Introduction to Quantitative Methods in Geography

GEOG 4023/5023 (Lecture)
Geog 4033/5033 (Lab)

Lecture: Tues/Thurs 12:30-1:45p, CLR 209
Lab: Tues 2-4:50p, KESDA

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Catalog Description: Introduces fundamental statistical and quantitative modeling techniques widely used in geography today. Emphasizes geographic examples and spatial problems, as statistical routines are now available on most computers.

My Description: Geography is a diverse discipline with a wide variety of subject matter including physical (environmental), human (socio-economic), and integrated (human-physical) topics of inquiry. Even within physical geography, biogeographers study different phenomena than hydrologists and climatologists. Therefore, it is not surprising to learn that there are a variety of advanced analytical methods that geographers can employ in their studies. This course serves as an introduction to some of the most commonly employed of these advanced analytical approaches. Because geography is so diverse, there are undoubtedly methods we will learn over the course of the semester that you will not need to use in your graduate research. There will also be subject matter we cover that is not specific to your area of study. But I guarantee that at some point you will encounter a research problem (or journal article, conference presentation, graduate student or colleague) that uses these methods and you will, at least, be able to talk about, understand and interpret the statistical results. I want you to be conversant in a wide range of statistical methods.

The course focuses multivariate methods widely used by geographers and other scientists, including multiple correlation and (spatial) regression, cluster detection, time series analysis, factor analysis and other terminology that can make you sound like you know what you're talking about (and hopefully you will when you're done here). By the end of the course, I want you to know how to select the appropriate statistical method to answer a research question, be comfortable using multiple software packages to analyze data and correctly interpret and write-up the results of your statistical analysis.

I don't believe in memorizing formulas or asking students to regurgitate those formulas. Therefore, this course emphasizes hands-on experience and practical understanding. You should leave this course with confidence in the methods we have discussed and an appreciation for how these statistical methods are applied to issues in geographic research. I will not emphasize the "black-box"

(mathematical equations) of each statistical approach as much as some other statistics courses do, rather I will emphasize conceptual understanding and how to implement statistical tests in *R* and interpret the output. I am more concerned that you can choose the correct statistical approach given your research question and data, correctly carry out statistical analysis in a software package and then tell me what the results mean. If you are really interested in the math, I can provide you with additional resources and readings.

Course Objectives:

1. To develop "statistical literacy," a working understanding of statistics that can help in critically evaluating data-driven results in your field of interest.
2. To obtain a rich set of statistical tools for data analysis, with an understanding of the how to choose which tool to use and how to implement them in statistical software.
3. To enable you to confidently and carefully interpret the results of data analyses and clearly communicate those results.
4. To receive practical experience in using real sets of data addressing meaningful research questions.
5. To explore how to design studies to collect appropriate data for addressing research questions.

Teaching Philosophy: I am here to organize the course and introduce you to the topics and readings we will examine. I don't have all the answers and I don't pretend to have all the answers, but I will share with you what I know. I will do my best to make the course interesting, relevant, and challenging. That being said, it's important that you understand that you have the most important role in making GEOG 5023 a success for you. You will determine how much you actually get out of this course. Doing the readings outlined, and coming to class and labs ready to think and participate in group discussions puts you in the best position to benefit from what this course offers. I encourage you to make full use of the learning opportunities that this class presents.

Prerequisites: Students enrolled in this course must have completed an introductory statistics course (e.g. GEOG 3023, APPM 4570, ECON 3818, PSYC 3101, SOCY 4061, EDUC 5716). This course satisfies the requirement for quantitative methods for MA and PhD students in Geography.

Readings: There are 2 required texts that will be supplemented with journal articles and book chapters that will be available from course website.

Required Texts:
Dalgaard, P. (2008). *Introductory Statistics with R*. 2nd edition. New York: Springer.
Bivand, R., E.J. Pebesma and V. Gomez-Rubio. *Applied Spatial Data Analysis with R*. New York: Springer.
Ward, M.D. and K.S. Gleditsch (2008). *Spatial Regression Models*. Thousand Oaks, CA: Sage.

Recommended Texts:
Bailey, T.C. and A.C. Gatrell (1995). *Interactive Spatial Data Analysis.* Essex, England: Prentice Hall.
Rogerson, P. (2006). *Statistical Methods for Geography*. 2nd Edition. London, SAGE Publications.

Labs: I will not be handing you a "script" for how to do a statistical analysis during the labs. I will provide you with a dataset and some programming advice and ask you to figure out how to use the software packages we learn to replicate published studies. The two R textbooks provide plenty of examples for how to program the specific analytical approaches we'll be using. Manuals for other software (GeoDa, GWR) will be available on the course website. You may work on your lab in groups. If you do please only write up one lab so I don't have to read the same assignment more than once.

Final Project: Another major part of this course is your project poster/presentation. You will need to hand in an abstract to me by the beginning of March (the 16th) and will spend the rest of the semester doing the analysis you propose and, eventually, preparing a poster. Your poster will be a summary of your project and it should be of conference quality. I will provide more details on the poster later in the course. The project presentation will be a brief 5-10 minute talk explaining your poster, similar to what you would do at a poster session at a conference. You will be graded primarily on how well you explain your methodology and results, and not on your speaking skills. Allow for a few minutes of questioning after your presentation.

