

*Syllabus*

**Units:** 4

**Term – Day – Time:** Fall 2021, Mondays 9:30 – 10:50 am  
& Wednesdays 9:30-10:50 a.m.

**Location:** VPD 107

**Instructor:** An-Min Wu, PhD

**Office:** AHF B55B

**Office Hours:** Tuesdays, 9-10 a.m. and Thursday, 2 - 3 p.m.  
Pacific Time via zoom – please contact me via email in  
advance to ensure I will be online. Also available most days  
between 9 a.m. – 6 p.m. by appointment via email. A secured  
zoom meeting link will be sent to you via email when I  
confirm the appointment date/time.

**Contact Info:** [anminwu@usc.edu](mailto:anminwu@usc.edu)

**Library Help:** Andy Rutkowski

**Office:** VKC B36B

**Office Hours:** By appointment

**Contact Info:** [arutkows@usc.edu](mailto:arutkows@usc.edu), 213-740-6390 (office),  
<http://bit.ly/andyhangout>

**IT Help:** Richard Tsung

**Office:** AHF B57E

**Regular Office Hours:** By appointment

**Contact Info:** [ctsung@usc.edu](mailto:ctsung@usc.edu)

## Course Description

This course explores theoretical foundations, methods, techniques, and software systems for spatial econometrics. The course aims to provide students with the knowledge and skills necessary to investigate socioeconomic problems, with the consideration of the effects of spatial dependence and spatial heterogeneity. Essential concepts of spatial econometrics are presented, including the fundamental spatial concepts, spatial autocorrelation, and the core components of regression and spatial regression models for both cross-sectional and panel data. The latest research in a variety of topics using spatial econometric models is also examined. Students will gain an in-depth understanding and hands-on experience to explore a variety of applications through a combination of lectures, discussions, presentations, and projects. Students will learn about the variety of geospatial data and techniques available for solving socioeconomic challenges and problems.

This course serves as a required course for the Spatial Economics and Data Analysis M.S. Program and an elective course in the Geographic Information Science and Technology M.S. and Graduate Certificate Programs. Anyone wishing to pursue a career using spatial and economic principles and methods to address environmental challenges in cities, agricultural and natural environments should gain an understanding of spatial statistics and spatial regression and therefore will benefit from this course.

## Learning Objectives

When you have completed this course, you will be able to:

- Articulate the key theoretical concepts of spatial econometrics and how spatial concepts can be used to produce new and better inferences in economics
- Describe the roles played by spatial dependence and spatial heterogeneity in identifying economic opportunities and solving social and environmental problems.
- Analyze cross-sectional data using spatial regression methods in the ArcGIS Pro, GeoDa and R software environments.
- Enhance written and oral communication skills that are essential for today's workforce.

**Prerequisite(s):** SSCI 583 or by permission of the instructor

**Co-Requisite(s):** None

## Class Conduct

**Harassment, sexual misconduct, interpersonal violence, and stalking** are not tolerated by the university. All faculty and most staff are considered Responsible Employees by the university and must forward all information they receive about these types of situations to the Title IX Coordinator. The Title IX Coordinator is responsible for assisting students with supportive accommodations, including academic accommodations, as well as investigating these incidents if the reporting student wants an investigation. The Title IX office is also responsible for coordinating supportive measures for transgender and nonbinary students such as faculty notifications, and more. If you need supportive accommodations you may contact the Title IX Coordinator directly ([titleix@usc.edu](mailto:titleix@usc.edu) or 213-821-8298) without sharing any personal information with me. If you would like to speak with a confidential counselor, Relationship and

Sexual Violence Prevention Services (RSVP) provides 24/7 confidential support for students (213-740-9355 (WELL); press 0 after hours)

## **Course Structure**

This is a four-credit course that meets twice per week. The course will be delivered using multiple methods, including lectures, class presentations, discussion and hands-on practice. Exercises utilize unpublished and published materials using ArcGIS Pro, GeoDa, and R, with a focus in R, and project-based homework assignments allow students to demonstrate their ability to apply spatial statistical and econometric methods in an appropriate, informed manner. Student participation is encouraged through reading discussions, hands-on practices, homework assignments, and class presentations.

