

Dana and David Dornsife College of Letters, Arts and Sciences Spatial Sciences Institute

SSCI 381 (35798R), Statistics for the Spatial Sciences

Syllabus

Units: 4

Term Day Time: Fall 2024, W and F from 8:00-9:50am

Location: WPH 101

Instructor: Katherine Lester, PhD Office: AHF B55A Regular Office Hours: Mon and Wed 2:30-3:30 pm PT. Also available most days and times by appointment via email. Contact Info: lesterk@usc.edu, 213-821-0672

Library Help: Andy Rutkowski Office: LIPA B40-A Office Hours: Thu 10 am-12 pm Contact Info: <u>arutkows@usc.edu</u>, see contact page on D2L for Zoom Room

IT Help: Myron Medalla Office: AHF B56B Office: By appointment via email Contact Info: spatial support@usc.edu, 213-740-4415

Course Scope and Purpose

This is an introductory course to statistics and statistical fundamentals in geospatial analysis. The emphasis will be on the theory and applications of spatial statistics as they pertain to analysis and problem solving. Statistics foundations and their spatial counterparts frequently used in spatial analysis will be introduced with real-world use cases. The course is designed to provide statistical principles necessary to conduct and understand fundamental analysis methods in spatial problem solving. This course will build on the fundamentals with use cases from spatial sciences. The topics will include descriptive and inferential statistics, sampling, estimation, and hypothesis testing. Commonly used spatial analysis methodologies such as spatial centrality and spatial regression will be introduced. Methodologies will be applied to case studies ranging from statistically exploring sociodemographic disparities pertinent to the COVID-19 pandemic to modeling earthquake occurrence patterns.

Learning Outcomes

Upon successful completion of this course, a student will be able to:

- Describe mathematical and statistical foundations for spatial statistics
- Identify appropriate spatial statistical methodologies for solving real-world problems
- Explore the strengths and limitations of statistical methodologies that are frequently used in spatial analysis
- Design a solution for a spatial modelling problem using spatial statistics

Students may vary in their competency levels on these abilities. You can expect to acquire these abilities only if you honor all course policies, attend classes regularly, complete all assigned work in good faith and on time, and meet all other course expectations of you as a student.

Prerequisite(s): None
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 (<u>titleix@usc.edu</u> or 213-821-8298) without sharing any personal information with me. If you would like to speak with a confidential counselor, Relationship and

Last Revised on 3/8/24

SSCI 381 Syllabus, Page 2 of 13

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

COVID-19 policy -- Students are expected to comply with all aspects of USC's COVID-19 policy including, but not limited to, vaccination, indoor mask mandate, and daily TrojanCheck. Failure to do so may result in removal from the class and referral to Student Judicial Affairs and Community Standards. Students are recommended to keep safe physical distancing, whenever possible, to prevent any possible transmission. Please contact your instructor if you have any safety concerns.

Diversity and Inclusion – It is my intent that students from all diverse backgrounds and perspectives be well served by this course, that students' learning needs be addressed both in and out of class, and that the diversity that students bring to this class be viewed as a resource, strength and benefit. It is my intent to present materials and activities that are respectful to everyone, and you are also expected to respect of others regardless of their race, ethnicity, gender identity and expressions, cultural beliefs, religion, sexual orientation, national origin, age, abilities, ideas and perspectives, or socioeconomic status. Your suggestions are encouraged and appreciated. Feel free to let me know ways to improve the effectiveness of the course for you personally or for other students.

Course Structure

The main theoretical concepts are provided through a directed reading of the text *Geographic Information Analysis.* The course reader will emerge as a collection of reading notes that provide the basis for an informed review of most chapters. Additional readings will be assigned to expand on the text when needed. The course will generally unfold on a biweekly basis. When possible, assignments will be given in advance, but usually they will be posted on or before Mondays. Practical exercises utilize published tutorial materials using ArcGIS and a final project allows students to demonstrate their ability to apply spatial analytical tools in an appropriate, informed manner.

Workload – This is a four credit, one semester course. Students should expect to spend 10-15 hours per week completing the work in this course.

