GEO 391/491: Statistical Data Analysis for GIS

Winter Quarter 2019 | DePaul University | Department of Geography

Time: Tue/Thurs 4:20-5:50 pm **Location**: SAC 224, LPC

1. Course Description: This course covers statistical concepts and techniques that are applied to geographic problems. Topics include descriptive statistics and inferential statistics geared toward working with geographic data in GIS. Students will learn techniques for summarizing variables, testing difference of means, and relationships among variables through lectures and hands-on exercises using calculators, SPSS and ArcGIS. GEO 141 or PSC 201 is a prerequisite for this class.

2. Instructors' Contact and Office Hours

	Instructor	Teaching Assistant	GIS Coordinator
Name	Sungsoon (Julie) Hwang	Isabelle Hattan	Cassie Follett
Contact	shwang9@depaul.edu (773) 325-8668	ihattan678@gmail.com	CFOLLETT@depaul.edu (773) 325-3267
Where	990 W Fullerton, 3133	990 GIS Lab: 990 W Fullerton, 3135	990 W Fullerton, 3134
When	T/TH 2-3 pm or by appointment	Mon 6-7 pm, Tue 3-4 pm	when technical issues arise in 990 GIS Lab

3. Course Topics: Through this course you will learn

- How to summarize values assigned to variables using descriptive statistics and graphs
- How sample is different from population, and what sampling means to inference
- How hypothesis testing is conducted as part of inferential statistics
- When and how to test difference of means among independent or related samples
- What spatial autocorrelation is, and how to measure spatial autocorrelation
- How to detect spatial hot spots and outliers statistically
- How to determine how a variable is associated with another variable

4. Learning Outcomes: After completing all requirements of GEO 391/491, you should be able to

- Calculate descriptive statistics using SPSS, and interpret them appropriately
- Summarize attributes from vector and raster data using ArcGIS
- Calculate descriptive spatial statistics using ArcGIS, and interpret them appropriately
- Calculate probability based on normal distribution
- Generate spatial samples for survey using ArcGIS
- Conduct an one-sample difference of means test manually
- Conduct difference of means tests (t-tests and ANOVA) appropriate for a given problem using SPSS, and interpret results appropriately
- Explore spatial autocorrelation of data using different techniques in ArcGIS
- Identify spatial clusters and spatial outliers from areal data in ArcGIS using statistical techniques, and interpret results appropriately
- Conduct correlation analysis, and interpret results appropriately in SPSS
- Propose and conduct quantitative geographic research using GIS and statistical techniques

5. Required Text

J. Chapman McGrew Jr., Arthur J. Lembo, Jr. Charles B Monroe (2014) *An Introduction to Statistical Problem Solving in Geography*, The Third Edition, Waveland Press (ISBN: 9781478611196)—this is required and available at the college bookstore in LPC (2425 N Sheffield Ave).

6. Course Outlines and Tentative Schedules

Wk	Date	Topic	Reading	In-class group exercises
1	1.08	Course overview	Syllabus	
	1.10	01. Descriptive statistics	Ch. 3	01. Descriptive statistics and graphs in SPSS
2	1.15	02. Descriptive statistics with GIS		02. Descriptive statistics in ArcGIS
	1.17	03. Descriptive spatial statistics	Ch. 4	03. Descriptive spatial statistics in ArcGIS
3	1.22	04. Probability	Ch. 6	04. Normal distribution - probability
	1.24	05. Sampling	Ch. 7	05. Spatial sampling in ArcGIS
4	1.29	Review for Test 1		
	1.31	**Test1**		
5	2.05	06. Hypothesis testing	Ch. 9	06. One-sample difference of means test
	2.07	07. Difference of means test:	Ch. 10	
6	2.12	Independent & paired t test	Ch. 11	
	2.14	Analysis of Variance (ANOVA)		07. Difference of means test (SPSS)
7	2.19	08. Spatial autocorrelation	Ch. 13	08. Explore spatial autocorrelation (ArcGIS)
	2.21	09. Areal pattern analysis	Ch. 15	09. Hot spot analysis (ArcGIS)
8	2.26	10. Correlation /**Proposal** due	Ch. 16	10. Correlation analysis (SPSS)
	2.28	Review for Test 2		
9	3.05	**Test2**		
	3.07	Work on project		
10	3.12	Work on project		
	3.14	**Project presentation**		
11	3.21	**Project report** due		

