GR4070: GIS and Spatial Analysis of Social Data

Quantitative Methods in the Social Sciences (QMSS)
Columbia University, Fall 2017
Mondays, 6:10-8:00 pm

Instructor: Michael Parrott
Office: Int. Affairs 509f, Thursdays, 1 to 3 pm and by appt
E-mail: mp3675@columbia.edu (primary contact)
Class Room: 233 Seeley W. Mudd Building
TA: Geelon So, geelon.so@columbia.edu, by appt.

The goal of this course is to provide an overview of, and an introduction to statistical techniques used in, the analysis of spatial/geographic data in the social sciences. It covers introductory concepts and tools related to Geographic Information Systems (GIS); including spatial data acquisition, spatial data management, and spatial data analysis. The course will also introduce students to the process of developing and writing an original spatial research project. GIS has become an increasingly useful tool for observing and analyzing social and physical phenomena over space. Most of the physical and social sciences, as well as multiple professions, are expanding the infrastructure of GIS data that allows for new interdisciplinary analyses to occur and for unexamined potential spatial relationships to be uncovered. This is especially true for social scientific analyses, where a wealth of spatial data on cultural, economic, physical, and demographic characteristics remain unexamined…. but easily accessible from many sources.

Students will do a series of in-class labs and develop a final research project from the materials and methods covered in these labs. In addition, the course will require a set of homework assignments and two exams (midterm and final). Through homework assignments and lab exercises, we will obtain hands-on experience with the kinds of GIS and spatial statistical methods most frequently employed by social scientists. A major goal of this course is to provide a relatively non-threatening introduction to GIS and its relation to hypothesis testing using statistical software. Most importantly, the course will provide students a basic grasp of what spatial data analysis is all about.

No previous GIS or other spatial data analysis background is required, but course participants should have taken at least one previous course in statistics, and would benefit from having had a second semester of statistics emphasizing linear regression.

Requirements

There will be seven homework assignments, and we will expect written work (and output) to be handed in on Monday of the following week at the start of class. Homework assignments in the latter half of the course will center on completion of a small research project in the student's area of interest using geographically referenced data. You will learn by doing. In class labs will require the use of a laptop and the various software tools we use in the class. Please bring a laptop to each class. Given that the content of this course is cumulative, and given that the lectures expand upon and elaborate rather than repeat the readings, it is essential that you attend class and that you not fall behind.

We will base the grading on the homework assignments and two exams, a mid-term and a final. In order to receive a grade for the course, you must complete *all* of the assignments. There are no

incompletes given in this course. The homework assignments are worth 60% of your grade, and the two exams are worth 20% each.

Required Books
(Check eBook availability from Columbia University Library before buying)

Steven J. Steinberg and Sheila L. Steinberg. 2006. *GIS: Geographic Information Systems for the Social Sciences*. Thousand Oaks, CA: Sage Publications.

Fotheringham, A. Stewart, Chris Brunsdon and Martin Charlton. 2000. *Quantitative Geography: Perspectives on Spatial Data Analysis*. London, UK: Sage Publications

Mitchell, Andy. 1999. *The ESRI Guide to GIS Analysis, Volume 1: Geographic Patterns and Relationships*. Redlands, CA: ESRI Press.

Mitchell, Andy. 2005. *The ESRI Guide to GIS Analysis, Volume 2: Spatial Measurements and Statistics*. Redlands, CA: ESRI Press.

Lloyd, Christopher D. 2010. Spatial Data Analysis: An Introduction for GIS Users. Oxford, UK: Oxford University Press.

Howell, Frank M., Jeremy R. Porter and Stephen Matthews. 2016. *Recapturing Space: New Middle Range Theory in Spatial Demography*. Springer Publications
(Full Content Available as eBook from Columbia University Library).

Porter, Jeremy R. and Frank M. Howell. 2012. *Geographical Sociology*. Springer Publications.
(Full Content Available as eBook from Columbia University Library).