Technological and Communication Requirements

ArcGIS and SPSS provided online via the GIST Server; hence, you do not need to install it on your own computer. Instead, every student must have the following technology requirements:

- A computer with a fast Internet connection.
- A functional webcam and a microphone for use whenever a presentation or meeting is scheduled.
- An up-to-date web browser to access the Server

Additionally, SPSS can be accessed through USC's Cloud Apps at <u>https://software.usc.edu/cloudapps-usc-edu/.</u>

If a student does not have access to any of these, please speak with the instructor at the start of the semester. Also, see the USC ITS Student Toolkit here: <u>https://keepteaching.usc.edu/students/student-toolkit/</u>

- *Desire2Learn (D2L)* This course will utilize the Desire2Learn (D2L) learning management system which allows students to access course content, upload assignments, participate in discussion forms, among other learning experiences.
- SSI Server and Tech Support This course utilizes the SSI Server which is a virtual desktop giving access to many different professional software. If you are unable to connect to the server or experience any type of technical issues, send an email using your USC account to SSI Tech Support at <u>spatial support@usc.edu</u>, making sure to copy (cc) me on the email.
- *Communications* All assignments given and all materials to be handed in will be submitted via D2L. The instructor will also create and monitor discussion forums through which students can discuss issues and assignments as needed. Students should read all email sent from D2L or from course instructor(s) as soon as possible. Also, students who do not regularly use their USC email accounts should double-check to be sure that mail sent from both the D2L accounts and the instructor's account (noted above) to your USC account is forwarded to an address used regularly and does not go into junk mail. The instructor will endeavor to respond to all email within 24 hours of receipt, aiming for no more than 72 hours delay. In the rare case that an instructor is off-line for an extended periodof time, an announcement will be posted to the class D2L site. Due to the synchronous and asynchronous nature of this course, it is each student's responsibility to stay informed and connected with others in our course. In addition to email, students are expected to login to D2L regularly to check for announcements.
- Discussion forums On the D2L site, I will post a series of discussion threads relevant to various sections of the course. Discussions provide a key means for student-to-student discussion and collaboration that can replicate the face-to-face contact you may have experienced in traditional classrooms. Here students can provide support to each other while working on your assignments, sharing hints and helpful tips, as you would in a classroom laboratory. Please post your questions about assignments there, as you would ask them publically in the classroom. I monitor the discussion threads and offer comments when necessary, but more importantly, consider the discussion board a key way to connect with your classmates and share your discoveries.

Required Readings and Supplementary Materials

The required textbooks for this course are:

• Rogerson, Peter A. 2020. *Statistical Methods for Geography: A student's guide (5th Edition)*. Thousand Oaks, CA: Sage Publications.

• Huff, Darrell. 1993. *How to Lie with Statistics*. New York, NY: W.W. Norton and Company. *Note-edition does not matter. If you find one from 1954 it's essentially the same*

Supplementary readings will be assigned from various sources including but not limited to:

- Bivand, R. S., Pebesma, E., and Gómez-Rubio, V. 2013. "Chapter 1: Hello World: Introducing Spatial Data." In *Applied Spatial Data Analysis with R* (2nd ed. 2013). Springer New York.
- Bolin, D., Verendel, V., Berghauser Pont, M., Stavroulaki, I., Ivarsson, O., & Håkansson, E. 2021. "Functional ANOVA modelling of pedestrian counts on streets in three European cities." *Journal of the Royal Statistical Society. Series A, Statistics in Society*, 184(4), 1176–1198.
- Capel, E., Cleal, C. J., Gerrienne, P., Servais, T., & Cascales-Miñana, B. 2021. A factor analysis approach to modelling the early diversification of terrestrial vegetation. *Palaeogeography, Palaeoclimatology, Palaeoecology*. Volume pp. *566*, 110170–.
- Cai, J., Kwan, M.-P., Kan, Z., & Huang, J. (2023). Perceiving noise in daily life: How real-time sound characteristics affect personal momentary noise annoyance in various activity microenvironments and times of day. *Health & Place*, 83, 103053–103053.
- Chen, Y., & Baker, J. W. 2019. Spatial correlations in CyberShake physics-based groundmotion simulations. *Bulletin of the Seismological Society of America*, 109(6), 2447–2458.
- Legendre, Pierre. "Spatial autocorrelation: trouble or new paradigm?" *Ecology* 74, no. 6 (1993): 1659-1673.
- Getis, Arthur, and J. Keith Ord. "The analysis of spatial association by use of distance statistics." In *Perspectives on Spatial Data Analysis*, pp. 127-145. Springer, Berlin, Heidelberg, 2010.
- Greenberg, A. J., Haney, D., Blake, K. D., Moser, R. P., & Hesse, B. W. 2018. Differences in Access to and Use of Electronic Personal Health Information Between Rural and Urban Residents in the United States. The Journal of Rural Health, 34(S1), s30–s38.
- Jato-Espino, D., Sillanpää, N., Andrés-Doménech, I., & Rodriguez-Hernandez, J. 2018. Flood Risk Assessment in Urban Catchments Using Multiple Regression Analysis. *Journal* of Water Resources Planning and Management, 144(2).
- Kwan, M.-P. 2012. The Uncertain Geographic Context Problem. Annals of the Association of American Geographers, 102(5), 958–968.
- Ripley, Brian D. "Tests of 'randomness' for spatial point patterns." *Journal of the Royal Statistical Society: Series B (Methodological)* 41, no. 3 (1979): 368-374.
- Shearmur, R., Ananian, P., Lachapelle, U., Parra-Lokhorst, M., Paulhiac, F., Tremblay, D.-G., & Wycliffe-Jones, A. 2022. Towards a post-COVID geography of economic activity: Using probability spaces to decipher Montreal's changing workscapes. Urban Studies (Edinburgh, Scotland), 59(10), 2053–2075.
- Guo, Diansheng. "Local entropy map: A nonparametric approach to detecting spatially varying multivariate relationships." *International Journal of Geographical Information Science* 24, no. 9 (2010): 1367-1389.

- Brunsdon, Chris, A. Stewart Fotheringham, and Martin E. Charlton. "Geographically weighted regression: a method for exploring spatial nonstationarity." *Geographical Analysis* 28, no. 4 (1996): 281-298.
- Ruiz, M., López, F., & Páez, A. 2010. Testing for spatial association of qualitative data using symbolic dynamics. Journal of Geographical Systems, 12(3), 281–309.

Readings subject to change.

Description and Assessment of Assignments

Weekly Assignments

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

Discussion Questions: 10 worth 1 point each. For every chapter in the Rogerson book, I will post3-5 questions for you to answer. Then, you will ask three questions of your own based on the readings. These assignments will be due by 5:00pm on the <u>MONDAY</u> before class. Your responses will help me guide our discussions and avoid "teaching to the text" lectures.

- *Projects: 3 worth 15 points each.* Over the course of the semester you will have three projects which will provide you the opportunity to apply the methods we discuss. You will have about two weeks to complete the assignment individually. Then, you will have one more week to discuss and compile a final version in a group of 3-4 students. Your project grade will be based on both the individual and group assessment.
- Discussion Leader: 1 worth 5 points. Each student will be assigned to lead a discussion on an article, research report, or another relevant document. While all students must read the assigned materials, the discussion leader will create 8-10 questions to help guide our conversation. Then, students will give a brief overview of the article to their classmates and lead us through the questions in class. These questions will be due at 5:00pm two days before the class date (i.e. if the article is assigned for Friday, your questions are due by Wednesday at 5:00pm).
- Midterm Exam: 1 worth 20 points. A written midterm exam will be given to gauge your understanding of the content covered in the first half of the course. Expect a variety of question types including short answer, diagramming, and mathematical calculations. Students are expected to take the exam on the scheduled day/time.
- *Final Exam: 1 worth 20 points*. A written final will be given to assess your understanding of the content covered after the midterm. Students are expected to take the exam on the scheduled day/time.

