



RPOS 619: SPATIAL ANALYSIS

Professor: Matthew Ingram
Office: Milne Hall 314-A
Dep: 518-442-3248
Ofc: 518-442-3940
Email: mingram@albany.edu

Location: HS 004
Time: Tue 5:45-9:25 PM
Office Hours: Tue 8-9:30
on main campus;
or by appointment

Course Description. Spatial analysis is essentially a method for examining phenomena of interest while explicitly accounting for the geographic interdependence of units of analysis. In greater depth, spatial analysis also leads to explicitly spatial theories of interactions among units, and spatial studies can be conceptual, theoretical, or empirical.

Why should you be interested in interdependence? Many research agendas treat units as independent or unrelated to each other. Sometimes this assumption is tenable, and sometimes it is untenable. Where this assumption is less tenable or realistic, spatial analysis lends itself to examining the phenomenon of interest while explicitly accounting for the geographic relations among units. In this way, spatial analysis is especially valuable for both theory testing and theory building. Regarding theory testing, multiple disciplines are increasingly interested in theories of diffusion, spread, or contagion; these ideas inhere in many existing theories, but are rarely examined empirically with appropriate methods. Spatial analysis lends itself to the study of diffusion and similar processes by explicitly accounting for dependence among units of analysis. The methods of spatial analysis can also be extended to examine broader notions of interdependence, including non-geographic, relational forms of connectivity among units, blending into network analysis, as well as resonating with core intuitions of multi-level and time-series analysis. Regarding theory building, notions of fixed effects, unit effects, or contextual effects abound empirical research. These are often atheoretical or empty categories that do not advance explanatory endeavors. Again, spatial analysis lends itself nicely to the study of local or regional effects, and to the elaboration of what substantive propositions can help complete explanations in particular geographic locations or areas.

In this class, students are expected to gain a practical, working understanding of the concept of geographic dependence, how to measure dependence using weights matrices, theoretical implications derived from the interdependence of units, how to collect data and organize data sets for spatial analysis, visualizing spatial data using GIS and mapping software, basic exploratory techniques (e.g., detecting global dependence, cluster analysis), as well as more advanced explanatory techniques to test hypotheses and generate new hypotheses using spatial econometrics. The main requirement is either (a) the replication of the analysis in a published paper using spatial analysis (this paper should be one that we have not already replicated in class), or (b) an original research paper applying both exploratory and explanatory techniques of spatial analysis (i.e., at least one exploratory technique plus at least one basic spatial econometric model).

The class is designed as a first, introductory course in spatial analysis. Like most methods, spatial analysis consists of a core set of approaches. This core is complemented by a wide array of extensions. We will cover the core set of approaches in detail, and we will also cover some extensions. However, it is not feasible or practical to cover all possible extensions in a single semester course, and new approaches are being developed all the time. So, the goal is to become thoroughly familiar with the core set of methods in this area, identify a range of extensions, and work through a selection of those extensions so that you have the tools to do your own basic spatial research and teach yourself additional tools later one, if necessary.

Specifically, among the core set of techniques, we will learn to conceptualize and measure different forms of spatial dependence, identify spatial autocorrelation, apply diagnostics to identify different spatial regimes and spatial processes in the data, and use two basic forms of spatial regression: spatial error models (SEM) and spatial lag (SLM). Among extensions, we will learn to work with a mixed or spatial durbin models (SDM), geographically weighted regressions (GWR) and variations of these models, and will spend a session learning about mixed-methods research designs with spatial data. We will also primarily be working with areal data since most social science data is specific to a particular political or jurisdictional unit, not a point in space.

Among other extensions, many variations are currently being applied and developed, including longitudinal models (spatio-temporal models), multi-level or hierarchical models, survival models, models with discrete or categorical outcomes, and Bayesian models. You are encouraged to explore these methods in your research paper if the methods are relevant to your research question, theory, and design, or to teach a tutorial on these methods (see below).

Goals. At the end of this course, I expect to have succeeded in reaching goals at three levels:

- Level 1 (most practical): be able to apply specific techniques of spatial analysis
- Level 2 (more general): be able to think more explicitly about interdependence and complexity, mainly in terms of geography and the role of spatial interdependence
- Level 3 (most general): show competence in a programming language (R or Python) and in collecting, organizing, and analyzing data using this language

Specific goals within these levels:

- Level 1:
 - Working familiarity with spatial weights
 - Working familiarity with exploratory techniques
 - Working familiarity with basic explanatory techniques
 - Familiarity with at least some extensions of spatial regression
 - Demonstrated ability use basic exploratory and explanatory techniques to replicate core empirical findings of published work using spatial analysis (in computer lab)
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- Level 2:

- Working familiarity with core concepts in spatial analysis
- Working familiarity with diverse strands of the literature on spatial analysis, including methodological pieces and more substantive research
- Working familiarity with major publication outlets, professional associations, and conferences associated with spatial analysis
- Ability to conduct own, original research using spatial analysis
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- Level 3:
 - Working familiarity with several software packages, including mapping software (e.g., GeoDa, R, ArcGIS, QGIS, Python), especially **free, open-source software**
 - I expect you to demonstrate a working knowledge and competence with at least one programming language, either R or Python
 - None of us are experts and we can all teach each other something; however, by end of semester, you must demonstrate an ability to walk through a replication of published research or your own original research in either R or Python

Inductive, Experiential Design. I have deliberately emphasized replications of published work in this class. In this way, we will dive into “learning by doing” spatial analysis, even before we may fully understand everything it is that we are doing. My hope is that the process of actually practicing spatial analysis will both (a) reduce any intimidation, fear, or insecurity you may have in thinking about learning a new research method, and (b) inspire or motivate you to learn more about the math or inner workings of the method by helping you see the usefulness of the approach. In this regard, the class is rather inductive, in that we start by actually practicing spatial analysis in a very concrete, specific research problem, and then use that specificity to broaden out to a more general understanding of the logic, math, and proper applications of the method. Aside from inductive, some might call this experiential learning, applied methods, or as encouraging “curiosity by design” (this is ITLAL’s phrase).