This is a graduate-level course, so you should expect this class to be intellectually challenging. As this is a four-credit course, students should expect to spend 10-15 hours per week completing the work in this course. As a graduate student, you are expected to engage with the information you are learning and to explore the ideas, opinion, and analysis that describe our collective effort to thoroughly interrogate the subject at hand. Learning arises from active engagement with the knowledge found in our reading materials and with one another. As in any graduate class, the instructor's role is that of a guide who keeps you on this path of discovery.

## **Technological Requirements**

The course will be focused on using R as well as GeoDa for course assignments and hands-on practices in class. Both R and GeoDa are free, open-source software. The practice in class will use R and RStudio (an integrated development environment for R), and therefore the installation of the software in your computer (PC or Mac) is preferred. All of these software platforms can also be accessed via VMWare on the remote SSI Server. For weekly zoom class meetings and online access to SSI Server, every student must have the following:

- A computer with a fast Internet connection.
- A functional webcam and a microphone for use whenever a presentation or meeting is scheduled.

If a student does not have access to any of these, please speak with the instructor at the start of the semester to establish a workaround.

If you are unable to connect to the SSI Server or experience any type of technical issues relating to the server, send an email using your USC account to Tech Support at [spatial\\_support@usc.edu](mailto:spatial_support@usc.edu); make sure to copy (c.c.) you instructor on the email. Questions pertaining to specific assignments should be directed to your instructor.

*Communications* – All course materials and correspondence will be posted on the course Blackboard website. Your quizzes, exam, and assignments will be graded and returned via Blackboard. In addition to email about time-sensitive topics, announcements will be posted on the Blackboard Announcement page. It is each student's responsibility to stay informed as to course activities and updates. All students are in charge of ensuring that email sent from the USC Blackboard account is not directed to junk mail.

The instructor will endeavor to respond to email within 24 hours of receipt, aiming for no more than a 72-hour delay. An announcement will be posted in the rare instance when an instructor is offline for 72 hours or more.

## Required Readings and Supplementary Materials

The required textbook for this course is:

- Chi, Guangqing, and Jun Zhu. 2019. *Spatial Regression Models for the Social Sciences*. Thousand Oaks, CA: SAGE Publications.

Supplementary readings will be assigned from various sources including:

- Angrist, J.D., and A.B. Krueger. 1991. Does compulsory school attendance affect schooling and earnings? *The Quarterly journal of economics* 106(4): 979–1014.
- Anselin, L. 2019. The Moran scatterplot as an ESDA tool to assess local instability in spatial association. In *Spatial Analytical Perspectives on GIS*, pp. 111-126. Edited by Manfred Fischer, Henk J Scholten, and David Unwin. London: Routledge.
- Anselin, L. and S. Ray. 2014. Two stage least squares. In: *Modern Spatial Econometrics in Practice: A guide to GeoDa, GeoDaSpace, and PySAL*, pp. 139-142. GeoDa Press LLC.
- Arbia, G. 2014. The classical linear regression model. In: *A Primer for Spatial Econometrics: With Applications in R*, pp. 1-25. Palgrave Maximillian.
- Baltagi, B. H., and D. Li. 2004. Prediction in the panel data model with spatial correlation. In *Advances in Spatial Econometrics: Methodology, Tools and Applications*, pp. 283-295. Edited by Luc Anselin, R.J.G.M Florax, Sergio J. Rey. Berlin: Springer.
- Baum-Snow, N., M. E. Kahn., & R. Voith. (2005). Effects of urban rail transit expansions: Evidence from sixteen cities, 1970-2000. *Brookings-Wharton papers on urban affairs*, 147-206.
- Celebioglu, F., & S. Dall'erba. 2010. Spatial disparities across the regions of Turkey: an exploratory spatial data analysis. *Annals of Regional Science* 45(2): 379-400.
- Davis, D.R. & D. E. Weinstein. (2002). Bones, bombs, and break points: the geography of economic activity. *The American Economic Review*, 92(5), 1269-1289.
- Elhorst, J. P. 2014. Spatial panel data models. In *Spatial Econometrics from Cross-Sectional Data to Spatial Panels*, pp. 37-93. Berlin, Heidelberg: Springer.
- Elhorst, J. P. 2010. Applied spatial econometrics: raising the bar. *Spatial Economic Analysis* 5(1): 9-28.
- Fotheringham, A.S., C. Brunsdon, C., and M. Charlton. 2007. Statistical inference for spatial data. In: Fotheringham, A.S., Brunsdon, C., & Charlton, M. (eds.) *Quantitative Geography*. pp. 184-211. London: SAGE Publications Ltd.
- Fujita, M., P. R. Krugman, & A. Venables. 2001. *The spatial economy: Cities, regions, and international trade*. MIT press.
- Getis, A. (2009). Spatial weights matrices. *Geographical Analysis*, 41(4), 404-410.

