GEO 344 (GIS III: Spatial Analysis for Sustainability)

Spring 2017 (3/25/17-6/9/17) | Department of Geography| DePaul University

The class meets on Wednesday at 4:20-7:35 pm in Geography GIS Lab (990 W Fullerton #3135)
Instructor: Sungsoon (Julie) Hwang (shwang9@depaul.edu, 773-325-8668, 990 W Fullerton # 3133)
Instructor's office hours: Tue, Wed, Thurs 2-3 pm in her office and by appointment
Teaching Assistant: Brooke Robinson (bethany.brooke.robinson@gmail.com, Lab hours: TBA)

1. Course Description

GEO 344 is an advanced-level GIS course. Students conduct spatial analysis into sustainability issues of their interest. Students will learn techniques for suitability analysis, point pattern analysis, network analysis, and spatial interpolation with GIS. Instruction is accomplished through lectures and hands-on computer lab exercises using ArcGIS. Formerly GEO 244. Prerequisite: GEO 242.

2. 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. You may encounter geographic problems like the following:

- "Where should a new gym (store, community garden) be built?" Identify and rate suitable locations based on multiple criteria (suitability analysis)
- "Where is lead (Pb) most concentrated?" Estimate unknown surface values at unsampled locations based on known surface values of surrounding locations (spatial interpolation)
- "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 (point pattern 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" (network analysis)
- "Are ambient ozone concentrations associated with asthma rates among children?" Analyze relationships among variables that occur in geographic space (integration and correlation)
- "How do crime hot spots change over time?" Mapping time (animation)

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

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

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

4. Required Text

Christopher Lloyd's *Spatial Data Analysis: An Introduction for GIS Users* by Oxford University Press (2010) (ISBN: 9780199554324).

The text is available at college bookstore in Lincoln Park Campus. **The college bookstore price matches through the first week of classes. Click here for more details.**

5. Outlines of Topics & Tentative Schedules

Wk.	Date	Topics	Readings	In-class lab activities	Homework (due Sun.)
1	3/29	Course overview Re-cap GIS fundamentals	Lloyd (text) ch 2	0. Kids vulnerable to toxic emissions?	
2	4/5	1. Suitability analysis	Lloyd ch 3, ch4, ch 5	1. Where are suitable snail habitats?	
3	4/12	2. Spatial interpolation	Lloyd ch 9; Burrough	2. Estimate/map ozone levels	**HW1** due 4/16
4	4/19	3. Point pattern analysis	Lloyd ch7	3. Where are crime hot spots?	**HW2** due 4/23
5	4/26	4. Network analysis	Lloyd ch 6	4. Where to locate a distribution center?	**HW3** due 4/30
6	5/3	5. Analyzing spatial relationships	Mitchell	5. Is asthma related to ozone level?	**HW4** due 5/7
7	5/10	6. Mapping temporal data (QGIS)	Kraak	6. Animate crime hot spots	**HW5** due 5/14
8	5/17	7. Pitfalls of spatial analysis	O'Sullivan	Discuss & trouble-shoot project proposal	**Proposal** due 5/21
9	5/24	Work on project			
10	5/31	**Presentation**			
11	6/7	**Report** due on D2L			

Burrough & McDonell (1998) Chapter 5 (Creating continuous surfaces from point data) pp. 98-131 and Chapter 6 (Optimal interpolation using geostatistics) pp. 132-141 in *Principles of GIS*

Mitchell (2005) Chapter 5 (Analyzing geographic relationships) in *ESRI Guide to GIS Analysis, Volume 2: Spatial Measurements and Statistics*

O'Sullivan & Unwin (2010) Chapter 2 (The pitfalls and potential of spatial data) in *Geographic Information Analysis*

Kraak & Ormeling (2009) Mapping time pp. 152-158 in *Cartography: Visualization of Spatial Data*

6. Grading Components

Components	Points	Notes
Participation	10	See below for rubric
6 labs	24	Each lab accounts for 4 points. This is done by a group of two.
5 homework	30	Each homework accounts for 6 points. This is done by a group of two.
Project	36	• Proposal: 6 points. This can be done individually or as a group. • Presentation: 5 points • Report: 25 points
Extra credit	3-5	Enter Poster Competition at ILGISA Chicago Regional Meeting on 4/28. Submit a poster by 4/14 (week 3). Max 5 points. or Enter 2017 ILGISA Map Competition "Most Interesting Map!". Submit a map and 1-page report by 6/1 (week 10). Max 3 points.

6.1 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.

6.2 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 of two persons to be 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. Labs are due 11:59 pm one week after handouts are distributed in the class unless noted otherwise.

- 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, map algebra, reclassification, and measurement
- Lab2 (spatial interpolation): learn how to map ozone level using ArcGIS Extension Geostatistical Analysis, including QQ-plot, trend surface analysis, variogram, spline, IDW, and Kriging
- Lab3 (point pattern analysis): learn how to determine whether crime incidences are spatially clustered, and visualize hot spots if any using quadrat analysis, average nearest neighbor, K function, and kernel density estimation
- Lab4 (network analysis): learn how to delineate service areas based on network distance and find sites that minimize transportation cost using ArcGIS Extension Network Analyst, including building network dataset, routing, service area analysis, and location-allocation
- Lab5 (analyzing spatial relationships): learn how to spatially integrate data (or variables) and examine the relationship between those variables by using exploratory spatial data analysis such as linking graphs to maps, linking statistics to maps, zonal statistics and correlation coefficient
- Lab6 (animation): learn how to handle spatial data with timestamp, and create an animated map showing crime incidences and crime hot spots using QGIS

6.3 Homework: apply techniques learned from labs to solve geographic problems similar to problems presented in labs. This is a group work. Discuss how you will go about solving problems with the peer who did the lab together at the completion of the lab, execute plan, and write a report together. In the report, describe a set (or sequence) of analytical methods used, and report on findings. Homework is due 11 days after a corresponding lecture. Problems for each homework are as follows.