I realize that this design may be exactly the opposite of what you are used to and the opposite of how many other methods courses are taught. Indeed, just about every methods course I have ever taken has spent a great deal of time working through mathematical proofs and basic principles before getting to a stage where applications of the methods are encouraged. Frankly, I have always found that structure to be dry, unimaginative, and discouraging, and therefore uninspiring and even discouraging of many people who are otherwise deeply interested in the questions to which the methods could be applied. So, we are jumping right into the fray from the very beginning, replicating published work and then, after reproducing key results and having “done” spatial analysis, we will stop to reflect on how we got those results and how that experience helps us work through research questions of our own. Again, my hope is that this structure will inspire you to want to learn more, not less.

We will work through multiple replications during the course of the semester, reading the published research and then working through reproducing the published results. Throughout, we will seek to understand not just the research questions, theoretical

motivations, empirical strategy, and core results of each piece, but also peak “under the hood” and reproduce all key findings in the piece. Further, we will conduct these replications in more than one software environment, seeking to understand the concepts and methods underlying the techniques rather than becoming comfortable with a single program or platform. This will be challenging at first, but this process will also build capacity for you to work flexibly on your own research over the long-term regardless of what specific commercial software might be available or unavailable to you at the time.

Workshop environment. This is not a lecture class. I will generally give an opening presentation at the start of each session (15-30 minutes, depending on topic), but you are expected to have read scheduled material, viewed videos and reviewed relevant code, actively engage in any discussions, and to work with data in every class meeting. Hands on work on replications and extensions of replications will take place in every class meeting.

Pre-requisites. Prior courses or a working familiarity in both research design and regression analysis are required (e.g., RPOS 517).

Software:

No software needs to be purchased for this class, yet students will be expected to become adept at moving among several software platforms, including Excel, GeoDa, R, Python, Stata, ArcGIS, QGIS, and GWR4. The main software utilized for analysis will be the free GeoDa, R, Python, QGIS, and GWR4. MS Office, Stata and ArcGIS are available on all campus computer labs, including the computers in Dewey Library.

You should download and install each the following. GeoDa, R, Python, and GWR4 also have manuals and other documentation that can be very helpful. See video on Blackboard site for introduction to downloading and installing GeoDa, R, Python, and GWR4.

GeoDa: <https://spatial.uchicago.edu/software>

GeoDaSpace: <https://spatial.uchicago.edu/software>

R: <http://cran.r-project.org/>

RStudio: <https://www.rstudio.com/>

Python: <https://www.python.org/> ; or <https://www.continuum.io/downloads>

GWR4: <http://gwr.maynoothuniversity.ie/gwr4-software/>

Windows emulator:

Some of the above programs (GeoDa, GWR4) may only run on Windows. If you run iOS and an OS version of software is not available, I suggest **Wine** as a windows emulator (technically, it’s more than an emulator). I am also looking into setting aside some extra space for remote desktop using X2Go (see below).

Wine download here: <https://www.winehq.org/>

X2Go download here: <http://wiki.x2go.org/doku.php>

Remote computing:

Some of the analyses we will run in this class are computationally intensive, and with even moderately sized data sets can take more than a day to run. In order to avoid unnecessary

delays, I am working on arranging for access to remote computing resources via CSDA and RIT, including access to R, RStudio or R commander (Rcmdr), and Python. We will discuss this further at relevant points in the semester and as I receive updates from main campus.

Readings

There are no required texts for this course. All required readings will be posted on Blackboard or circulated via email. However, I strongly recommend that you purchase at least one reference text on spatial analysis. You may choose from any of the ones listed below, though I have listed them in the order that I would recommend them (most recommended first). main texts for this course are:

- Anselin, Luc, and Sergio Rey. 2014. *Modern Spatial Econometrics in Practice*. GeoDa Press LLC (available at online book sellers).
 - This is a highly accessible, fairly comprehensive, recent text by one of the giants in the field, and also one that demonstrates the usage of GeoDa, GeoDa Space, and PySAL, all of which are respected and free software packages for spatial analysis.
- Ward, Michael D., and Kristian Skrede Gleditsch. 2008. *Spatial Regression Models*. Thousand Oaks, CA: SAGE (Quantitative Applications in the Social Sciences).
 - This is an excellent introduction to spatial analysis from two political scientists, so it is especially accessible to students in social science and policy studies. The shortcoming is that it is not very comprehensive; its main focus is on building towards spatial error and spatial lag regressions, and the authors then refer readers elsewhere for other extensions. It is also written exclusively for usage in R.
- Darmofal, David. 2015. *Spatial Analysis for the Social Science*. Cambridge, UK: Cambridge University Press.
 - Good, recent book by a political scientist covering a wide range of topics and social science applications.
- Bivand, Roger S., Edzer Pebesma, Virgilio Gómez-Rubio. 2013. *Applied Spatial Data Analysis with R*. 2nd ed. London: Springer.
 - This is an excellent book by another giant in the field, but it can be rather technical for newcomers and is also written exclusively (as the title indicates) for usage in R.
- Elhorst, J. Paul. 2013. *Spatial Econometrics: From Cross-Sectional Data to Spatial Panels*. London: Springer.
- LeSage, James, and Robert Kelley Pace. 2009. *Introduction to Spatial Econometrics*. Boca Raton, FL: Chapman and Hall (Statistics: A Series of Textbooks and Monographs).

