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

SSCI 681, Advanced Quantitative Methods for Population, Health and Place

Syllabus

Units: 4

Term Day Time: Fall 2021 – Wednesdays 2:00 – 4:50 pm

Location: THH 221

Instructor: Orhun Aydin, PhD
Office: AHF B56G
Regular Office Hours: Fri 12-1 pm. Also available by appointment via email.
Contact Info: oaydin@usc.edu, 213-740-2835

Library Help: Andy Rutkowski
Office: VKC 36B
Office Hours: Thu 10 am-12 pm.
Contact Info: arutkows@usc.edu, see contact page on Blackboard for Zoom Room

IT Help: Richard Tsung
Office: AHF 145D
Office Hours: By appointment
Contact Info: spatial_support@usc.edu, 213-821-4415

Course Scope and Purpose

Time has become an indispensable dimension in spatial analysis. Whether it is the dynamics of our planet, our cities, or our social patterns, time is a common denominator that unlocks spatial data's full potential. Space-time is an essential dimension to evaluate spatial data that has a time component.

In this PhD-level course, the fundamentals of temporal and spatiotemporal data science will be introduced. The course consists of modern methods to represent, visualize, summarize, forecast and manage spatiotemporal data will be explored. Applied examples will be performed in R and ArcGIS Pro. A working knowledge of R and ArcGIS is required.

Learning Outcomes

On completion of this course, students should be able to:

- Identify the principles and approaches that might be used to solve various spatiotemporal problems in GIS
- Learn how to wrangle and visualize spatiotemporal field data
- Identify strategies for analyzing different temporal data in spatial analysis
- Communicate and derive insights from spatiotemporal data.

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 (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

The course will be taught as a series of classes that will introduce concepts, theory and use-cases behind spatio-temporal analysis. Teaching strategies are designed to empower the students with broad knowledge of spatio-temporal statistics and practical skills to solve real-world problems. Classes will consist of lectures on fundamentals and discussions about reading materials. Students will be required to complete hands-on assignments that explore data wrangling, visualization and forecasting for spatio-temporal problems.

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 is 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

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:
https://keepteaching.usc.edu/students/student-toolkit/

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 spatial_support@usc.edu, making sure to copy (cc) me on the email.

Communications – All materials to be handed in will be submitted via Blackboard. It is each student's responsibility to stay informed about what is going on in our course. In addition to email about time-sensitive topics, any important announcements will be posted on the Announcement page in Blackboard. Be sure to check these each time you log onto Blackboard.

I will send via email through Blackboard any notices that are time-sensitive. Please be sure that you read as soon as possible all emails sent from Blackboard or from me. Do not ignore course email until the day before assignments are due. Also double check to be sure that email sent from the USC blackboard account does not go into your junk mail!

While I am usually on-line all day and will probably respond to emails from students very quickly, I will endeavor to respond to all email within 24 hours of receipt, aiming for no more than 72 hours delay. In the rare case when I expect to be off-line for more than 72 hours, I will post an announcement on the Blackboard site.

Discussion forums – On the Blackboard 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:

- Wikle, Christopher K., Andrew Zammit-Mangion, and Noel Cressie. Spatio-temporal Statistics with R. CRC Press, 2019.

Supplementary readings will be assigned from various sources including:

- De Gooijer, Jan G., and Rob J. Hyndman. "25 years of time series forecasting." International Journal of Forecasting 22, no. 3 (2006): 443-473.
- Desjardins, M. R., Hohl, A., & Delmelle, E. M. (2020). Rapid surveillance of COVID-19 in the United States using a prospective space-time scan statistic: Detecting and evaluating emerging clusters. Applied Geography, 118, 102202.
- Ferreira, Nivan, Jorge Poco, Huy T. Vo, Juliana Freire, and Cláudio T. Silva. "Visual exploration of big spatio-temporal urban data: A study of new york city taxi trips." IEEE Transactions on Visualization and Computer Graphics 19, no. 12 (2013): 2149-2158.
- Fischer, Manfred M. "Computational neural networks: a new paradigm for spatial analysis." Environment and Planning A 30, no. 10 (1998): 1873-1891.
- Harris, Nancy L., Elizabeth Goldman, Christopher Gabris, Jon Nordling, Susan Minnemeyer, Stephen Ansari, Michael Lippmann et al. "Using spatial statistics to identify emerging hot spots of forest loss." Environmental Research Letters 12, no. 2 (2017): 024012.
- Michelot, Theo, Roland Langrock, and Toby A. Patterson. "moveHMM: an R package for the statistical modelling of animal movement data using hidden Markov models." Methods in Ecology and Evolution 7, no. 11 (2016): 1308-1315.
- Peuquet, Donna J. "Time in GIS and geographical databases." Geographical information systems 1 (1999): 91-103.
- Ramsay, James O. "Functional data analysis." Encyclopedia of Statistical Sciences 4 (2004).
- Seidel, Dana Paige, Eric Dougherty, Colin Carlson, and Wayne M. Getz. "Ecological metrics and methods for GPS movement data." International Journal of Geographical Information Science 32, no. 11 (2018): 2272-2293.

- Yuan, May. "Temporal GIS and spatio-temporal modeling." In Proceedings of Third International Conference Workshop on Integrating GIS and Environment Modeling, Santa Fe, NM, vol. 33. 1996.

Description and Assessment of Assignments

Weekly Assignments

There are several different kinds of assignments with at least one due weekly. These are described in the Weekly Folders on Blackboard. Due dates are shown in the summary that follows.

Resume Assignment – 1 worth 1 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. Please prepare your resume in the SSI template which will be provided to you. Unless you opt out, your resume will be included in the Spatial Sciences Institute Graduate Programs Resume Book. This resume book is compiled annually and, along with our web presence, is used to promote our programs, and more importantly, your skills, experience and professional aspirations.

Lab Assignments 12 worth a total of 60 points. Each week students will be given a lab assignment to apply spatio-temporal analysis to real world data. The labs will be use ArcGIS Pro and R language. RStudio, although not required, is highly recommended.

Final Project – 1 worth a total of 15 points. In the second half of the course, each student will work on a project determined in consultation with the instructor. These projects will focus on a spatio-temporal problem that is aligned with student's research/interests. The final report (20%) in the form of a story-map and the class presentation (15%) will summarize and visualize the research statement, range of approaches attempted, shortcomings/assumptions of approaches and and the range of solutions that have been attempted thus far, as reported in the published literature.

Class Discussion – 12 a total of 24 points. To make sure you take a moment to reflect on all that you have learned in the course, you will participate in discussions on topics assigned by the instructor.

Final Project

To integrate your learning of all the material covered in the course, in the final project you will design, undertake and report on an individually chosen spatiio-temporal analysis project that will be the context of discussion in several of the assignments. The four components of the Project are:

Proposal - 2 points. A brief description of the spatial question(s) you would like to ask or the spatial problem you want to solve and briefly how you plan to solve it.

Class Presentation - 5 points (aforementioned). A Story Map that you will present in the last week of class and provide feedback for other's project. Each student will present their final project in the last week. The presentation will be divided in to four main categories:

Introduction of the Problem, Methods (Spatial, Temporal and Spatio-Temporal), Case Study, Results and Visualizations. Members of project groups are expected to be well-versed in every aspect of their team's research as the instructor will randomly assign group members to present different sections of the class presentation. Group members are expected to answer questions from the audience. Members of the audience taking the class are expected to ask questions and draw parallels from their work. You are expected to give feedback to all presentations. Time allotted on class presentations of the final project will depend on the number of students enrolled.

Final Story Map - 13 points. A written report on your project methodology and outcomes.