Grading: Grades will be based on the following elements.

Participation	Attendance/discussion	5%
Labs	As outlined in class schedule	45%
Midterms	Take homes	10% (each)
Project	Abstract (due Mar. 16)	5%
	Poster (due Apr. 29)	15%
	Presentation (occurring during final exam)	10%

Late lab assignments up to 1 week late will be downgraded 20%, 100% thereafter. **Students must complete all lab assignments to receive a passing grade, even if they are submitted too late to receive any points**. No incompletes will be given for the course. No assignments may be submitted via email.

Although labs may be completed in groups, **exams must be entirely your own work**!

University Policies

Disabilities: If you qualify for accommodations because of a disability, please submit to me a letter from Disability Services within the **first two weeks** of the semester. Disability Services determines accommodations based on documented disabilities. Contact: http://www.colorado.edu/disabilityservices.

Class Behavior: Students and faculty each have responsibility for maintaining an appropriate learning environment. Those who fail to adhere to such behavioral standards may be subject to discipline. Professional courtesy and sensitivity are especially important with respect to individuals and topics dealing with differences of race, culture, religion, politics, sexual orientation, gender, gender variance, and nationalities. Further information is available at: http://www.colorado.edu/policies/classbehavior.html.

Discriminatory and Sexual Harassment: The University of Colorado at Boulder policy on Discrimination

and Harassment, the University of Colorado policy on Sexual Harassment and the University of Colorado policy on Amorous Relationships apply to all students, staff and faculty. Any student, staff or faculty member who believes s/he has been the subject of discrimination or harassment based upon race, color, national origin, sex, age, disability, religion, sexual orientation, or veteran status should contact the Office of Discrimination and Harassment (ODH) at 303-492-2127 or the Office of Judicial Affairs at 303-492-5550. Information about the ODH, the above referenced policies and the campus resources available to assist individuals regarding discrimination or harassment can be obtained at http://www.colorado.edu/odh.

Academic Integrity: All students of the University of Colorado at Boulder are responsible for knowing and adhering to the academic integrity policy of this institution. See the following site: http://www.colorado.edu/academics/honorcode/. "Our university community aspires to the highest standards of integrity and does not accept dishonesty or respect. We are committed to the fundamentalist values of honesty trust fairness, respect, and responsibility. These values enable us to promote teaching and learning, academic excellence, the pursuit of truth, free and open inquiry and discourse, responsible citizenship, and compassion. Each person at the University of Colorado at Boulder is responsible for upholding the honor code and helping to create an environment in which the integrity of the campus community is defined by mutual respect, self respect, and shared responsibility."

Religious Observances/Absences: Campus policy regarding religious observances requires that faculty make every effort to reasonably and fairly deal with all students who, because of religious obligations, have conflicts with scheduled exams, assignments or required attendance. Please come to me in advance if this is an issue, so we can work out alternative arrangements. See full details at: http://www.colorado.edu/policies/fac_relig.html.

Things You Should Already Know

The following are concepts covered in GEOG 3023 and in similar courses in other geography (sociology, ecology, psychology, statistics) departments. I'm expecting you to already be familiar with these concepts as a starting point for our discussion here. If you are not familiar with one or more of these, please let me know so I can point you to some resources to get you caught up.

Basic Statistical Concepts
- Uses of Statistics
- Measurement Scales: Nominal, Ordinal, Interval, Ratio
- Probability Distributions

Description
- Central Tendency
- Dispersion
- Skewness and Kurtosis

Samples and Sampling
- Sampling Methods
- Estimates from Samples
- Sample Size

Comparative Methods and Significance Testing
- Six steps of a formal statistical test
- K-S Test
- t-Test
- Chi-Square Test