Replication Materials

All replication materials will be provided to you. The data and related files will be posted on the course site on Blackboard. Also, I have created multiple videos that help guide you through the replications. These videos are intended to supplement not replace the class experience. They are also intended as a more permanent resource for you to consult if you do not apply the methods from this class in the near future, but find yourself coming back to spatial analysis at a later point. Most videos are linked on the Blackboard site, but are

also available on You Tube, so you should be able to access these beyond the end of this semester.

Replication, video, and other course materials are here:

<http://mattingram.net/Teaching/SpatialAnalysis/>

*** **Note:** I have gathered the necessary data for the replications, in many cases by personally approaching the authors. If you decide to use the data and related files in your own research, please speak with me first. At a minimum, I would expect you to acknowledge the class and the original author, but I may also have information from the author about restrictions on how the data should be shared or cited.

Grading

- Participation: 60%
- Tutorial: 10%
- Replication or Research Paper: 30%

Participation. This is primarily a lab-oriented course. That is, we will spend our time in the computer lab, working through different phases of spatial analysis. Thus, you are expected to read carefully and come prepared to participate actively in discussion and also actively apply the covered material in lab exercises.

Your contributions should be related to the material and constructive. Differing opinions are encouraged as long as they are relevant and respectful. You are also expected to promote a classroom environment that makes it easy for your peers to engage with the material. In this regard, please keep distractions to a minimum. With regards to **technology in the classroom**, please turn your phones and other handheld devices off during class. Texting during class is unacceptable. Laptop and computer use is allowed for taking notes and other activities relevant to class, but sending emails, instant messaging, checking social media, or watching videos online is unacceptable. If you are engaged in any of these distracting activities, or otherwise using technology inappropriately in the classroom, you will be asked to leave for the day. If this happens a second time, you will receive a zero (0) for your participation grade, which in this class essentially translates to a failing grade for the entire course.

Tutorials. To the extent you can contribute additional material, please feel free to do so at any time. We all learn from each other, and I learn as much from everyone in class as you do from me. Regardless of how much you contribute or participate in class, though, you are also required to teach the rest of us something once during the course. This is the “tutorial”.

The content of the tutorial is for you to choose and all options are open as long as it is related to spatial analysis. The main idea is that after the tutorial, someone who did not know about the topic of the tutorial would have a practical, applied sense of how to do what you taught in the tutorial. The content can be any kind of “mental” or “metal” tool. Mental tools consist of conceptual, theoretical, and methodological ideas. Metal tools consist of technical resources (e.g., a particular way of organizing workflow, writing papers,

developing code, sharing data and code, or of executing a particular kind of analysis). The only restriction is that your tutorial not cover something that is already going to be covered in class. You can cover something covered in class, but you must offer some new insight or treatment of it. For instance, if we discuss a particular spatial concept or theory, you could offer a tutorial on same thing, but you must build off of what was already covered in class. Similarly, if we do something in R, you could offer a tutorial on how to do the same thing in a different way (e.g., using a different package) or in some other environment (e.g., Python).

The format of the tutorial is also fairly flexible (lecture, slide presentations, replication, instructional video, etc.) but your tutorial must include at least two core elements: (1) a written report that documents the full content of the tutorial, and (2) a presentation for the class. Again, format is flexible. Your written report can take many forms (e.g., a brief paper narrating the lesson of the tutorial; commented code in R, Python, or other language; a web interface like shiny). Your presentation can also take many forms (e.g., in-person lecture in front of class, video). Be creative!

Please speak with me prior to preparing your tutorial just so that I understand what you plan to do and to make sure it meets the expectations above. You must inform me of your planned tutorial by **Week 6** of class [see course schedule below].

Replication or Research Paper. A replication of a published paper or original research paper that employs spatial analysis is the final requirement for this course.

Replication: This option is most useful if you do not have your own original research project in mind. If that is the case, then see me for a set of papers for which I also have the data. You will be expected to re-analyze the data by generating your own code following the steps and many examples we will work through in class. Alternately, if you already have a project of your own in mind and know of a related paper that uses spatial analysis, you can do a replication of a paper other than the ones I have pre-selected. If you can acquire the data from that paper, then you can re-do their analysis in an area that is already conceptually and theoretically familiar to you. In this way, you might identify alternative, un-tested explanations, ways to add data to test those explanations, or perhaps other ways to organize or use the data, theory, or methods from that paper. This option would be very beneficial for helping you think about whether to apply spatial analysis in your own master's or dissertation work.

If you are interested in the replication option, please speak with me so that we can try to identify the best option for you and acquire any needed data as soon as possible.

Research Paper: If you have a clear research project or question in mind and already know that you want to apply spatial analysis to this project (especially if you already have the data), then this option is for you and the one that will most directly help you progress towards your academic program (e.g., dissertation). We will work throughout the semester to organize your data for spatial analysis, construct spatial weights, and conduct exploratory and explanatory analysis. If you choose this option, you will be required to demonstrate these exploratory techniques and explanatory techniques (at least through a simple spatial error and/or spatial lag model).

NOTE: I expect you to let me know which route you plan to take – replication or research paper – no later than Week 8.