Grading Breakdown

Assessment	Number	Points Each	Total Points
Weekly Assignments			
Resume Assignment	1	1	1
Lab Assignments	12	5	60
Final Project	1	15	15
Class Discussion	12	2	24
Project Components			
Proposal	1	2	2
Class Presentation	1	5	5
Final Story Map	1	13	13
Total	29	-	100 points

Assignment Submission Policy

Unless otherwise noted, 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 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 2 points up to FOUR days late. No points will be given for submissions more than FOUR days late. Note that all assignments worth 2 points 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.

Schedule

	Topic	Readings and Assignments	Deliverables/Due Dates
Week 1 8/23	**Introduction to Spatiotemporal Analysis & R Review** Brief introductions coupled with a discussion of class goals, projects, and reading assignments.	Wikle et al. (2019), Ch. 1 For the first lab assignment, students will perform simple analysis using R. In addition, the R-ArcGIS bridge will be tested to ensure students are ready for the upcoming assignments.	Students will complete and submit R-Review assignment (Lab #1) that will assess their previous R language knowledge. Submit Lab #1 on Bb no later than 11:59 pm on Wednesday, 9/1.
Week 2 8/30	**Time Series Representation in GIS** This class will focus on the use space-time cubes to summarize spatiotemporal data.	Read Yuan (1996) and Peuquet (1999). For the second lab assignment, students will explore the fundamentals of time series analysis in GIS.	Students will complete Lab #2 that will assess: (a) the time-related terminology used in GIS; and (b) their understanding of space-time data structures in GIS. Submit Lab #2 on Bb no later than 11:59 pm on Wednesday, 9/8.
Week 3 9/6* *Monday, 9/2 is university holiday	**Classical Time Series Models** This class will focus on recognizing the differences in the suitability of different models of time-series	Wikle et al. (2019), Ch. 3.3, 3.4 For the third lab assignment, students will explore ARMA and ARIMA models to explain time-series characteristics.	Students will complete Lab #3 that will assess: (a) the applications of different statistical models for time series; and (b) their understanding of the mathematical fundamentals behind different models. Submit Lab #3 on Bb no later than 11:59 pm on Wednesday, 9/15.
Week 4 9/13	**Time Series Prediction** This class will focus on the generation of forecasts for different time series.	De Gooijer & Hyndman (2006). For the fifth lab assignment, students will practice with the metrics used to select a method for predicting time series. In addition, students will explore the metrics to describe a good forecast model.	Students will complete Lab #4 that will assess: (a) their understanding of the core concepts behind forecast & estimation; and (b) the utilization of diagnostic metrics for assessing results.

	Topic	Readings and Assignments	Deliverables/Due Dates
			Submit Lab #4 on Bb no later than 11:59 pm on Wednesday, 9/22.
Week 5 9/20	**Analyzing Spatio-Temporal Patterns of a Pandemic: COVID-19 Case Study**	Desjardins et al. (2020)	Students will complete Lab #5 that will assess: (a) their understanding of the applications of time-series analysis to the COVID-19 pandemic (b) the utilization of spatio-temporal representations for dynamic pandemic data. Submit Lab #5 on Bb no later than 11:59 pm on Wednesday, 9/29.
Week 6 9/27	**Functional Data Analysis** This class will focus on the basis for interpreting function scores to understand time-series signatures.	Ramsay (2004) For the fourth lab assignment, students will perform functional data analysis to model and decompose time series. In addition, students will use visualizations in R and mapping in ArcGIS Pro to summarize spatiotemporal data.	Students will complete Lab #6 that will assess: (a) their understanding of the differences between FDA and prior statistical models; and (b) the utilization of basis functions for understanding time series. Submit Lab #6 on Bb no later than 11:59 pm on Wednesday, 10/6.
Week 7 10/4	**Visualizing and Wrangling Spatiotemporal Data**	Wikle et al. (2019), Ch. 5.1 Ferreira al (2013) For the sixth lab assignment, students will learn modern methods for visualizing and managing spatiotemporal data in GIS.	Students will complete Lab #7 that will assess: (a) the ability to clean-up data spatiotemporally; (b) the utilization of different methods to visualize spatiotemporal data; and (c) their understanding of the utility and shortcomings of Hovmoller plots. Submit Lab #7 on Bb no later than 11:59 pm on Wednesday, 10/13.