Grading Breakdown

Assessment	Number	Points Each	Total Points
Discussion Questions	10	1	10
Projects	3	15	45
Discussion Leader	1	5	5
Midterm Examination	1	20	20
Final Examination	1	20	20
Total	16	-	100

Grading Scale

Assignments in this and other SSCI courses, are graded on the letter grade scale where A is exemplary, B is very good, C is satisfactory, D is unsatisfactory, and F needs improvement. Final grades use the same letter grade scale with C being the minimum passing grade for credit at the graduate level. The grading scale follows:

А	> 93 points	B-	80-82 points	D+	67-69 points
A-	90-92 points	C+	77-79 points	D	63-66 points
B+	87-89 points	С	73-76 points	D-	60-62 points
В	83-86 points	C-	70-72 points	F	<60 points

Assignment Submission Policy

Unless otherwise noted, assignments must be submitted via D2L by the due dates specified in the Course Schedule below and on the assignment instructions.

Unless otherwise noted, all Reading Assignments and Tutorials are *due by 11:59 pm Pacific Time (PT) on Mondays.* Project components have different due dates as indicated on the Course Schedule below. Your attention to on-time assignment submission is essential if I am to meet my goal to return comments on your submitted assignments before the next one is due. Sometimes this is impossible, so I will post a notice on anticipated delays if needed.

Strict penalties apply for late assignments as follows:

- All assignments will be penalized 1 point per day up to FOUR days late. No points will be given for submissions more than FOUR days late. Note that all assignments worth 1 point will receive 0 points if submitted late.
- Additionally, no written work will be accepted for grading after 5 pm PT on the last day of classes.
- Absences from class sessions must be requested by sending an email to the instructor. Excused absences from class sessions will be granted only for valid reasons; please notify me of the reason for your absence in your email.

Last Revised on 3/8/24

Grading Timeline

My goal is to provide grading and feedback on each course assignment no later than one week after the assignment was submitted.

Course Content Distribution and Synchronous Session Recordings Policies

USC has policies that prohibit recording and distribution of any synchronous and asynchronous course content outside of the learning environment.

Recording a university class without the express permission of the instructor and announcement to the class, or unless conducted pursuant to an Office of Accessibility Services (OSAS) accommodation. Recording can inhibit free discussion in the future, and thus infringe on the academic freedom of other students as well as the instructor. (Living our Unifying Values: The USC Student Handbook, page 13).

Distribution or use of notes, recordings, exams, or other intellectual property, based on university classes or lectures without the express permission of the instructor for purposed other than individual or group study is prohibited. This includes but is not limited to providing materials for distribution by services publishing course materials. This restriction on unauthorized use also applies to all information, which has been distributed to students or in any way has been displayed for use in relationship to the class, whether obtained in class, via email, on the internet, or via any other media. (Living our Unifying Values: The USC Student Handbook, page 13).

Learning Experience Evaluations

Please note Learning Experience Evaluations for the course take place at the end of the semester and are facilitated by the University. These evaluations provide an important review of student experiences in the course.

Course Schedule

Week	Topic Assignments & Readings		Deliverables/Due Dates			
Module 1: Introducing Statistical Methods for Geography						
Week 1 8/28	The scientific method, probability, and statistics					
8/30	Descriptive and inferential methods, special considerations for spatial data	Rogerson Ch.1, Huff Ch. 1				
Module 2: Descriptive Statistics						
Week 2 9/4	Data types, charts, and measures of central tendency	Rogerson Ch. 2	Discussion Questions due Monday, 9/2 by 5:00pm			