The assignment should follow the structure set out in the detailed instructions, which I will distribute later in the semester. Make sure you refer to this document in preparing your work for this assignment. We will also discuss the instructions in greater detail later in the semester.

Other Policies

Email. I expect you to check your email. You are responsible for material sent by email.

Late Work and Missed Assignments. All work must be turned in within the first 5 minutes of class on the day it is due, or by 5pm if there is no class on the due date. Without a legitimate (e.g., medical or family emergency) and documented explanation, late work will be penalized one letter grade for each day it is late up to 50% off, and it is considered late if turned in beyond the time limits above (i.e., after the first 5 minutes of class, or after 5pm on days there is no class; this includes weekends and holidays).

Academic Integrity. All students must familiarize themselves with the *Standards of Academic Integrity* on the University's website and pledge to observe its tenets in all written and oral work, including oral presentations, quizzes and exams, and drafts and final versions of essays. The full standards and examples of dishonest behavior are available at: http://www.albany.edu/undergraduate_bulletin/regulations.html.

Americans with Disabilities Act (ADA). Qualified students with disabilities needing appropriate academic adjustments should contact me as soon as possible to ensure your needs are met in a timely manner.

Miscellaneous. If you feel you need any help or simply want clarification on any of the material, please do not hesitate to raise your question in class or approach me outside of class. I will hold regular office hours throughout the summer session. If you cannot arrange to come talk with me during these hours, please call or email me, or contact the Department of Political Science administrative offices, so that we can set up an appointment.

CLASS SCHEDULE

WEEK 1 (8/30)

Introductions:

- Syllabus
- Class Structure
- Expectations
- Introductory presentation and discussion
- Software

WEEK 2 (9/06)

Replication 1: Baller et al. 2001

- Required:
 - 1A: GeoDa and GeoDa Space
 - 1B: R
- Optional:
 - 1C: Python (using PySAL; from Anselin and Rey 2014)

WEEK 3 (9/13)

Basic Principles 1: Dependence, Matrix Algebra, Spatial Matrices, Shapefiles

Readings:

- “Galton’s Problem”
 - Read Tylor 1889 and critiques; focus on Galton’s critique
- Neumayer, Eric, and Thomas Plümer, (2013), “W”.
- Moore, Will H., and David A Siegel. 2013. “Chapter 12: Fun with Vectors and Matrices.” In Moore and Siegel, *A Mathematics Course for Political and Social Research*. Princeton: Princeton University Press.
 - If interested, see web site for book for additional video lectures, exercises, and solutions: <http://people.duke.edu/~das76/MooSieBook.html>
- “ESRI Shapefile Technical Description”, An ESRI White Paper (July 1998)
- Basic Principles of spatial weights from Anselin and Rey (2014):
 - 35-42 (contiguity); 75-79 (distance)
- Vasiliev, Irina Ren. 1996. “Visualization of Spatial Dependence: An Elementary View of Spatial Autocorrelation.” In Sandra Arlinghaus, ed. *Practical Handbook of Spatial Statistics*. Boca Raton, FL: CRC Press.
- Griffith, Daniel A. 1996. “Some Guidelines for Specifying the Geographic Weights Matrix Contained in Spatial Statistical Models.” In Sandra Arlinghaus, ed. *Practical Handbook of Spatial Statistics*. Boca Raton, FL: CRC Press.
- Assunção, R. E. and Reis, E. A. 1999. “A new proposal to adjust Moran’s I for population density.” *Statistics in Medicine* 18: 2147-2162.

Recommended:

- Moran, Patrick Allen Pierce. 1948. “The interpretation of statistical maps.” *Journal of the Royal Statistical Society B*, 10, 243-251.
- Moran, Patrick Allen Pierce. 1950a. “Notes on Continuous Stochastic Phenomena.” *Biometrika* 37: 17-23.
- Moran, Patrick Allen Pierce. 1950b. “A Test for Serial Independence of Residuals.” *Biometrika* 37: 178-181.
- Geary, R.C. 1954. “The Contiguity Ratio and Statistical Mapping.” *The Incorporated Statistician* 5(3)
- Tobler, Waldo. 1970.
- Tobler, Waldo. 2004.
- Griffith, Daniel A. 1987. *Spatial Autocorrelation: A Primer*. Washington, D.C.: Association of American Geographers.

- Moellering, Harold. 1984. "Real maps, virtual maps, and interactive cartography." In Gaile and Willmott, eds. *Spatial Statistics and Models*: Reidel. pp. 109-132.

Replication:

- Review software concerns, "laws", spatial data, dependence, spatial weights
- Continue with Baller et al. 2001, reflecting on readings

WEEK 4 (9/20)

Basic Principles 2: Levels of Analysis, MAUP, and Ecological Inference

Reading:

- Wong, David W. S. 1996. "Aggregation Effects in Geo-Referenced Data." In Sandra Arlinghaus, ed. *Practical Handbook of Spatial Statistics*. Boca Raton, FL: CRC Press.
- Luc Anselin and Wendy Tam Cho, 2002, "Spatial Effects and Ecological Inference," *Political Analysis* 10: 276-297.