	Topic	Readings and Assignments	Deliverables/Due Dates
Week 8 10/11* *10/14-10/15 is a university holiday	**Exploratory Methods for Spatiotemporal Data**	Wikle et al. (2019), Ch. 5.2, 5.3, 5.4, 5.5, 5.6 For the seventh lab assignment, students will explore exploratory analysis of spatio-temporal data using Empirical Orthogonal Functions and Canonical Correlation Analysis.	Students will complete Lab #8 that will assess: (a) their understanding of the application of cross-spectral analysis to uncover temporal relationships; (b) the utilization of EOF for spatiotemporal problems; and (c) the ability to explore spatiotemporal relationships using CCA. Submit Lab #8 on Bb no later than 11:59 pm on Wednesday, 10/20.
Week 9 10/18	**Spatiotemporal Pattern Mining** This class will focus on the underlying theory and assumptions of different approaches for performing spatiotemporal pattern mining.	Harris et al (2017) For the eighth lab assignment, students will use ArcGIS's space-time pattern mining tools to map space-time data.	Students will complete Lab #9 that will assess: (a) the uses of hot spot analysis for spatio-temporal data; and (b) the ability to explain changes to hot and cold spots in space-time. Submit Lab #9 on Bb no later than 11:59 pm on Wednesday, 10/27.
Week 10 10/25	**General Dynamic Spatio-Temporal Models (DSTMs)**	Wikle et al. (2019), Ch. 8.1, 8.2, 8.3, Pick 2 out of 9.1, 9.2, 9.3 and 9.4 For the ninth lab assignment, students will practice using DSTMs for modelling space-time data.	Students will complete Lab #10 that will assess: (a) the ability to perform spatiotemporal analysis using DSTMs; and (b) their understanding the fundamentals of spatio-temporal forecasts via DSTMs. Submit Lab #10 on Bb no later than 11:59 pm on Wednesday, 11/3.
Week 11 11/1	**Recurring Neural Networks for Spatiotemporal Models**	Fischer (1998, 2006). For the tenth lab assignment, students will experiment with the uses of RNNs and LSTMs for predicting time-series.	Students will complete Lab #11 that will assess: (a) the use of neural network applications for space-time analysis; (b) their understanding of

	Topic	Readings and Assignments	Deliverables/Due Dates
			neural network topology for time data; and (c) the differences of LSTM-based prediction. Submit Lab #11 on Bb no later than 11:59 pm on Wednesday, 11/10.
Week 12 11/8	**Movement and Trajectory Analysis in GIS**	Seidel et al. (2018) For the eleventh lab assignment, students will explore movement data and its uses in GIS analysis.	Students will complete Lab #12 that will assess: (a) the differences between movement data and ordinary time-series data; and (b) the types of problems pertaining to movement in GIS that are typically studied. Submit Lab #12 on Bb no later than 11:59 pm on Wednesday, 11/23.
Week 13 11/15	**Hidden Markov Models**	Patterson (2016). For the twelfth lab assignment, students will explore uses of Hidden Markov Models to study movement data.	Students will utilize this week's knowledge in previously assigned Lab #12.
Week 14 11/22* *11/24-11/28 is a university holiday	No Class		
Week 15 11/29	**In Class Presentations of Final Story Maps**		Students will present their Story Maps during class on 12/1
Final Exams 12/8-12/15	No Class		Students will turn in their final Story Map. Submit your final Story Map URL on Bb no later than 11:59 pm on Wednesday, 12/15.

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.

Support Systems

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

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
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
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, 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
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.