Recommended Books

Ormsby, Tim, Eileen Napoleon, Robert Burke, Carolyn Groessl, and Laura Bowden. 2010. *Getting to Know ArcGIS Desktop, Second Edition Updated for ArcGIS 10.* Redlands, CA: ESRI Press.

Allen, David W. 2010. *GIS Tutorial 2: Spatial Analysis Workbook, 2nd Edition.* Redlands, CA: ESRI Press.

Monmonier, Mark. 1993. *Mapping it Out: Expository Cartography for the Humanities and Social Sciences.* Chicago, IL: University of Chicago Press.

Related Articles (free download)

Anselin, Luc. 1989. "What is Special about Spatial Data? Alternative Perspectives on Spatial Data Analysis." Working Paper. Santa Barbara, CA: NCGIA.
http://www.irss.unc.edu/odum/content/pdf/anselin_1

Anselin, Luc. 1995. "Local Indicators of Spatial Association – LISA." *Geographical Analysis* 27: 2: 93-115.

Anselin, Luc. 2002. "Under the Hood: Issues in the Specification and Interpretation of Spatial Regression Models." *Agricultural Economics* 27: 3: 247-267.

Anselin, Luc and I. Syabri. 2006. "GeoDa: An Introduction to Spatial Data Analysis." *Geographical Analysis* 38: 1: 5-22.

Haining, Robert. 2009. "The Special Nature of Spatial Data." In Fotheringham and Rogerson, eds. *The Sage Handbook of Spatial Analysis*. London, UK: Sage Publications.

Wendy K. Tam Cho and James G. Gimpel. 2012. "Geographic Information Systems and the Spatial Dimensions of American Politics." *Annual Review of Political Science* 443-460.

Kristian Skrede Gleditsch and Nils B. Weidmann. 2012. "Richardson in the Information Age: Geographic Information Systems and Spatial Data in International Studies." *Annual Review of Political Science* 461-482.

Software Manuals and Tutorials (free download)

Levine, Ned. 2004. *Crimestat III: A Spatial Statistics Program for the Analysis of Crime Incident Locations.* Houston, TX: Ned Levine and Associates/Washington, DC: National Institute of Justice.

Anselin, Luc. 2003. *GeoDa 0.9 User's Guide*. Spatial Analysis Laboratory, Department of Agricultural and Consumer Economics. University of Illinois. Urbana, IL: University of Illinois. geodacenter.org/downloads/pdfs/geoda093.pdf

Anselin, Luc. 2003. *GeoDa 0.9.5-I Release Notes.* Spatial Analysis Laboratory, Department of Agricultural and Consumer Economics. University of Illinois. Urbana, IL: University of Illinois. **geoda**center.org/downloads/pdfs/**geoda**095i.pdf

Anselin, Luc. 2003. *An Introduction to EDA with GeoDa*. Spatial Analysis Laboratory, Department of Agricultural and Consumer Economics. University of Illinois. Urbana, IL: University of Illinois. http://geodacenter.asu.edu/system/files/quicktour.pdf.

Anselin, Luc. 2005. *Exploring Spatial Data with GeoDa: A Workbook*. Spatial Analysis Laboratory, Department of Agricultural and Consumer Economics. University of Illinois. Urbana, IL: University of Illinois. www.csiss.org/clearinghouse/**GeoDa**/**geoda**workbook.pdf

The following websites are useful for your future in using GIS and we will visit them at various times throughout the semester for reading and lab materials:

Center for Spatially Integrated Social Science (http://www.csiss.org)
GeoDa Center, Arizona State University (http://geodacenter.asu.edu)
Luc Anselin (http://geography.asu.edu/anselin)
Bradley P. Carlin (http://www.biostat.umn.edu/~brad)
Peter J. Diggle (http://www.lancs.ac.uk/staff/diggle)
Stewart Fotheringham (http://ncg.nuim.ie/ncg/people/staff/fotheringham/index.shtml)