- Gibbons, S. & H. G. Overman. 2012. Mostly pointless spatial econometrics? *Journal of Regional Science* 52(2): 172-191.
- Harris, N. L., E. Goldman, C. Gabris, J. Nordling, S. Minnemeyer, S. Ansari, & M. Lippmann. 2017. Using spatial statistics to identify emerging hot spots of forest loss. *Environmental Research Letters* 12(2): 024012.
- LeSage, J., and R. K. Pace. 2009. *Introduction to spatial econometrics*. Boca Raton, FL: CRC press.
- Li, G., S. Sun, & C. Fang. 2018. The varying driving forces of urban expansion in China: Insights from a spatial-temporal analysis. *Landscape and Urban Planning*, 174, 63-77.
- Livings, M. and A. Wu. 2020. Local measures of spatial association. *The Geographic Information Science & Technology Body of Knowledge* (3rd Quarter 2020 Edition), John P. Wilson (Ed.)
- Lloyd, C. 2014. Scale and multivariate data. In: *Exploring Spatial Scale in Geography*. John Wiley & Sons, Incorporated. pp. 106-111.
- Lukongo, O. E., & T. Miller. 2018. Evaluating the spatial consequence of interest rate ceiling using a spatial regime change approach. *The American Economist*, 63(2), 166-186.
- Miura, K. 2011. An introduction to maximum likelihood estimation and information geometry. *Interdisciplinary Information Sciences*, 17(3), 155-174.
- Nilsson, P. 2014. Natural amenities in urban space—A geographically weighted regression approach. *Landscape and Urban Planning*, 121, 45-54.
- Partridge, M.D., M. Boarnet, S. Brakman, and G. Ottaviano. 2012. Introduction: whither spatial econometrics? *Journal of Regional Science* 52(2): 167-171.
- Proost, S., & J. F. Thisse. 2019. What can be learned from spatial economics? *Journal of Economic Literature*, 57(3), 575-643.
- Purwaningsih, T., A. Ghosh, & C. Chumairoh. 2017. Spatial data modeling in disposable income per capita in china using nationwide spatial autoregressive (SAR). *International Journal of Advances in Intelligent Informatics*, 3(2), 98–106.
- Qian, S.S. 2016. Multilevel linear regression. In: *Environmental and Ecological Statistics with R* (2nd ed.). Chapman and Hall/CRC. pp.436-452.
- Salvati, L. 2019. Examining urban functions along a metropolitan gradient: a geographically weighted regression tells you more. *Letters in Spatial and Resource Sciences*, 12(1), 19-40.
- Sparks, P.J., and C. S. Sparks. 2010. An application of spatially autoregressive models to the study of US county mortality rates. *Population, Space & Place* 16(6): 465-481.
- Tian, L., H. Wang, and Y. Chen. 2010. Spatial externalities in China regional economic growth. *China Economic Review* 21: S20-S31.

- Wang, C. H., & N. Chen. 2015. A GIS-based spatial statistical approach to modeling job accessibility by transportation mode: Case study of Columbus, Ohio. *Journal of Transport Geography*, 45, 1–11.
- Wu, A. & K. K. Kemp. 2019. Global measures of spatial association. *The Geographic Information Science & Technology Body of Knowledge* (1st Quarter 2019 Edition), John P. Wilson (Ed.)
- Yin, C., M. Yuan, Y. Lu, Y. Huang, Y. Liu. 2018. Effects of urban form on the urban heat island effect based on spatial regression model. *Science of the Total Environment*, 634, 696–704.
- Zeng, Du, & Zhang. 2019. Spatial-Temporal Effects of PM2.5 on Health Burden: Evidence from China. *International Journal of Environmental Research and Public Health*, 16(23), 4695–.

