GEO 344: GIS III – Spatial Analysis for Sustainability

Spring 2019 (3/30/2019-6/14/2019) | Department of Geography | DePaul University

Time: Tue/Thurs 1:00-2:30 pm **Location**: 990 W Fullerton # 3135 GIS Lab

1. Course Description: GEO 344 is an advanced-level course. Students conduct spatial analysis into sustainability issues of their interest. Students will learn techniques for site suitability analysis, point pattern analysis, spatial interpolation, network analysis, and temporal analysis with GIS. Instruction is accomplished through lectures and hands-on computer lab exercises using ArcGIS. GEO 242 is a prerequisite for this class.

2. Instructors' Contact and Office Hours

	Instructor	Teaching Assistant	GIS Coordinator
Name	Sungsoon (Julie) Hwang	Christine Confederate	Cassie Follett
Contact	shwang9@depaul.edu (773) 325-8668	chrisbect@gmail.com	CFOLLETT@depaul.edu (773) 325-3267
Where	990 W Fullerton, 3133	990 W Fullerton, 3135 (GIS Lab)	990 W Fullerton, 3134
When	Tue/Thu 11:30a-12:30p or by appointment	Mon/Fri 12-1 pm	when technical issues arise in 990 GIS Lab

3. Course Topics

This course will teach you advanced techniques for analyzing data involving location in a real-world setting, building on techniques learned through GEO 241 and GEO 242. Topics include

- Site suitability analysis: "Where should a new gym (store, community garden) be built?" Identify and rate suitable locations based on multiple criteria
- Point pattern analysis: "Where are crime (epidemic) hotspots?" Determine whether events (like cancer incidents, traffic crashes, crime incidents) are clustered, and identify spatial clusters at various geographic scales if any
- Spatial interpolation: "Where is lead (Pb) most concentrated?" Estimate unknown surface values at unsampled locations based on known surface values of surrounding locations
- Network analysis: "Where should a distribution center be located such that transportation cost is minimized?" Identify the least cost path in a road network, and locate the facilities in a way that supplies the demand points most efficiently"
- Analyzing spatial relationships: "Are ambient ozone concentrations associated with asthma rates among children?" Analyze relationships among variables that occur in geographic space
- Analyzing change: "How do crime hot spots change over time?"

Course materials are aligned with US DOL's Geospatial Technology Competency Model**.**

4. Learning Outcomes—after completing all requirements, you should be able to

- Conduct site suitability analysis appropriately
- Conduct point pattern analysis appropriately
- Conduct spatial interpolation appropriately
- Conduct network analysis appropriately
- Analyze spatial relationships among multiple variables from disparate sources appropriately
- Analyze changes from a spatiotemporal database appropriately
- Propose and conduct spatial analysis for exploring a sustainability issue appropriately

5. Readings

Required textbook: Christopher Lloyd (2010) *Spatial Data Analysis: An Introduction for GIS Users.* Oxford University Press (ISBN: 9780199554324) – available at college bookstore in LPC.

Other readings are provided on D2L.

6. Outlines of Topics and Tentative Schedules

Wk	Dt.	Topic	Reading	In-class lab activities	Homewk.
1	4.02 4.04	Course overview Re-cap GIS fundamental	 Ch 2, 3	 0. Kids vulnerable to toxic emissions?	
2	4.09 4.11	1. Site suitability analysis	Ch 5	1. Where are suitable snail habitats?	
3	4.16 4.18	2. Point pattern analysis	Ch 7	2. Where are crime hot spots?	
4	4.23 4.25	3. Spatial interpolation	Ch 9	3. Estimate/map ozone levels	**HW1** Due 4.22
5	4.30 5.02	4. Network analysis	Ch 6	4. Where to locate a distribute center?	**HW2** Due 4.29
6	5.07 5.09	5. Analyzing spatial relationships	Ch 3	5. Is asthma related to ozone level?	**HW3** Due 5.06
7	5.14 5.16	6. Analyzing changes		6. How did crime hot spots change?	**HW4** Due 5.13
8	5.21 5.23	7. Pitfalls of spatial analysis	O'Sullivan		**Proposal** Due 5.20
9	5.28 5.30	Work on project			
10	6.04 6.06	 **Presentation**			
11	6.11 6.13	**Report** due on D2L **MOM** due on D2L			

7. Grading Components

Components	Points	Notes	Due dates
Participation	10	See below for rubric	Every week
6 labs	24	Each 4 pt. Group submission	Every week
4 homework	24	Each 6 pt. Individual submission	Monday on week 4-8
Project	35	Proposal 5 pt. Presentation 5 pt. Report 25 pt.	Week 10, 11
Map of the Month (MOM)	7	Submit a map and abstract to be considered for publication in DePaul MOM	Week 11

7.1 Participation: score is 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 and out of class, and stays on task in class-time activities.
- 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 participant in and out of class, 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.

7.2 Labs: learn advanced GIS analytic techniques in ArcGIS. Type answers to questions while following instructions for ArcGIS. You can complete labs individually, but should submit answers to questions in labs as a group assigned during class hours each week. Labs will be completed in class when instructors are present under most circumstances. If the lab cannot be completed in time, make arrangement with a lab teaching assistant.