Recommended:

- Openshaw, Stan. 1984. "The Modifiable Areal Unit Problem" *Geo Abstracts*
- Fotheringham A. S., Wong David W. S., 1991, "The modifiable areal unit problem in multivariate statistical analysis" *Environment and Planning A* 23(7) 1025 – 1044.
- Wong, David. 2009. "The Modifiable Areal Unit Problem (MAUP)." In A. Stewart Fotheringham and Peter Rogerson, eds. *SAGE Handbook of Spatial Statistics*.
- Shui, Daniel. 2000. "New Directions in Ecological Inference: An Introduction." *Annals of the Association of American Geographers* 90(3).
 - This is the introduction to several pieces debating the MAUP and ecological inference; contributors include Luc Anselin, Stewart Fotheringham, Gary King, and John O'Loughlin.
- King, Gary. 2000. "Geography, Statistics, and Ecological Inference." *Annals of the Association of American Geographers*, 90:3, 601-606, DOI: 10.1111/0004-5608.00214
- Dark, Shawna J., and Danielle Bram. 2007. "The modifiable areal unit problem (MAUP) in physical geography." *Progress in Physical Geography* 31(5): 471-479.

Computer Lab:

- **Replication 1, cont.:**
 - finish Baller et al.
 - apply Basic Principles 1-2 to Baller et al.
 - Re-do the analysis with two different weights specifications
 - E.g., rook-1 and queen-1
 - Re-do the analysis with data aggregated to state level
- **Practical skills (hopefully practice with your own data)**
 - Data Organization/Manipulation
 - Merging Spatial and Non-Spatial Data
 - Data Visualization/Mapping
 - Constructing Spatial Weights
 - Moving between GeoDa, R, Excel, and ArcGIS
 - If still looking for project, please speak with me and consider:
 - Updating Baller et al. to 2000 and 2010
 - Find data

- Match geographic units

WEEK 5 (9/27)

Exploratory Spatial Analysis

Reading:

- Messner, Steven F., Luc Anselin, Robert D. Baller, Darnell F. Hawkins, Glenn Deane, and S.E. Tolnay. 1999. "The spatial patterning of county homicide rates: An application of exploratory spatial data analysis." *Journal of Quantitative Criminology* 15: 423-450.
- Anselin 2005: 43-77, 78-104; 106-128, 129-164

Recommended:

- Anselin, L. 1995. "Local indicators of spatial association." *Geographical Analysis* 27, 93-115
- Getis, A. and Ord, J. K. 1996. "Local spatial statistics: an overview." In P. Longley and M. Batty (eds) *Spatial analysis: modelling in a GIS environment* (Cambridge: Geoinformation International), 261-277.

Computer Lab:

- **Troubleshooting Spatial Weights**
 - Example from Marcelo's spatial regimes analysis in Brazil
- **Replication 2:**
 - Messner et al. 1999
 - Table 1 (panel B)
 - Figures 4-9

WEEK 6 (10/04)

Broader Picture 1: Exploratory Spatial Analysis, cont.

Readings:

- Tiefelsdorf, (2002)
- Goodchild, Michael, et al., 2000, "Toward Spatially Integrated Social Science"
- Harbers, Imke, and Matthew C. Ingram. 2014. "Politics in Space: Methodological Considerations for Taking Space Seriously in Subnational Comparative Research." APSA Paper.
- Tam Cho, Wendy K., and James Gimpel. 2012. "Geographic Information Systems and the Spatial Dimension of American Politics." *Annual Review of Political Science* 15: 443-460.
- Franzese, Robert Jr., and Jude C. Hays. 2008. "Spatial Interdependence in Comparative Politics: Substance, Theory, Empirics, Substance." *Comparative Political Studies* 41(4/5): 742-780.
- Franzese, Robert Jr., and Jude C. Hays. 2008b. "Empirical Models of Spatial Interdependence." In Janet Box-Steffensmeier, Henry E. Brady, and David Collier, eds. *The Oxford Handbook of Political Methodology*. Oxford: Oxford University Press, pp. 570-604.

Recommended:

- Darmofal, David. 2006. "Spatial Econometrics" Paper from Political Methodology Section [check for release of book on spatial econometrics]

- Elazar, Daniel. 1999. "Political science, geography, and the spatial dimension of politics." *Political Geography*
- Logan, John (2010) - TBA
- Steinberg, Steven J., and Sheila L. Steinberg. 2006. *Geographic Information Systems for the Social Sciences: Investigating Space and Place*. Thousand Oaks: SAGE.
- *Political Analysis*, Special Issue 10(3) (2002)

Computer Lab:

- Review Replications 1 and 2
- Get caught up on preparation of spatial data and exploratory analysis with own data

WEEK 7 (10/11)

*** NO CLASS (Holiday) ***

***** By next week (Week 8), identify the topic of your final paper. If you are doing replication, try to identify a published work that we are not already replicating that you would like to replicate, and research whether data set is available. If you are doing research of your own, try to gather data or bring data to start organizing for spatial analysis. *****

WEEK 8 (10/18)

Basic Principles 3: OLS and Diagnostics for Spatial Model Specification

Readings:

- Messner, Steven F., Raymond H.C. Teske, Jr., Robert D. Baller, and Helmut Thome. 2013. "Structural Covariates of Violent Crime Rates in Germany: Exploratory Spatial Analyses of Kreise." *Justice Quarterly*, DOI:10.1080/07418825.2011.645862
- Luc Anselin, 2002, "Under the Hood. Issues in the Specification and Interpretation of Spatial Regression Models" in *Spatial Regression Models*
- Luc Anselin, 1988, "Lagrange Multiplier Test Diagnostics for Spatial Dependence and Spatial Heterogeneity." *Geographical Analysis* 20: 1-17.
- Luc Anselin, Anil K. Bera, Raymond Florax, Mann J. Yoon. 1996. "Simple diagnostic tests for spatial dependence." *Regional Science and Urban Economics* 26: 77-104

Recommended:

- Keith Ord, 1975, "Estimation Methods for Models of Spatial Interaction", *Journal of the American Statistical Association* 70: 120-126.
- Florax, Raymond J.G.M, Hendrik Folmer, and Sergio J Rey. 2003. "Specification searches in spatial econometrics: the relevance of Hendry's methodology." *Regional Science and Urban Economics* 33(5): 557-579.

