Spatial Econometrics and Modeling
GEO 4169 & LAS 4953
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Class meeting times: R | Period 6 (12:50 PM - 1:40 PM) T | Period 5 - 6 (11:45 AM - 1:40 PM) Turlington 3018

Office Hours: T 2:00PM – 3:30PM or by appointment

This course addresses spatial statistical models, from both theoretical and empirical perspectives. It shows students how to assess the presence of spatial autocorrelation in their data, and how to specify appropriate regression models that produce reliable results when spatial autocorrelation is present. As a consequence, students learn to implement a variety of spatial models, developed by econometricians and spatial analysts in geography. Spatial lag and spatial error models are addressed, as are situations with complex autocorrelation patterns affecting independent variables, and error terms and dependent variables simultaneously. The instructional premise of the course is that such methods should not be approached via "cook-book," but instead by considering the underlying estimation theory. Thus, we will spend time at the beginning dusting off a few mathematical preliminaries in order to have notational facility with matrix algebra, and an intuitive understanding of basic probabilistic concepts. We will address estimation by considering the so-called "maximum likelihood function," and also by reference to Bayesian inference. On this basis, we will develop the models of interest, namely spatial regression techniques for both continuous and discrete dependent variables. Students will be introduced to an extensive spatial-econometrics library, with MATLAB scripts written for a wide variety of statistical situations, such as panel analysis, truncated dependent variables, etc. The course will be conducted primarily in MATLAB and GeoDa, both available from UF APPs. We will have occasion to use Stata and R, as well. The course is open to both advanced undergraduate and graduate students. Grades will be determined by homework and tests, and graduate students will write and present a research paper.

Grading: The course is presented in lecture format, with some practical lab-oriented instruction in computational methods. Grades for undergraduates are determined on the basis of homework assignments and tests (mid-term and final), with homework accounting for 40% (10 points for each of 4 assignments), and the two tests, 30% each. Homework can be done in groups working together; tests are to be completed on the basis of individual effort.

Grading Scale (Undergraduate):

87.0 - 100: A
84.0 - 86.99: A-
81.0 - 83.99: B+
78.0 - 80.99: B
75.0 - 77.99: B-
72.0 - 74.99: C+
69.0 - 71.99: C
66.0 - 68.99: C-
63.0 - 65.99: D+
60.0 – 62.99: D
50.0 – 59.99 D-

0.0 – 59.99 E

Pre-requisites: The pre-requisite for this class is GEO 4167, Intermediate Quantitative Analysis, or equivalent. More importantly, students must be motivated by an interest in spatial analysis, and a willingness to do the work. I will not lecture on advanced mathematics, but I will show how it is used by economists and geographers to arrive at key results. I do hope to advance student knowledge of matrix notation, insofar as it is used as a shorthand for describing data-sets, and as the basic set-up for estimating regression models. That is, I do not expect students to become experts in solving systems of equations by brute force. I do hope that they will learn the easy route of doing such solutions with software like MATLAB. Bottom-line: You do not need to have a strong math background to succeed in this class. You simply need to be a good student, which you no doubt are.

Testing: The two tests will be administered as open book, take home tests. The second test will be handed out on the last day of class. If you find this conflicts with your reading days, please let me know in advance. I will not give early tests to accommodate personal travel. Undergraduate Students will have 4 days to complete each test.

Readings: I draw my readings from a wide cross-section of literature, books, published articles, etc. These readings are meant to provide background, and I do not expect you to digest the materials in their entirety, as they can be quite mathematical. But you will have them in your virtual archives for future reference as you go on to apply what you learn. The prime textual information will come from my lectures. It will often be the case that I will call attention to some aspect of the readings, and elaborate the main points in my class presentations. I will do my best to make my class notes available on the Canvas system.

Course Policies and Useful Information:

Class Attendance and Make-Up Policy
Class attendance is expected. Excused absences are consistent with university policies in the undergraduate catalog (https://catalog.ufl.edu/ugrad/current/regulations/info/attendance.aspx) and require appropriate documentation. Makeups for the Mid-term and Final will be provided for students who miss either exam due to extreme, documented circumstances. Late homework assignments will also be accepted under similar circumstances. Students should arrange with the instructor for makeup material, and the student will receive one week to prepare for any makeup assignment, if circumstances allow it.

Students Requiring Accommodations Students with disabilities requesting accommodations should first register with the Disability Resource Center (352-392-8565, www.dso.ufl.edu/drc/) by providing appropriate documentation. Once registered, students will receive an accommodation letter which must be presented to the instructor when requesting accommodation. Students with disabilities should follow this procedure as early as possible in the semester.

Course Evaluation Students are expected to provide feedback on the quality of instruction in this course by completing online evaluations at https://evaluations.ufl.edu. Evaluations are typically open during the last two or three weeks of the semester, but students will be given specific times when they are open. Summary results of these assessments are available to students at https://evaluations.ufl.edu/results/.

Class Demeanor Students are expected to arrive to class on time and behave in a manner that is respectful to the instructor and to fellow students. Please avoid the use of cell phones and restrict eating to

outside of the classroom. Opinions held by other students should be respected in discussion, and conversations that do not contribute to the discussion should be held at minimum, if at all.

