun Use:** If you wish, please share your name and pronouns with me and how best to address you in class and via email. I use he/him/his for myself and you may address me as "Dr./Prof. Yang."

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

Tentative Course Schedule (will be adjusted during the semester. Last modified on August 25, 2023):
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 (9/6)
- 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 (10/18)
- 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: Spatial Autocorrelation, Part II (Continued) and Part III
- Bivariate spatial autocorrelation
- HW#11 due
- Miscellaneous Topics and Catching-up (May be skipped)
  - Regression with Spatial Data
  - Geographically Weighted Regression (GWR)
  - Linear Features
- Reading Assignment: Section 14.3; Wong & Lee: Sections 8.7.3, 8.8, 8.10

Week 16: **Final Exam Week: (Wednesday. 12/6)**
- Project due
- All late HW assignments for consideration due