## Description and Assessment of Assignments

Your grade in this course will be determined based on the basis of several different assessments:

*Resume Assignment – 2 worth a total of 4 points.* We require all current students to post and maintain a public resume, short biography and recent photo on our shared SSI Student Community Blackboard site. The resume is required to be prepared using the SSI template and following the SSI guideline.

The first resume assignment is planned during the first week and can be resubmitted upon the improvement and timeline suggested by the instructor. A second resume assignment is planned toward the end of the course so you can add the skills learned from this course to enhance your resume.

*Lead Class Discussion – 1 worth a total of 8 points.* Class discussion will focus on the theory portions of the course as presented in the weekly readings. Students will lead class discussion in pair on the assigned topic and schedule once during the semester. The objective is to promote the students in evaluating and integrating course readings as well as to enhance public presentation skills. Each pair of student discussion leaders prepares for a 15-minute opening statement presentation followed by 2-3 questions raised from the presentation material for class discussion.

*In-Class Work / Class Discussion - a total of 14 points.* An in-class engagement grade for the semester will be assigned based upon student engagement for in-class activities. Students unable to join classes synchronously will be able to obtain the grades by joining the online discussion forum in the same week. Failure to participate in in-class engagement activities will receive no grade for that week.

*Quizzes – 5 worth a total of 20 points.* There would be quizzes on the lectures and readings from the previous weeks. The top 5 scores would be counted toward the final grade. There is no mid-term exam, so the quizzes are the assessment of how well the students have learned the material during the semester.

*Projects – 4 worth a total of 26 points (1<sup>st</sup> Project worth 5 points, and Project 2,3,4 worth 7 points).* Students will be assigned 4 project-based homework assignments during the course. The assignments include one research plan and three hands-on exercises on spatial techniques

explored in theory in the texts. The last project is to develop a Story Map with a case study of spatial statistics and spatial econometrics using the methods learned throughout the course. Students will present the last project's Story Map in the final presentation (see below).

*Final Presentation* – 1 worth a total of 8 points. A final presentation of the project Story Map will be delivered in the final week during the class session.

*Final Exam* – 1 worth a total of 20 points. A comprehensive final exam will be conducted during the final exam week following the university exam schedule.

## Grading Breakdown

Assessment	Number	Points Each	Total Points
Resume Assignments	2	2	4
Presentation/Lead Class Discussions	1	8	8
In-class Work / Class Discussion		14	14
Quizzes	5	4	20
Projects 1	1	5	5
Project 2,3,4	3	7	21
Final Presentation	1	8	8
Final exam	1	20	20
Total	-	-	100

## Assignment Submission Policy

Assignments must be submitted via Blackboard by the due dates specified in the Course Schedule below and on the assignment instructions. Unless otherwise noted, all assignments are *due by 11:59 pm Pacific Time (PT) on the due dates*. Your attention to on-time assignment submission is essential.

If you are physically located in a different time zones and have difficulty to join the live zoom sessions, please make sure to contact me in advance so I can arrange quizzes asynchronously.

## Course Schedule: A Weekly Breakdown

	Topics	Readings and Assignments	Deliverables/Dues
<i>Module 1: Overview of Spatial Economics and Spatial Econometrics</i>			
<b>Week 1</b> 8/23	Introduction to course	Resume Assignment 1 Fujita et al. (2001) Ch1	Resume Assignment 1: due Friday, 8/27