Computer Lab:

- Revisit Baller et al. and also run diagnostics for Messner et al. 2013

- Examine diagnostics
- Analyze discrete heterogeneity, as before
- Examine continuous heterogeneity (stationarity tests in GWR4 and R)

WEEK 9 (10/25)

Spatial Regression 1: Spatial Error Models

Reading:

- Messner et al. 2013
- Anselin 2005: 165-223
- Review Harbers and Ingram 2014; Tam Cho and Gimpel 2012

Recommended:

- Baller, Robert D., Luc Anselin, Steven F. Messner, Glenn Deane, Darnell F. Hawkins. 2001. "Structural Covariates of U.S. Homicide Rates: Incorporating Spatial Effects." *Criminology* 39(3): 561-590.
- Darmofal, David. 2006. "The political geography of macro-level turnout in American political development." *Political Geography* 25: 123-150.
- Chi, Guangqing, and Jun Zhu. 2008. "Spatial Regression Models for Demographic Analysis." *Population Research and Policy Review* 27: 17-42.

Computer Lab:

- **Replication 3:**
 - Messner et al. 2013 (or Darmofal 2006, if available)

WEEK 10 (11/01)

Spatial Regression 2: Spatial Lag Models

Readings:

- LeSage, James P. (2014). "What regional scientists need to know about spatial econometrics." *Review of Regional Studies* 44:13-32.

Computer Lab:

- **Replication 4:**
 - TBA
- Work on own data

WEEK 11 (11/08)

Spatial Regression 3: Mixed or Spatial Durbin Models (SDM)

Reading:

- Recommended
 - Mears and Bhati (2006)

Computer Lab:

- **Replication 5:**
 - Ingram 2014
- Work on own data

WEEK 12 (11/15)

*** NOTE: MATT LIKELY IN MEXICO FOR WORKSHOP ***

Spatial Regression 4: Geographically Weighted Regression (GWR)

Reading:

- Fotheringham, A. Stewart, Chris Brunson, and Martin Charlton. 2002. *Geographically Weighted Regression: the analysis of spatially varying relationships*. Chichester, England: Wiley and Sons.
- Charlton, Martin, and A. Stewart Fotheringham. 2009. "Geographically Weighted Regression: White Paper." National Centre for Geocomputation, National University of Ireland Maynooth. Available at: http://ncg.nuim.ie/ncg/gwr/GWR_WhitePaper.pdf (last viewed March 30, 2013).
- Calvo, Ernesto, and Marcelo Escolar. 2003. "The local voter: A geographically weighted approach to ecological inference." *American Journal of Political Science* 47(1): 189–204.
- Öcal, Nadir, and Jülide Yildirim. 2010. "Regional effects of terrorism on economic growth in Turkey: A geographically weighted regression approach." *Journal of Peace Research* 47(4): 477–489.
- Leung Y, Mei C-L, Zhang W-X. 2000. "Statistical tests for spatial nonstationarity based on the geographically weighted regression model" *Environment and Planning A* 32(1) 9 – 32.
 - Good discussion of model comparison and stationarity tests

Computer Lab:

- **Replication 6:**
 - Ocal, Nadir, and Jülide Yildirim. 2010. "Regional effects of terrorism on economic growth in Turkey: A geographically weighted regression approach." *Journal of Peace Research* 47(4): 477-489.
- **Options:**
 - Darmofal 2006
 - Re-do Baller et al. 2001 with GWR (examining continuous heterogeneity versus the discrete heterogeneity of the two spatial regimes they analyze)
 - Work on own data

WEEK 13 (11/22)

Spatial Regression 5: GWR Extensions – GWR-SL and beyond

Reading:

- Schoff et al. (2014)
- Ingram and Marchesini (2014), "A Spatial Analysis of Homicide across Brazil's Municipalities"

Recommended:

- Kelejian and Prucha (several)
- Paez et al. (2002)

Computer Lab:

- **Replication 7:**
 - Schoff et al. (2014) or Ingram and Marchesini

WEEK 14 (11/29)

Mixed-Methods Research Designs

Reading:

- Harbers, Imke, and Matthew C. Ingram. 2015. “Geo-Nested Analysis: Case Selection Techniques for Sequencing Spatial Regressions and Qualitative Research.” Paper presented at Quantitative Social Sciences workshop, University of Amsterdam; ECPR Joint Sessions, Warsaw, Poland; and American Political Science Association, San Francisco, CA.
- Harbers, Imke, and Matthew C. Ingram. 2016. “Testing Existing Theories and Building New Ones: A Menu of Mixed-Methods Research Designs with Spatial Data.” Paper for annual meeting of American Political Science Association.