7. Grading Components

Components	Points (/100)	Description
Exercises	**30**	10 group exercises in class. Each exercise is worth 3 points
Tests	**32**	Two closed-book, non-cumulative tests. Each is worth 16 points.
Project	**28**	Proposal (4) + presentation (4) + report (20)
Participation	**10**	Attendance, class discussion, and participation to group exercises

Grading scale: A = 93-100%; A- = 90-92.99%; B+ = 87-89.99%; B = 83-86.99%; B- = 80-82.99%; C+ = 77-79.99%; C = 73-76.99%; C- = 70-72.99%; D+ = 60-69.99%; D = 50-59.99%; F = 0-49.99%

Exercises: Three persons will be paired to work on exercises designed to reinforce concepts covered in readings and lectures. The format includes reflecting on concepts learned in the class, calculating statistics manually, interpreting analysis results in SPSS, and making maps that incorporate statistical concepts in ArcGIS. If groups can't complete exercises in the class, it is expected that groups complete exercises on their own. I suggest you work with a lab assistant during lab hours. Unless noted otherwise, exercises are due on D2L in a week before the class from the date when exercises are handed out.

Tests: There will be two closed-book tests in the classroom. You will be allowed to bring one sheet of paper in which you write down formulae. You will be provided with information necessary to solve problems, including normal table, student distribution, and F table, etc. Test1 covers the first half, and Test2 covers the second half. The format of tests will vary from manual calculation, short essay, to conducting analysis in SPSS and ArcGIS.

Project: You are to conduct a small geographic research amenable to quantitative analysis during the last two weeks of the quarter. The research should use empirical data and employ statistical techniques (descriptive statistics or/and hypothesis testing) learned from the course. You should submit one-page research proposal, and present your work before classmates. By week 11, submit a paper that addresses the purpose of a study, research hypotheses, data collection, data analysis, and findings. Detailed guidelines will be provided later.

I recommend that you (a) choose a familiar topic so that you don't have to spend bulk of time in reviewing literature and familiarizing yourself with data; (b) focus on research questions that can be tested. For example, it will be easier to examine change in temperature than in religious views because temperature is more robust to measurement than religious views and temperature data is easy to collect (i.e., available from NOAA website). Project can be done either individually or in group.

Minimum Requirements	GEO 391	GEO 491
The number of data items or variables of interest	At least one	At least two
The number of GIS techniques (e.g., mapping, spatial analysis, geocoding, digitizing, GPS data collection, table join)	At least two	At least three
Length of the paper	Minimum 3 pages in single spacing	Minimum 5 pages in single spacing
The number of maps included in the paper	At least one	At least two

In the previous quarter, students have written about whether diversity has increased or decreased by newly drawn wards boundary in Chicago, how abortion rates are associated with political affiliation in US States, whether Wicker Park has gentrified, and so on. Detailed guidelines will be provided on D2L.

Participation: assigned according to the criteria below

- A (9 - 10) = Student is present in all or nearly class meetings, and prepared, at all times, to respond to questions. Student is an active participant in small group activities, in and out of class, and in class-time activities stays on task.
- B (8 - 9) = Student participates as above, 75% of the time.
- C (6.5 - 8) = Student does not volunteer comments; responses demonstrate vague familiarity with course readings. Student is a passive member of small group activities and/or does not stay on task during class-time activities.
- D (5 - 6.5) = Student never volunteers, cannot respond to direct questions, keeps silent during class discussions and is unable to summarize readings if asked.
- F (0 - 5) = Student misses many class sessions and/or sits silently in classes when present, or is disruptive and non-participatory in the classroom.

Late Work Policy: Late work will NOT be accepted. Extensions can be requested if needed, but will be only granted if excused. This policy applies to exercises only.

Makeup Exam/Incomplete Grade Policy: A makeup exam or an incomplete grade can be arranged or granted only when credible dire and documented medical or family situations arise and these circumstances are communicated in a timely fashion.