Andrew Lawson (http://www.sph.sc.edu/alawson) Serge Rey (http://geography.asu.edu/rey)
Peter Rogerson (http://www.acsu.buffalo.edu/~rogerson/)
David M. Theobald (http://www.nrel.colostate.edu/~davet/)
GeoVISTA Center, Penn State University (http://www.geovista.psu.edu/index.jsp)
S4: Spatial Structures in the Social Sciences (http://www.s4.brown.edu)
ESRI website (http://www.esri.com) & ESRI Virtual Campus (http://training.esri.com)
Mapping & Crime Website: (http://www.ncjrs.gov/html/nij/mapping/index.html)
National Center for Geographic Information & Analysis (http://www.ncgia.ucsb.edu)
AI-Geostats: (http://www.ai-geostats.org)
Open Geospatial Consortium, Inc. (http://www.opengeospatial.org)
FedStats (http://www.fedstats.gov),
Mapstats (http://www.fedstats.gov/qf/);
and Data.gov U.S. National Atlas (http://nationalatlas.gov)
Census Bureau Geography Division (http://www.census.gov/geo/www/)
Jenness Enterprises: (http://www.jennessent.com/)

Calendar of Class Sessions and Labs

September 4; Labor Day. No class.

September 11; Week 1. Orientation to Spatial Thinking: What makes spatial data analysis different? The increasing significance of spatial thinking in social science research. Problems from public policy, business and marketing, community planning and development, sociology, health care, crime analysis, political science, ecology and other fields.

Week 1 lab exercise: Introduction to QGIS; Visualizing spatial data using QGIS; Understanding quantities and creating classes; Mapping density; symbols vs. shades

Reading Assignments	
Steinberg 2006.	Chapters 1-3
Anselin. 1989.	"What is Special about Spatial Data?"
Haining. 2009.	"The Special Nature of Spatial Data."
Mitchell. 1999.	*ESRI Guide Volume 1,* Chapters 1-4.

September 18; Week 2. Exploring Spatial Data I: Finding and downloading data; basic GIS concepts; location; xy coordinates; types of spatial data; geocoding; points; polygons; polylines; scale and aggregation; MAUP; Ecological Fallacy. Note: **HW 1 is Due**

Week 2 lab exercise: Using QGIS for data and file handling, manipulation of tables

Reading Assignments	
Steinberg 2006.	Chaps 4-6
Fotheringham. 2000.	*Quantitative Geography,* Chapters 1-3.
Mitchell. 1999.	*ESRI Guide Volume 1,* Chapters 4-7.
Lloyd. 2010.	*Spatial Data Analysis.* Chapters 1-2.

September 25; Week 3. Exploring Spatial Data II; More on data management and tables; Geoprocessing data; Change over time; Gauging distance and proximity using GIS; Buffering; Points in polygons. Note: **HW 2 is due.**

Week 3 lab exercise: Using GIS for computation and measurement; geocoding data points.

Reading Assignments	
Steinberg 2006.	Chaps 7-9
Mitchell. 1999.	*ESRI Guide Volume 1, Chapters 4-7.*
Fotheringham. 2000.	*Quantitative Geography,* Chapter 4.
Lloyd. 2010.	*Spatial Data Analysis.* Chapter 2.
Mitchell 2005.	*ESRI Guide Volume 2,* Chapters 1-2.

October 2; Week 4. Exploratory Spatial Data Analysis; Districts, Aggregation and Reaggregation; Spatial distribution; Clustering; various plots and mapping. Note: **No HW due this week.**

Week 4 lab exercise: Introduction to ESDA Using QGIS; Introduction to ESDA using GeoDA

Reading Assignments	
Mitchell. 2005.	*ESRI Guide Volume 2,* Chapters 3-4
Lloyd. 2010.	*Spatial Data Analysis.* Chapters 3-5
Anselin. 2003.	*GeoDa User's Guide/documentation*
Anselin and Syabri. 2006.	"GeoDa: An Introduction…."