Week	Торіс	Assignments & Readings	Deliverables/Due Dates		
9/6	Variability, z-scores, and spatial descriptives	Legendre (1993), Huff Ch. 2 Descriptives Project			
		Assignment			
	Module	3: Probability			
Week 3 9/11	Introduction to probability	Rogerson Ch. 3	Discussion Questions due Monday, 9/9 by 5:00pm		
9/13	Discrete probability distributions	Getis and Ord (2010), Huff Ch. 3			
Week 4 9/18	Continuous probability distributions	Rogerson Ch. 4	Discussion Questions due Monday, 9/16 by 5:00pm		
9/20	Probability models	robability models Shearmur et al. (2022), Huff Ch. 5-7			
Module 4: Inferential Statistics					
Week 5 9/25	Confidence intervals, z-tests, and t- tests	Rogerson Ch. 5	Discussion Questions due Monday, 9/23 by 5:00pm		
9/27	Assumption checking and spatial considerations/methods	Ripley (1979), Huff Ch. 4	Descriptives Project (Individual) due Friday, 9/27 by 5:00pm		
	Module 5: A	nalysis of Variance			
Week 6 10/2	Introduction to variance and assumption checking	Rogerson Ch. 6	Discussion Questions due Monday, 9/30 by 5:00pm		
10/4	Kruskal-Wallace and ANOVA Bolin et al. (2021)		Descriptives Project (Group) due Friday, 10/4 by 5:00pm		
Module 6: Correlation					
Week 7 10/9	Midterm Exam		Midterm Exam		
10/11	*Fall Break, No Class				
Week 8 10/16	Introduction to correlation	Rogerson Ch. 7 Covariance and Correlation Assignment	Discussion Questions due Monday, 10/14 by 5:00pm		
10/18	Spearman's rank correlation and spatial considerations	Chen and Baker (2019), Huff Ch. 8-10			
Module 7: Data Reduction					

Week	Торіс	Topic Assignments & Readings				
Week 9 10/23	Factor Analysis	Rogerson Ch. 8	Discussion Questions due Monday, 10/21 by 5:00pm			
10/25	Cluster Analysis	Capel et al. (2021)	Variance and Correlation Project (Individual) due Friday, 10/25 by 5:00pm			
	Module	8: Regression				
Week 10 10/30	Introduction to bivariate regression	Rogerson Ch. 9	Discussion Questions due Monday, 10/28 by 5:00pm			
11/1	Assumption checking and linear v. non- linear methods	Greenberg et al. (2018)	Variance and Correlation Project (Group) due			
Week 11 11/6	Multiple regression	Regression Project Assignment Rogerson Ch. 10	Friday, 11/1 by 5:00pm Discussion Questions due Monday, 11/4 by 5:00pm			
11/8	Variables and common errors	Jato-Espino et al. (2018)				
Week 12 11/13	Introduction to spatial patterns and spatial regression	Rogerson Ch. 11	Discussion Questions due Monday, 11/11 by 5:00pm			
11/15						
Week 13 11/20	Geographically weighted regression	Brunsdon, Fotheringham, and Charlton (1996)				
11/22	Introducing R	Bivand, Pebesma, and Gomez- Rubio (2013, Ch. 1)	Regression Project (Individual) due Friday, 11/22 by 5:00pm			
Week 14 11/27	* Thanksgiving Break-No Class					
11/29	* Thanksgiving Break-No Class					
Module 9: Thinking like a Spatial Statistician						
Week 15	Hotspots and local entropy, qualitative methods	Guo (2010), Ruiz Lopez & Paez (2010)				
12/6	Uncertain geographic context problem, neighborhood effect averaging problem, stationarity bias	Kwan (2012), Cai et al. (2023)	Regression Project (Group) due Friday, 12/6 by 5:00pm			
	Final Exam – Wednesday, Dec. 11 @ 8:00-10:00am PST					

Statement on Academic Conduct and Support Systems

Academic Integrity

Last Revised on 3/8/24

The University of Southern California is a learning community committed to developing successful scholars and researchers dedicated to the pursuit of knowledge and the dissemination of ideas. Academic misconduct, which includes any act of dishonesty in the production or submission of academic work, comprises the integrity of the person who commits the act and can impugn the perceived integrity of the entire university community. It stands in opposition to the university's mission to research, educate, and contribute productively to our community and the world.

All students are expected to submit assignments that represent their own original work, and that have been prepared specifically for the course or section for which they have been submitted. You may not submit work written by others or "recycle" work prepared for other courses without obtaining written permission from the instructor(s).