- Lab1 (suitability analysis): learn how to assess suitability of snail habitat based on multiple criteria in both vector and raster environment. You will learn overlay, buffer, attribute query, spatial query, Euclidean distance tool, map algebra, reclassification
- Lab2 (point pattern analysis): learn how to determine whether crime incidences are spatially clustered, and visualize hot spots if any using average nearest neighbor, K function, kernel density estimation, and optimized hot spot analysis
- Lab3 (spatial interpolation): learn how to map ozone level using ArcGIS Extension Geostatistical Analysis. The first half focuses on techniques for exploring data, such as histogram, variogram, QQ-plot, and trend surface analysis. The second half focuses on using ordinary Kriging to perform spatial interpolation
- Lab4 (network analysis): learn how to create network dataset, find the shortest path, delineate service areas based on network distance, and find sites that minimize transportation cost using ArcGIS Extension Network Analyst
- Lab5 (analyzing spatial relationships): learn how to integrate data (or variables) and examine the relationships between those variables by using exploratory spatial data analysis, graphing, zonal statistics and correlation coefficient
- Lab6 (analyzing changes): learn how to handle spatial data with timestamp, create an animated map showing crime incidences/hot spots using QGIS, and conduct emerging hot spot analysis

7.3 Homework: apply techniques learned from labs to solve geographic problems similar to problems presented in labs. This is an individual work. Submit a report that describes a set (or sequence) of analytical methods used, and discusses findings. Problems for each homework are as follows.

- HW1: Where to locate a new school?
- HW2: Are bike crashes spatially clustered, and where are hot spots?
- HW3: Estimate concentration of zinc in soil sample
- HW4: Where to locate community gardens that minimize travel distance?
- HW5: How does income relate to access to hospital at a neighborhood scale?

7.4 Project: propose and conduct a GIS project to explore geographic dimensions of a sustainability issue that interests you using advanced methods of spatial analysis. You should employ at least two sets of advanced analytical methods covered in GEO 344. Other factors (the number of variables and size of data) can be taken into account in determining the appropriateness of the proposed project by an instructor. Project can be done individually or as a group of 3 or less persons.

- **Proposal**: address the area/purpose of project, objectives, literature, study area, data (including sources), and techniques you will use.
- **Presentation**: address backgrounds, objectives, methods, and results.
- **Report**: write a 3-4 page report with a single spacing excluding figures and references. Report should include title, abstract, introduction, review of at least five related work, methods, results, conclusions, and references.

You are allowed to do project unrelated to sustainability under a certain circumstance (e.g., you have substantive knowledge and interest in a certain topic or your job requires you to do a certain type of project). Detailed guidelines and gallery of previous student projects will be provided on D2L.

7.5 Map of the Month: Submit a map and abstract from any of your previous GIS work (including a final project for GEO 344). Your submission will be considered for the DePaul Map of the Month (MOM) https://via.library.depaul.edu/mom/.

A good map for the MOM is the one that tells a story, and can engage the public. You can check out some popular maps in the MOM website: Alex Williams' map showing hot spots of shooting incidences relative to level I trauma center in Chicago. Jack Floyd's map depicting change in hate crimes; and

You need to submit two files:
- High-resolution map (300 dpi or high) in TIFF or JPG format
- Abstract in 150-250 words that introduces a topic of the map, describe how the map is created, and discuss findings from the map.

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%

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

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, you can download and install ArcGIS Desktop on your home computer for free. Reach out to a GIS coordinator for instructions. ArcGIS is only supported in a Windows computer.

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 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. Contact a GIS coordinator or TSC if you have any problem with using Virtual Lab.

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 344 addresses 1), 2), 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. Learning Objectives by Modules

Module 0. Recap of GIS fundamentals and ArcGIS skills – read chapter 2

- Turn XY data into spatial data: datum, map projection, and coordinate systems
- Make effective thematic maps: visual variables, data normalization, and visual hierarchy
- Manipulate and query tabular data: field data type, field calculator, and SQL query

Module 1. Site suitability analysis – read chapter 5 and section 10.2 (map algebra)

- Use spatial join, union, intersect, clip, and erase tools for vector suitability analysis
- Use map algebra (raster calculator), and reclassify tools for raster suitability analysis
- Use process diagram to graphically represent processes of GIS analysis

Module 2. Point pattern analysis – read chapter 7, Getis Ord Gi*, and optimized hot spot analysis

- Conduct average nearest neighbor analysis (NNA), and interpret NNA results
- Describe how K function works, and interpret K function results
- Conduct optimized hot spot analysis (Getis-Ord Gi*)
- Use kernel density estimation for density mapping

Module 3. Spatial interpolation – read chapter 9

- Explore data for normal distribution (histogram, QQ plot), spatial autocorrelation (variogram, Moran's I), and global trend (trend surface analysis) using Geostatistical Analyst
- Describe how Inverse Distance Weighting (IDW) works

- Perform spatial interpolation using Ordinary Kriging
- Interpret cross-validation results (root mean square error) to assess accuracy of spatial interpolation

Module 4. Network analysis – read chapter 6 and location-allocation analysis
- Describe network data model
- Describe how Dijkstra's algorithm (shortest path algorithm) works
- Perform service area analysis
- Perform location-allocation

Module 5. Analyzing spatial relationships – read correlation coefficient
- Identify steps for analyzing spatial relationships from data of disparate sources
- Use graphs, statistics, and maps to analyze spatial relationships among variables

Module 6. Analyzing changes – read emerging hot spot analysis
- Identify different options to depict changes in GIS
- Conduct emerging hot spot analysis

Module 7. Pitfalls of spatial analysis—read pitfalls of spatial analysis
Discuss implications of the following concept for spatial analysis
- Modifiable areal unit problem
- Ecological fallacy
- Scale
- Spatial autocorrelation
- Edge effect
- Nonuniformity of space