October 9; Week 5. Point Patterns; CrimeStat; Random spatial distribution; K-function. Note: **HW 3 is due**

Week 5 lab exercise: Using CrimeStat for point pattern analysis; Spatial analysis in QGIS; Exam review

Reading Assignments	
Mitchell. 2005.	*ESRI Guide Volume 2,* Chapter 4
Fotheringham. 2000.	*Quantitative Geography.* Chapter 6.
Lloyd. 2010.	*Spatial Data Analysis.* Chapter 7
Levine. 2005.	*CrimeStat III manual*

October 16; Week 6. **Mid-Term exam handed out (Due by October 23rd)**

No lab session this week.

October 23; Week 7. Creating Interactive Maps, ESDA and Point Patterns in R

Week 7 lab exercise: Using R for various skills we have learned thus far; interactive mapping with Leaflet package

Reading Assignments	
R Overview	*https://cran.r-project.org/doc/contrib/Paradis-rdebuts_en.pdf*
R Leaflet Overview	*https://rstudio.github.io/leaflet/*

October 30; Week 8. Introduction to Spatial Autocorrelation; Weights matrixes; Theoretical implications of alternative weighting schemes; Spatial Autocorrelation statistics; Review of Regression; Correlation; Local forms of spatial data analysis. Note: **HW 4 is due**

Week 8 lab exercise: Computing weights matrixes in GeoDA and QGIS; Computing measures of spatial

autocorrelation; Local autocorrelation statistics (LISA)

Reading Assignments	
Mitchell. 2005.	*ESRI Guide Volume 2,* Chapter 5.
Fotheringham. 2000.	*Quantitative Geography.* Chapter 5.
Lloyd. 2010.	*Spatial Data Analysis.* Chapter 8.
Anselin. 1995.	"Local Indicators of Spatial Association."
Anselin. 2003.	*GeoDa User's Guide/documentation.*

November 6; University holiday, no class

November 13; Week 9. More on Regression and Spatial Autocorrelation: OLS Regression Diagnostics; Spatial Lag and Spatial Error Models. Note: **HW 5 is due**

Week 9 lab exercise: Using GeoDA for regression

Reading Assignments	
Fotheringham. 2000.	*Quantitative Geography.* Chapter 7.
Lloyd. 2010.	*Spatial Data Analysis.* Chapter 8.
Anselin. 2003.	*GeoDa User's Guide/documentation.*

November 20; Week 10. (Online class this week, Happy Thanksgiving!) Continuation of regression model estimation; Statistical inference; discussion and presentation of results; Deriving meaning from results, describing results, writing-up your work. Note: **No HW due this week**

Week 10 lab exercise: Using GeoDa to evaluate regression residuals; spatial heterogeneity and dependence; Visualizing regression output

Reading Assignments	
Fotheringham. 2000.	*Quantitative Geography.* Chapter 8.
Lloyd. 2010.	*Spatial Data Analysis.* Chapter 8.
Anselin. 2002.	"Under the Hood…"
Anselin. 2003.	*GeoDa User's Guide/documentation.*

November 27; Week 11. Geographically Weighted Regression; Spatial Interpolation. Note: **HW 6 is due**

Week 11 lab exercise: Using GIS for Geographically Weighted Regression; Exam Review

Reading Assignments	
Fotheringham. 2000.	*Quantitative Geography.* Chapters 5, 10
Lloyd. 2010.	*Spatial Data Analysis.* Chapter 9.

December 4; Week 12. Geographically Weighted Regression; Spatial Interpolation; Best practices in the Social Sciences for writing up your work. Note: **No HW due this week**

Week 12 open lab to assist with final HW

December 11; Last week of class. Note: **HW 7 is due** **Final exam handed out (Due by December 18th)**