Other violations of academic integrity include, but are not limited to, cheating, plagiarism, fabrication (e.g., falsifying data), collusion, knowingly assisting others in acts of academic dishonesty, and any act that gains or is intended to gain an unfair academic advantage.

The impact of academic dishonesty is far-reaching and is considered a serious offense against the university. All incidences of academic misconduct will be reported to the Office of Academic Integrity and could result in outcomes such as failure on the assignment, failure in the course, suspension, or even expulsion from the university.

For more information about academic integrity see <u>the student handbook</u> or the <u>Office of</u> <u>Academic Integrity's website</u>, and university policies on <u>Research and Scholarship Misconduct</u>.

Please ask your instructor if you are unsure what constitutes unauthorized assistance on an exam or assignment, or what information requires citation and/or attribution.

Students and Disability Accommodations:

USC welcomes students with disabilities into all of the University's educational programs. The Office of Student Accessibility Services (OSAS) is responsible for the determination of appropriate accommodations for students who encounter disability-related barriers. Once a student has completed the OSAS process (registration, initial appointment, and submitted documentation) and accommodations are determined to be reasonable and appropriate, a Letter of Accommodation (LOA) will be available to generate for each course. The LOA must be given to each course instructor by the student and followed up with a discussion. This should be done as early in the semester as possible as accommodations are not retroactive. More information can be found at <u>osas.usc.edu</u>. You may contact OSAS at (213) 740-0776 or via email at <u>osasfrontdesk@usc.edu</u>.

Support Systems:

Counseling and Mental Health - (213) 740-9355 – 24/7 on call

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

<u>988 Suicide and Crisis Lifeline</u> - 988 for both calls and text messages – 24/7 on call

Last Revised on 3/8/24

SSCI 381 Syllabus, Page 11 of 13

The 988 Suicide and Crisis Lifeline (formerly known as the National Suicide Prevention Lifeline) provides free and confidential emotional support to people in suicidal crisis or emotional distress 24 hours a day, 7 days a week, across the United States. The Lifeline is comprised of a national network of over 200 local crisis centers, combining custom local care and resources with national standards and best practices. The new, shorter phone number makes it easier for people to remember and access mental health crisis services (though the previous 1 (800) 273-8255 number will continue to function indefinitely) and represents a continued commitment to those in crisis.

<u>Relationship and Sexual Violence Prevention Services (RSVP)</u> - (213) 740-9355(WELL) – 24/7 on call

Free and confidential therapy services, workshops, and training for situations related to genderand power-based harm (including sexual assault, intimate partner violence, and stalking).

Office for Equity, Equal Opportunity, and Title IX (EEO-TIX) - (213) 740-5086

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

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

The Office of Student Accessibility Services (OSAS) - (213) 740-0776

OSAS ensures equal access for students with disabilities through providing academic accommodations and auxiliary aids in accordance with federal laws and university policy.

USC Campus Support and Intervention - (213) 740-0411

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

Diversity, Equity and Inclusion - (213) 740-2101

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.

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

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.

<u>USC Department of Public Safety</u> - UPC: (213) 740-6000, HSC: (323) 442-1200 – 24/7 on call

Non-emergency assistance or information.

Office of the Ombuds - (213) 821-9556 (UPC) / (323-442-0382 (HSC)

Last Revised on 3/8/24

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SSCI 381 Syllabus, Page 12 of 13

A safe and confidential place to share your USC-related issues with a University Ombuds who will work with you to explore options or paths to manage your concern.

Occupational Therapy Faculty Practice - (323) 442-2850 or otfp@med.usc.edu

Confidential Lifestyle Redesign services for USC students to support health promoting habits and routines that enhance quality of life and academic performance.

Resources for Online Students

The Course D2L page and the SSI Student Hub on D2L 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 <u>https://libraries.usc.edu/</u>. Also, the USC Libraries have many important resources available for distance students through the link: <u>https://libraries.usc.edu/faculty-students/distance-learners</u>. These include instructional videos, remote access to university resources, and other key contact information for distance students.