Relationships
- Correlation

Trends
- Simple Linear Regression

GEOG 4023/5023 - Reading Schedule

Week	Date	Lecture	Programming	Reading	Programming Practice	Lab
1	Jan 12 Jan 14	Introduction Intro to R: Data Manipulation & Graphing	Dalgaard, Chpts. 1-4	Anselin, L. 1989. "What is Special About Spatial Data? Alternative Perspectives on Spatial Data Analysis." *NCGIA Tech Paper 89-4*.	Dalgaard: Exercises 1.1-1.5, 4.1-4.5	No Lab this week
2	Jan 19 Jan 21	Intro to R: Descriptive Statistics Intro to R: Inferential Statistics	Dalgaard, Chpts. 5, 6, 8		Dalgaard: 5.1, 5.2, 8.1-8.4	Lab 0: R
3	Jan 26 Jan 28	Intro to R: Correlation & Simple Regression	Dalgaard, Chpt. 7	Friel, S, M. Marmot, A.J. McMichael, T. Kjellstrom, D. Vågerö. 2008. Global health equity and climate stabilisation: a common agenda. The Lancet 372: 1677-82.	Daalgard: 6.1-6.4	Lab 1: Simple Statistics
4	Feb 2 Feb 4	Multiple Regression & Diagnostics	Dalgaard, Chpts. 11-12	Harrison, D. and D.L. Rubinfeld. 1978. "Hedonic Housing Prices and the Demand for Clean Air." *Journal of Environmental Economics and Management* 5:81-102.	Daalgard: 11.1, 11.3-11.5, 12.1, 12.4-12.9	
5	Feb 9 Feb 11	Logistic Regression	Dalgaard, Chpt. 13	Sherriff, R.L. and T.T. Veblen. 2007. "A Spatially-Explicit Reconstruction of Historical Fire Occurrence in the Ponderosa Pine Zone of the Colorado Front Range." *Ecosystems* 9:1342-1347.	Daalgard: 13.1,13.2, 13.4	Lab 2: Logistic Regression
6	Feb 16 Feb 18	**NO CLASS – Work on Exam #1** Spatial Autocorrelation	Bivand, Chpts. 1-4, 9	Ward & Gleditsch, Chpt. 1	Import a .shp of your own and map it in R! Replicate examples in Chpts. 4 & 9	Work on Exam #1
7	Feb 23 Feb 25	Spatial Autocorrelation Spatial Regression w/R	Bivand, Chpt. 10 GeoDa 0.9.3 User's Guide	Ward & Gleditsch, Chpt. 2-3 Voss, P.R., et al. 2006. "County child poverty rates in the US: a spatial regression approach." *Popul Res Policy Rev* 25: 369-91. Emch, M., et al. 2006. "Relationship between neighborhood-level killed oral cholera vaccine coverage and protective efficacy: evidence for herd immunity." *Intl of Epidemiology* 35: 1044-50.	Replicate examples in Chpt. 10	
8	Mar 2 Mar 4	Spatial Regression w/GeoDa Geographically Weighted	GWR3 Manual	Fotheringham, A.S., Brunsdon, C. and M. Charlton. "Geographically Weighted Regression" in		Lab 3: Spatial

		Regression		*Geographically Weighted Regression,* pp. 1-9, 28-64. Wang, Q., Ni, J. and J. Tenhunen. "Application of a geographically-weighted regression analysis to estimate net primary production of Chinese forest ecosystems." 2005. *Global Ecology and Biogeography* 14: 379-93. O'Loughlin, J. and F. Witmer. "*The Localized Geographies of Violence in the North Caucasus of Russia, 1999-2007."* Forthcoming. ***Annals of the AAG***.		Regression
9	Mar 9 Mar 11	Point Pattern Analysis	Bivand, Chpt. 7	B&G, Chpts. 3 & 4 Si, Y.L, et al. "Spatial and Temporal Patterns of Global H5N1 Outbreaks." 2008. *The International Archives of the Photogrammetry, Remote Sensing and Spatial Information Sciences*. XXXVII. Part B2. Si, Y.L, et al. "Spatio-temporal dynamics of global H5N1 outbreaks match bird migration patterns." 2009. *Geospatial Health* 4(1): 65-78.	Replicate examples in Chpt. 7	Lab 4: GWR
10	Mar 16 Mar 18	Point Pattern Analysis		Kulldorff, et al. "Evaluating Cluster Alarms: A Space-Time Scan Statistic and Brain Cancer in Los Alamos, New Mexico. 1998. *Am J Public Health* 88: 1377-1380.		Lab 5: Point Patterns **Abstract Due**
11	Mar 23 Mar 25	NO CLASS – Spring Break				
12	Mar 30 Apr 1	Time Series Analysis	Cowpertwait, Chpts. 1-2	Burt, J. and G. Barber. 1996. *Elementary Statistics for Geographers*, Chpt. 4 **Optional**: Chatfield, C. 1996. *The Analysis of Time Series: An Introduction*, Chpts. 1-2		Work on Exam #2 or project
13	Apr 6 Apr 8	Time Series Analysis	Cowpertwait, Chpts. 4-6	Burt, J. and G. Barber. 1996. *Elementary Statistics for Geographers*, Chpt. 15 **Optional**: Chatfield, C. 1996. *The Analysis of Time Series: An Introduction*, Chpts. 3-4		Work on project
14	Apr 13 Apr 15	NO CLASS - AAG Meeting				No Lab - AAG
15	Apr 20 Apr 22	Time Series Analysis		Pegg, M., et al. 2003. Hydrological alteration along the Missouri River Basin: A time series approach,		Lab 6: Time Series

				Aquat. Sci. 65: 63-72. Sharma, et al. 2009. Forecasts using Box–Jenkins models for the ambient air quality data of Delhi City, *Environ Monit Assess* 157:105–112		
16	Apr 27 Apr 29	PCA/Factor Analysis		An Introduction to Principal Components Analysis in R. Primer on the Global Warming Debate. PCA and the "Hockey Stick" Controversy. Meier, C.L. and W.D. Bowman. "Links between plant litter chemistry, species diversity, and below-ground ecosystem function." 2008. *PNAS* 105(50): 19780-19785.		Work on project **Poster Due**
	May 5 1:30pm	FINAL – Poster Presentations				