Materials and Supplies Fees There are no additional fees for this course.

University Honesty Policy UF students are bound by The Honor Pledge which states, "We, the members of the University of Florida community, pledge to hold ourselves and our peers to the highest standards of honor and integrity by abiding by the Honor Code. On all work submitted for credit by students at the University of Florida, the following pledge is either required or implied: "On my honor, I have neither given nor received unauthorized aid in doing this assignment." The Honor Code (https://www.dso.ufl.edu/sccr/process/student-conducthonor-code/) specifies a number of behaviors that are in violation of this code and the possible sanctions. Furthermore, you are obligated to report any condition that facilitates academic misconduct to appropriate personnel. If you have any questions or concerns, please consult with the instructor in this class.

Counseling and Wellness Center Contact information for the Counseling and Wellness Center: http://www.counseling.ufl.edu/cwc/Default.aspx, 392-1575; and the University Police Department: 392-1111 or 9-1-1 for emergencies.

Class Calendar

Week 1	Jan 6-10	Introduction
Week 2	Jan 13-17	Data Arrays and Matrix Algebra. Intro to MATLAB
Week 3	Jan 20-24	Principles of Probability (Inference, Bias) Intro to GeoDa Assignment 1. Data arrays and matrices in MATLAB Due the following Tuesday
Week 4	Jan 27-31	Data Generating Processes; the Regression Model
Week 5 `	Feb 3-7	Spatial Representation, Data Types Assignment 2. Using GeoDa for regression Due the following Tuesday
Week 6	Feb 10-14	Spatial Regression, Preliminaries GeoDa applications. Test 1 Administered. Take Home. All course materials from Week 1 to Week 5 Due the following Tuesday
Week 7	Feb 17-21	The "Spatial Error and Lag Models" MATLAB Library
Week 8	Feb 25-28	The "Sac Model," the "Durbin Model"
Week 9	Mar 2-6	Spring Break
Week 10	Mar 9-13	Grad Student Presentations: Objectives and Data. Undergraduates in attendance Assignment 3. Spatial regressions with MATLAB Due the following Tuesday.
Week 11	Mar 16-20	Model Selection and goodness-of-fit
Week 12	Mar 23-27	Bayesian probability and inference
Week 13	Mar 30-Apr 3	Bayesian regression Assignment 4. Bayesian spatial regressions with MATLAB Due the following Tuesday
Week 14	Apr 6-10	Limited dependent variables in spatial context
Week 15	Apr 13-17	Limited dependent variables: Applications
Week 16	Apr 20-24	Grad Student Presentations: Findings. Undergraduates in Attendance. Test 2 Administered. Take Home. All course materials from Week 7 to Week 15. Due the following Tuesday.

COURSE RESOURCES

Anselin, L. 1988. *Spatial Econometrics Methods and Models*. The Netherlands: Kluwer Academic Publishers.

Anselin, L. 2003. Spatial externalities, spatial multipliers, and spatial econometrics. *International Regional Science Review* 26(2): 153-166.

Anselin, L. 2006. *Spatial Regression*. Unpublished manuscript. Urbana Illinois: Spatial Analysis Laboratory.

Anselin, L. 2005. *Exploring Spatial Data with GeoDa: A Workbook*. Center for Spatially Integrated Social Science, Spatial Analysis Laboratory (hhtp://sal.uiuc.edu)

Binmore, K.G. 1982. *Mathematical Analysis: A Straightforward Approach* (2nd edition). Cambridge: Cambridge University Press.

Greene, W.H. 2000. *Econometric Analysis*, 4th ed. New Jersey: Prentice Hall

Griffith, D.A., Amrhein, C.G. 1991. *Statistical Analysis for Geographers*. Englewood Cliffs, New Jersey: Prentice Hall.

Hoel, P.G., Port, S.C., and Stone, C.J. 1971. *Introduction to Probability Theory*. (Vol 1) Boston: Houghton Mifflin Company.

Hoel, P.G., Port, S.C., and Stone, C.J. 1971. *Introduction to Statistical Theory*. (Vol 2) Boston, Houghton Mifflin Company.

LeSage, J.P. 1997. Bayesian estimation of spatial autoregressive models. *International Regional Science Review* 20(1&2): 113-129.

LeSage, J.P. 1998. *Spatial Econometrics*. Unpublished manuscript.

LeSage, J.P. Bayesian estimation of limited dependent variable spatial autoregressive models. *Geographical Analysis* 32(1): 19-35.

LeSage, J.P. 2006. *Application of Bayesian Methods to Spatial Econometrics*. Unpublished manuscript.

LeSage, J. P. and Pace, R. K. 2009. *Introduction to Spatial Econometrics*. Boca Raton, FL: CRC Press.

Miller, R.E. 2000. *Optimization: Foundations and applications*. New York: John Wiley & Sons, Inc.

Smith, T.E. and LeSage, J.P. 2004. A Bayesian probit model with spatial dependencies, in *Spatial and Spatiotemporal Econometrics*. Lesage, J.P. and Pace, R.K. (eds). Amsterdam: Elsevier.

Zellner, A. 1971. *An Introduction to Bayesian Inference in Econometrics*. New York: John Wiley & Sons, Inc.