WEEK 15 (12/06)

*** Last day of class ***

We have several options we could explore in this last week, including (a) broader picture issues, or (2) further extensions of spatial models (categorical data; count data; multi-level models; conceptualizing space and operationalizing dependence; graphing results; network analysis; complexity and contextual analysis generally)

Option 1: Spatio-Temporal Regression

Reading:

- Gleditsch, Kristian and Michael Ward. 2000. “War and Peace in Time and Space: The Role of Democratization.” *International Studies Quarterly* 44(1):1–29.
- Franzese and Hays 2008
- Findley, Michael, and Joseph Young (2011), “Terrorism, Democracy, and Credible Commitments.” *International Studies Quarterly*
- Franseze Hays PA 2007
 - Any spatial model performs better than non-spatial OLS
- On Longitudinal Analysis, also look at Franseze Hays on History and Network Co-Evolution (PA 2012)
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Recommended

- Beck, Nathaniel, Kristian Skrede Gleditsch, and Kyle Beardsley. 2006. “Space Is More than Geography: Using Spatial Econometrics in the Study of Political Economy.” *International Studies Quarterly* 50: 27-44. (TSCS models discussed at 39-42)
- Ward, Michael, and Kristian Skrede Gleditsch. 2008. *Spatial Regression Models*. Thousand Oaks, CA: SAGE Publications.
- Elhorst, J.P. 2001. “Dynamic Models in Space and Time.” *Geographical Analysis* 33:119-140. (also under “graphing results”)
- Franzese, R., Hays, J. 2007. “Spatial-Econometric Models of Cross-Sectional Interdependence in Political Science Panel and Time-Series-Cross-Section Data.” *Political Analysis* 15(2): 140-164. (also under “graphing results”)
- Elhorst, J.P. 2010. “Spatial Panel-Data Models.” In M.M. Fischer & A. Getis, eds., *Handbook of Applied Spatial Analysis*. Berlin: Springer, pp. 377-407.

- Franzese, R., Hays, J. 2008. "Empirical Models of Spatial Interdependence." In J. Box-Steffensmeier, H. Brady, D. Collier, eds., *Oxford Handbook of Political Methodology*. Oxford: Oxford University Press, pp. 570-604.
 - Check version: Franzese notes in his own syllabus from August 2013 that students should use a hyperlinked version because "it corrects an error in the printed version".

Computer Lab:

- **Replication 8:**
 - Findley and Young 2011 (terrorism events from 1970-1997)
- **Options**
 - Franzese and Hays 2008
 - Ward and Gleditsch 2008
 - Work on own data

Other options:

Broader Picture 2:

- Goodchild, Michael F., Donald G. Janelle. 2010. "Toward critical spatial thinking in the social sciences and humanities." *GeoJournal* 75: 3-13.

Categorical dependent variables:

- Beron, K., Murdoch, J., Vijverberg, W. 2003. "Why Cooperate? Public Goods, Economic Power, and the Montreal Protocol." *Review of Economics and Statistics* 85(2): 286-297.
- Franzese, R., Hays, J., Cook, S. 2013. "Spatial-, Temporal-, and Spatiotemporal-Autoregressive Probit Models of Interdependent Binary Outcomes: Estimation and Interpretation," Spatial Models of Politics Conference (February, Texas A&M).
- LeSage, J., Pace, K. 2009. *Introduction to Spatial Econometrics*. Boca Raton: CRC Press, Taylor & Francis Grp, Chapter 10, pp. 279-322.

Count or event data:

- Darmofal, D. 2009. "Bayesian Spatial Survival Models for Political Event Processes," *American Journal of Political Science* 53(1):241-57.
- Franzese, R., Hays, J. 2009. "A Comparison of the Small-Sample Properties of Several Estimators for Spatial-Lag Count-Models," Political Methodology Society Annual Meetings.
- Suggested: Griffith, D., Haining, R. 2006. "Beyond Mule Kicks: The Poisson Distribution in Geographical Analysis." *Geographical Analysis* 38: 123-139.

Duration/survival models:

- Hays, Jude C., and Aya Kachi. 2009. "Interdependent Duration Models in Political Science," American Political Science Association Annual Meeting.

Complex, Multi-Level, Time-Series, Cross-Sectional Modeling:

- Pang, Xun. 2014. "Varying Responses to Common Shocks and Complex Cross-Sectional Dependence: Dynamic Multilevel Modeling with Multifactor Error Structures for Time-Series Cross-Sectional Data." *Political Analysis* (Autumn) 22 (4): 464-496.
- Pang, Xun. 2014. "Replication data for: Varying Responses to Common Shocks and Complex Cross-Sectional Dependence: Dynamic Multilevel Modeling with Multifactor Error Structures for Time-Series Cross-Sectional Data", <http://dx.doi.org/10.7910/DVN/25430> UNF:5:CJFgK1PHYQztfyhPOCAh+w== IQSS Dataverse Network [Distributor] V2 [Version]

Graphing results:

- Franzese, R., Hays, J. 2007. "Spatial-Econometric Models of Cross-Sectional Interdependence in Political Science Panel and Time-Series-Cross-Section Data." *Political Analysis* 15(2): 140-164.
- Elhorst, J.P. 2001. "Dynamic Models in Space and Time." *Geographical Analysis* 33:119-140.

Spatial analysis and network analysis:

- Land, K., Deane, G. 1992. "On the Large-Sample Estimation of Regression Models with Spatial or Network-Effects Terms: A Two-Stage Least Squares Approach." *Sociological Methodology*, Vol. 22, pp. 221-248.
- Hay, Jude C., Aya Kachi, Robert J. Franzese Jr. 2010. "A spatial model incorporating dynamic, endogenous network interdependence: A political science application." *Statistical Methodology* 7: 406-428.
- Franzese, R., Hays, J., Kachi, A. 2012. "Modeling History Dependence in Network-Behavior Coevolution" *Political Analysis* 20(2): 175-90.