8/25	Introduction to spatial econometrics	LeSage & Pace (2009) Ch1	
<b>Week 2</b> 8/30	Urban economics overview	Fujita et al. (2001) Ch2 Proost & Thisse (2019) Sec.4 Baum-Snow et al. (2005)	Sign-up for lead class discussion
9/01	Regional science overview	Fujita et al. (2001) Ch3 Proost & Thisse (2019) Sec.3 Davis & Weinstein (2002)	
<b>Week 3</b>  9/8* *9/6 is a University holiday	Spatial statistics concept framework	Fotheringham et al. (2007) Ch8 Chi & Zhu (2019) Ch2 p.21-33 Project 1	In-class quiz
<i>Module 2: Spatial Weights and Spatial Autocorrelation</i>			
<b>Week 4</b> 9/13	Spatial weights matrix	Chi & Zhu (2019) p.33-41 Getis (2009)	
9/15	Global measures of spatial association	Chi & Zhu (2019) p.41-46 Wu & Kemp (2019) Anselin (2019)	
<b>Week 5</b>  9/20	Local measures of spatial association	Chi & Zhu (2019) p.47-53 Livings & Wu (2020) Celebioglu & Dall'erba. (2010)	Submit Project 1 on the Blackboard no later than 5 p.m. on Tuesday, 9/21
<i>Module 3: Non-Spatial Regression Models</i>			
9/22	Classic linear regression models	Arbia (2014) Ch1 Project 2	In-class quiz
<b>Week 6</b> 9/27	Endogeneity, instruments and two step least squares (2SLS)	Anselin & Ray (2014) pp. 139-142 Angrist & Krueger (1991)	
9/29		Muir (2011)	



	Likelihood function & maximum likelihood estimation		
<b>Week 7</b> 10/4	Multilevel linear regression (MLR)	Chi & Zhu (2019) Sec. 4.3 pp. 98-110 Qian (2016) Sec. 10.4 pp. 436-452.	
<i>Module 4: Spatial Regression Models</i>			
10/6	Motivation of regression for spatial econometrics models	LeSage and Pace (2014) Ch2 Chi & Zhu (2019) Sec 3.1 pp.55-64	In-class quiz
<b>Week 8</b> 10/11	Spatial autoregressive process	Lloyd (2014) Sec. 5.5 pp.106-111 Purwaningsih et al. (2017)	Submit Project 2 on the Blackboard no later than 5 p.m. on Tuesday, 10/12
10/13* *10/14-15 are Fall Recess	Spatial lag models (SLM)	Chi & Zhu (2019) Sec 3.2 pp.65-73 Wang and Chen (2015) Project 3	
<b>Week 9</b> 10/18	Spatial error models (SEM)	Chi & Zhu (2019) Sec 3.3 pp.74-83 Yin et al. (2018)	In-class quiz
10/20	Spatial Durbin models	Elhorst (2010) Zeng et al. (2019)	
<b>Week 10</b> 10/25	Spatial cross-regressive models	Chi & Zhu (2019) Sec 4.1-4.2 pp. 85-97	
10/27	Models dealing with spatial heterogeneity: Spatial regime models	Chi & Zhu (2019) Sec 5.1-5.2 pp.113-126	

<b>Week 11</b> 11/1	Geographically weighted regression	Chi & Zhu (2019) Sec 5.3 pp.127-138 Nilsson (2014) Salvati (2019)	Submit Project 3 on the Blackboard no later than 5 p.m. on Tuesday, 11/2
<i>Module 5: Advanced Spatial Regression Methods</i>			
11/3	Dealing with both spatial dependency and spatial heterogeneity I	Chi & Zhu (2019) Ch 6 Resume assignment 2 Project 4	In-class quiz
<b>Week 12</b> 11/8	Dealing with both spatial dependency and spatial heterogeneity II	Baltagi & Li (2004) Lukongo & Miller (2018)	Submit Resume Assignment 2 by Friday, 11/12
11/10	Spatial panel model	Chi & Zhu (2019) Ch7 pp.155-167 Elhorst (2014) pp.37-53; 53-93	
<b>Week 13</b> 11/15	More on spatiotemporal analysis	Harris et al. (2017) Li et al. (2018)	In-class quiz
11/17	Problems and critiques of spatial econometrics models	Gibbons & Overman (2012) Patridge et al. (2012)	
<b>Week 14</b> 11/22* *11/24-28 are University holidays	Practical applications of spatial econometric models and summative discussion	Sparks & Sparks (2010) Tian et al. (2010)	Submit Project 4 on 11:59 p.m. on Tuesday, 11/23
<b>Week 15</b> 11/29 12/1* *Friday, 12/3 is the last day of class	Project presentation I  Project presentations II		Project presentations during class time
<b>Final Exam Week</b> (12/8-12/15)	Final Exam		Final exam follows the Final Exam Schedule