8. Access to ArcGIS

Digital Student License: If you're enrolled in a GIS class at DePaul University (that has an ESRI site license), you can download and install ArcGIS Desktop on a personal computer for free. Regarding ArcGIS license, reach out to a GIS coordinator. ArcGIS is only supported in a Windows computer.

ArcGIS in an Apple computer: Although there are ways to use ArcGIS in an Apple computer, there are many technical issues to get around. Reach out to the GIS Coordinator for resources on running GIS software on a Mac or Linux computer. Installing ArcGIS on an Apple computer may take at least several hours depending on how familiar you are with computers and concepts like formatting, boot order, etc. As an alternative, you can borrow a PC for the course term or come to the campus.

Labs with ArcGIS Desktop: SAC GIS lab (SAC 224), SAC 268, 990 GIS lab (990 W Fullerton, Room# 3135), Richardson Library, Loop Library, Daley 1327

GIS Lab Open Hours

- 990 GIS Lab (990 W Fullerton, Room# 3135): https://las.depaul.edu/academics/geography/geographic-information-systems-certificate/Pages/gis-lab.aspx or the lab door.
- SAC GIS lab (SAC 224): http://qrc.depaul.edu/hours.htm or the lab door.

DePaul Virtual Lab: you can access ArcGIS Desktop in both PC and Mac remotely at http://vlab.depaul.edu. There is no need for installing ArcGIS, but experiences may not be smooth as ArcGIS is computationally intensive. At least 8 Mbps is required for internet speed. There is a known issue with saving files from ArcGIS Desktop through Virtual Lab in an Apple Computer. Reach out a GIS coordinator if you encounter this issue.

9. Miscellaneous

Attendance/Absentee Policy: Consistent with university's policy, all students are expected to attend class meetings. Unless absence is explained on medical or compassionate grounds (documentation is required), absence from any classes is grounds for a grade adjustment.

Academic Honesty and Plagiarism: Academic honesty and integrity are expected at all times. Academic dishonesty, such as cheating or copying during exams, will be punished severely. Plagiarism – using someone else's work without acknowledgment and, therefore, presenting their ideas or quotations as your own work – is strictly forbidden. DePaul University officials will be informed of any instance of academic dishonesty and notification will be placed in your file. Please read the DePaul Academic Integrity Resources page (http://academicintegrity.depaul.edu/Resources/index.html) for definitions and explanations of plagiarism and the University's Academic Integrity expectations for students. Cutting and pasting text taken directly from a web-site without appropriate referencing and quotation

marks is plagiarism and is forbidden. Submitting work that has any part cut and pasted directly from the internet is grounds for an automatic grade of zero.

University Center for Writing-Based Learning: Collaborates with writers from all disciplines, backgrounds, levels of expertise, and roles within the University community. Their goal is to help develop better writers along with better writing and reflection through continual revision. If you need assistance with writing assignments, they can be contacted at: 773.325.4272 (LPC) or wcenter@depaul.edu

Universal Design for Learning: GEO is committed to helping students achieve their full potential by removing barriers to learning and making reasonable accommodation when appropriate. Please help us by identifying barriers and suggesting ways we can diminish or remove them.

Students with special learning needs, or who are in circumstances which necessitate special consideration, must contact the instructor at the beginning of the course or earlier. Students with a documented disability who wish to discuss academic accommodations should contact the instructor as soon as possible and immediately contact the DePaul University's Office of Students with Disability at http://studentaffairs.depaul.edu/studentswithdisabilities/.

Please note: All university employees must report to the Title IX Coordinator all relevant details about any incidents of sex discrimination, including sexual harassment and sexual or relationship violence, of which they become aware. DePaul employees are also mandated reporters under the Illinois Abused and Neglected Child Reporting Act [325 ILCS 5/4]. If you need to speak directly with a Title IX Coordinator, email titleixcoordinator@depaul.edu.