Conceptualizing/operationalizing spatial dependence:

- Tollefsen, Andreas Forø, Håvard Strand, and Halvard Buhaug. 2012. "PRIO-GRID: A Unified Spatial Data Structure." *Journal of Peace Research* 49, 2: 363-74.
- Zhukov, Yuri M. 2012. "Roads and the diffusion of insurgent violence: The logistics of conflict in Russia's North Caucasus." *Political Geography* 31: 144-156.

Additional Resources at UAlbany:

- (1) Center for Social and Demographic Analysis: <http://csda.albany.edu/>
- (2) Sociology Department
- (3) Geography Department
- (4) Epidemiology Department
- (5) New working group on spatial social science (as of Spring 2015; unclear if still operating)
- (6) New working on network analysis (as of Spring 2016; still in place)

Additional Resources elsewhere:

- (1) Data sources
 - Yale G-Econ project: <http://gecon.yale.edu/>

- AidData: <http://aiddata.org/subnational-geospatial-research-datasets>
- (2) University Centers and Institutes
- Arizona State University: GeoDa Center for Spatial Analysis and Computation
 - i. <https://geodacenter.asu.edu/>
 - Brown: S4 – Spatial Structures in the Social Sciences
 - i. <http://www.s4.brown.edu/index.htm>
 - Carleton College
 - i. http://apps.carleton.edu/collab/spatial_analysis/
 - Harvard: Center for Geographic Analysis
 - i. <http://gis.harvard.edu/>
 - Michigan: Spatial Analysis in the Social Sciences
 - i. <http://www.isr.umich.edu/cps/events/spatial/>
 - Stanford: Center for Spatial and Textual Analysis
 - i. <http://cesta.stanford.edu/>
 - UC Santa Barbara
 - i. Center for Spatially Integrated Social Science (CSISS)
 1. <http://www.csiss.org/>
 - ii. Center for Spatial Studies
 1. <http://spatial.ucsb.edu/>
 - iii.
 - iv. Teach Spatial (UC Santa Barbara)
 1. <http://www.teachspatial.org/>
 - University College London: Bartlett Center for Advanced Spatial Analysis
 - i. <http://www.bartlett.ucl.ac.uk/casa>
 - USC Dornsife Spatial Sciences Institute
 - i. <http://spatial.usc.edu/>
- (3) Software
- GeoDa and GeoDa Space
 - i. <https://geodacenter.asu.edu/>
 - Python Spatial Analysis Library (PySAL)
 - i. <https://geodacenter.asu.edu/>
 - ii. Also, main Python page: <https://www.python.org/>
 - R
 - i. <http://www.r-project.org/>
 - ii. Multiple online user sites
 - iii. R user group in Albany
 1. <http://www.meetup.com/Albany-R-Users-Group/> (active as of Summer 2016)
 - STARS
 - i. <http://regionalanalysislab.org/index.php/Main/STARS>
 - Geospatial Analysis: A Comprehensive Guide (Online ed.)
 - ii. <http://www.spatialanalysisonline.com/>
- (4) Conferences
- Spatial Statistics
 - i. <http://www.spatialstatisticsconference.com/>

- Spatial Models of Politics conferences
 - i. Texas A&M, Feb. 2013: <http://eucenter.tamu.edu/content/scholarly-conference-spatial-models-politics-europe-and-beyond>
 - Geographical Analysis, Urban Modeling, and Spatial Statistics
 - i. http://oldwww.unibas.it/utenti/murgante/geog_an_mod_14/index.html
- (5) Special Journal Issues:
- *Political Science Research and Methods*: Vol. 4, Issue 1 (January 2016)
 - *Political Analysis*: Vol. 10, Num. 3 (August 2002)
 - i. Special Issue on Spatial Methods in Political Science
 - *Mobilization*: Vol. 8, Num. 2 (June 2003)
 - i. Special Issue: Space, Place, and Contentious Politics
 - *Political Geography*: Vol. 21, Num. 2 (2002)
 - i. The Development and Application of Spatial Analysis for Political Methodology
- (6) Associations
- Regional Science
 - i. <http://www.regionalscience.org/>
 - GIScience
 - i. <http://giscience.org/>
- (7) Selected peer-reviewed, academic journals publishing spatial analysis in social sciences
- Political Analysis
 - Political Geography
 - Journal of Quantitative Criminology
 - Journal of Economic Geography
 - Health and Place
 - Population, Space, and Place
 - Demography
 - Population Studies
 - Spatial Demography
 - Criminology
 - GeoJournal
 - Journal of Geographical Systems
 - Regional Science and Urban Economics
 - Networks and Spatial Economics
 - Applied Spatial Analysis and Policy
 - Comparative Political Studies
 - Justice Quarterly
 - International Studies Quarterly
- (8) Web sites
- General
 - i. <https://github.com/>
 - ii. <http://dataverse.org/>
 - Spatial Analysis

- i. <http://spatial.ly/>
 - ii. <http://www.uclm.es/profesorado/vgomez/useR2014/>
 - iii. <http://spatioanalytics.com/>
- Math for Social Sciences
 - i. <http://people.duke.edu/~das76/MooSieBook.html>
- Replication data sets:
 - i. Journal of Peace Research
 - 1. <http://jpr.sagepub.com/content/47/4/477.full.pdf+html>
 - ii. AidData
 - 1. <http://aiddata.org/aiddata-research-releases>
 - iii. Dataverse
 - 1. <http://dataverse.org/>
 - iv. Eric Neumayer's website:
 - 1. <http://www.lse.ac.uk/geographyAndEnvironment/whosWho/profiles/neumayer/Home.aspx>
 - 2. You might especially like this if you want to work in Stata