## Statement on Academic Conduct and Support Systems

### *Academic Conduct*

Plagiarism – presenting someone else’s ideas as your own, either verbatim or recast in your own words – is a serious academic offense with serious consequences. Please familiarize yourself with the discussion of plagiarism in SCampus in Part B, Section 11, “Behavior Violating University Standards <https://policy.usc.edu/files/2020/07/SCampus-Part-B-1.pdf>. Other forms of academic dishonesty are equally unacceptable. See additional information in SCampus and university policies on scientific misconduct, [policy.usc.edu/scientific-misconduct](https://policy.usc.edu/scientific-misconduct).

### *Support Systems*

*Counseling and Mental Health*– (213) 740-9355 – 24/7 on call  
[engemannshc.usc.edu/counseling](https://engemannshc.usc.edu/counseling)

Free and confidential mental health treatment for students, including short-term psychotherapy, group counseling, stress fitness workshops, and crisis intervention.

*National Suicide Prevention Lifeline* – 1 (800) 273-8255 – 24/7 on call  
[www.suicidepreventionlifeline.org](https://www.suicidepreventionlifeline.org)

Free and confidential emotional support to people in suicidal crisis or emotional distress 24 hours a day, 7 days a week.

*Relationship and Sexual Violence Prevention Services (RSVP)* – (213) 740-9355(WELL), press “0” after hours – 24/7 on call  
[studenthealth.usc.edu/sexual-assault](https://studenthealth.usc.edu/sexual-assault)

Free and confidential therapy services, workshops, and training for situations related to gender-based harm.

*Office of Equity and Diversity (OED)* – (213) 740-5086 | *Title IX Compliance* – (213) 821-8298  
[equity.usc.edu](https://equity.usc.edu), [titleix.usc.edu](https://titleix.usc.edu)

Information about how to get help or help someone affected by harassment or discrimination, rights of protected classes, reporting options, and additional resources for students, faculty, staff, visitors, and applicants.

*Reporting Incidents of Bias or Harassment*– (213) 740-5086 or (213) 821-8298  
[usc-advocate.symplicity.com/care\\_report](https://usc-advocate.symplicity.com/care_report)

Avenue to report incidents of bias, hate crimes, and microaggressions to the Office of Equity and Diversity | Title IX for appropriate investigation, supportive measures, and response.

*The Office of Disability Services and Programs* – (213) 740-0776  
[dsp.usc.edu](https://dsp.usc.edu)

Support and accommodations for students with disabilities. Services include assistance in providing readers/notetakers/interpreters, special accommodations for test taking needs, assistance with architectural barriers, assistive technology, and support for individual needs.

*USC Campus Support and Intervention – (213) 821-4710*

[campussupport.usc.edu](http://campussupport.usc.edu)

Assists students and families in resolving complex personal, financial, and academic issues adversely affecting their success as a student.

*Diversity at USC – (213) 740-2101*

[diversity.usc.edu](http://diversity.usc.edu)

Information on events, programs and training, the Provost's Diversity and Inclusion Council, Diversity Liaisons for each academic school, chronology, participation, and various resources for students.

*USC Emergency - UPC: (213) 740-4321, HSC: (323) 442-1000 – 24/7 on call*

[dps.usc.edu](http://dps.usc.edu), [emergency.usc.edu](http://emergency.usc.edu)

Emergency assistance and avenue to report a crime. Latest updates regarding safety, including ways in which instruction will be continued if an officially declared emergency makes travel to campus infeasible.

*USC Department of Public Safety – - UPC: (213) 740-6000, HSC: (323) 442-120 – 24/7 on call*

[dps.usc.edu](http://dps.usc.edu)

Non-emergency assistance or information.

### ***Resources for Online Students***

The Course Blackboard page and the GIST Community Blackboard page have many resources available for distance students enrolled in our graduate programs. In addition, all registered students can access electronic library resources through the link <https://libraries.usc.edu/>. Also, the USC Libraries have many important resources available for distance students through the link: <https://libraries.usc.edu/faculty-students/distance-learners>. These include instructional videos, remote access to university resources, and other key contact information for distance students.