10. Department of Geography Learning Goals—GEO 391/491 addresses 1), 5), 6), and 7).

Courses in the Department of Geography teach students:

1) Understand spatial patterns and processes of modification of the Earth's physical and cultural landscapes
    a. As social constructions.
    b. As systems that link the Earth with human society in interdependent, dialectical relationships, and
    c. Through mapping and visualization.
2) Understand the concept of scale as a spatial phenomenon that ties the local, the regional, the national, the transnational, and the global in a system of interaction.
3) Understand the phenomenology of the discipline of Geography—most importantly, "space", "place", "landscape," "region," and "location".
4) Distinguish that spaces, places, and so on, may have both objective and subjective/symbolic dimensions.
5) Develop research and writing competences that would allow you to:
    a. Formulate a cogent research question about the spatial character of a physical, socio-cultural, or environment-societal phenomenon,
    b. Write about it in ways that reflect analytical and critical thinking, and
    c. Ethical concern over social and environmental justice, consistent with the University's social mission.
6) Engage competently in qualitative and quantitative spatial analysis, and with exercises that are concerned with explaining spatial regularities (for example, the spatial calculus behind the location of retail commerce in Chicago, or transnational flows of capital).

7) Learn the basic utility and use competently one or more of the information technologies that are now redefining the logistical limits of spatial analysis: geographic information systems (GIS) and remote sensing.
8) Achieve greater general knowledge of the world, its regions, its physical systems, its cultures, and political-territorial divisions.

11. GEO 391 Learning Objectives/Outcomes by Modules

Module 1: Descriptive Statistics (Read chapter 3)

- Describe measures of central tendency, including *mode*, *median*, and *mean*
- Describe measures of dispersion, including *interquartile range*, *variance*, and *standard deviation*
- ➢ Ex 01: Calculate descriptive statistics using SPSS, and interpret them appropriately

Module 2: Descriptive Statistics with GIS

- Calculate descriptive statistics from vector data in ArcGIS
- Perform statistical operations of map algebra (local and zonal statistics) from raster data in ArcGIS
- ➢ Ex 02: Calculate descriptive statistics from spatial data using ArcGIS

Module 3: Descriptive Spatial Statistics (Read chapter 4)

- Describe spatial measures of central tendency, that is *mean center*
- Describe spatial measures of dispersion, that is *standard distance*
- ➢ Ex03: Calculate descriptive spatial statistics using ArcGIS, and interpret them appropriately

Module 4: Probability (Read chapter 6—focus on normal distribution)

- Describe characteristics and appropriate use of the *normal distribution*
- Describe *z score*
- ➢ Ex04: Calculate *probability* of a given condition based on normal distribution

Module 5: Sampling (Read chapter 7)

- Distinguish between *population* and *sample*
- Describe when to use different types of *sampling strategy* with spatial data in mind
- ➢ Ex05: Generate spatial random samples from survey to construct error matrix in ArcGIS

Module 6: Hypothesis Testing (Read chapter 8, 9)

- Understand what *standard error* of estimates is
- Describe basic concepts in hypothesis testing—*null hypothesis*, *type I error*, *significance level*, *test statistics*, and *p-value*
- ➢ Ex06: Test hypothesis (one-sample difference of means test) using *p-value approach*

Module 7: Difference of Means Tests (Read chapter 10, 11)

- Describe objective and test statistic of *two-sample difference of means test* (aka. Independent samples t-test)
- Describe objective and test statistic of *matched-pairs difference test* (aka. Paired samples t-test)
- Describe objective and test statistics of *ANOVA*
- ➢ Ex07: Conduct difference of means test (t-tests and ANOVA) appropriate for a given problem using SPSS, and interpret results appropriately

Module 8: Spatial Autocorrelation (Read chapter 13, 15 on Moran's I)

- Understand concepts of *spatial autocorrelation*
- Describe methods for exploring spatial autocorrelation, including *variogram* and *Moran's I*
- ➢ Ex08: Explore spatial autocorrelation of data and make an isarithmic map in ArcGIS

Module 9: Areal Pattern Analysis (Read chapter 15)

- Describe *Local Moran's I*
- Describe *Getis-Ord Gi**
- ➢ Ex 09: Determine spatial clusters/outliers from areal data in ArcGIS, and interpret results appropriately

Module 10: Correlation (Read chapter 16)

- Describe different ways to conduct correlation analysis—graphing (*scatter plot*) and *correlation coefficient*
- Describe an objective and inferential test statistic of *Pearson correlation coefficient*
- ➢ Ex10: Conduct correlation analysis, and interpret results appropriately in SPSS and ArcGIS