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

6.4 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. Consult an instructor. Project can be done individual 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 (eg. 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.

6.5 Extra credit: you can do one of the following that counts toward extra credit.

A. ILGISA Poster Competition: enter the Poster Competition in the 2017 ILGISA Chicago Regional Meeting held at DePaul Center (1 E Jackson Blvd) on 4/28 (Friday of Week 5). Posters will be displayed during lunch, and attendees will vote on their favorite. The winning poster will be announced at the closing of the Regional Meeting, and will win a $25 gift certificate. This is a good chance to meet GIS professionals from IL and beyond. Two GEO seniors and one alum got awards last year.

The poster format is best when your material can be most effectively communicated in visual form, so it would be good to limit text to brief statement. Poster should be clearly legible from a distance of four feet. Poster will be displayed on a 4' by 8' (landscape-oriented only) poster board supplied by the host. Posters will be graded based on organization, visual presentation clarity, content, and significance.

To be considered for extra credit, you should do the following:

1. By April 7 (Week 2 Fri): submit a draft poster in ppt file on D2L dropbox ExtraCredit. Feedback will be provided if submitted in time.
2. By April 14 (Week 3 Fri): submit a revised poster file in ppt file on D2L dropbox ExtraCredit and email the poster to contact@ilgisa.org.
3. On April 28 (Week 5 Fri): stand by your submission during lunch to answer any attendee questions in DePaul Center 8th Floor Conference Center.

Extra credit A is graded as follows:

- 5 points: do all of three tasks above and good effort in revision and good quality poster
- 4 points: do all of three tasks above and good effort in revision
- 3 points: do all of three tasks above but minimal revision was made
- 2 points: do some of three tasks above

B. ILGISA Map Competition: enter the 2017 ILGISA Map Competition under Traditional Map Category. The theme this year will be "Most Interesting Map!". There are two categories in this Map Competition: traditional map category and web mapping category. Topic/theme is open, and no data is being provided.

Submissions for the traditional map category shall include a 24 x 36 inch PDF map and a brief report (1 page) containing executive summary (brief abstract in 1 paragraph), methodology (description of any analysis techniques and considered factors), and results. Entries will be ranked with a 1 through 5 based on cartographic quality, analytical techniques (if applicable), and overall clarity.

Student and professional entries will be scored separately. It is requested that the top three finalists from each category give a 20 minute presentation at the 2017 Conference explaining their entries. Winner (student and professional) from each category will receive a $50 gift card.

To be considered for extra credit, you should do the following:

1. By May 25 (Week 9 Thurs): submit a draft map and report on D2L dropbox ExtraCredit. Feedback will be provided if submitted in time.
2. By June 1 (Week 10 Thurs): submit a revised map and report on D2L dropbox ExtraCredit and email the submission to contact@ilgisa.org.

Extra credit B is graded as follows.

- 3 points: do all of two tasks above and good effort in revision and good quality poster
- 2 points: do all of two tasks above and good effort in revision
- 1 points: do some of two tasks above

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 can be accepted with the reduction of 20% of the grade per day being late. For instance, if you turn in labs 5 days after due dates, no points will be granted.

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.

7. Learning Objectives by Modules

Module 1. Suitability analysis

- Describe how distances, perimeters, and areas are measured in spatial data
- Describe analytical techniques for overlay analysis, including spatial join, union, intersect, identity, clip, erase, reclassify, and map algebra (raster calculator)

Module 2. Spatial interpolation

- Interpret variogram (both experimental and model variogram) for spatial interpolation
- Explore data for normal distribution, spatial autocorrelation (variogram), trend surface analysis, and isotrophy (directional effects)
- Create an isarithmic map using inverse distance weighting, spline, and ordinary Kriging
- Interpret cross-validation results (RMSE) for spatial interpolation

Module 3. Point pattern analysis

- Perform quadrat analysis
- Describe how kernel density estimation works
- Interpret results of nearest neighbor analysis
- Describe how K function works, and interpret results of K function

Module 4. Network analysis

- Describe how network data model is different from other data model (structure) for GIS
- Describe how Dijkstra's algorithm (shortest path algorithm) works
- Perform service area analysis
- Perform location-allocation

Module 5. Analyzing spatial relationships

- Describe why it is important to analyze spatial relationships among variables in exploring sustainability issues
- Describe how graphing, statistics, and mapping complement each other in regard to analyzing spatial relationships among variables
- Identify a series of appropriate techniques for analyzing spatial relationships from data of disparate sources

Module 6. Visualizing time in GIS

- Describe different ways in which time is represented in geospatial data
- Describe different ways in which time is visualized in GIS

Module 7. Pitfalls of spatial analysis—describe each of the following problem or concept with a specific example in mind, and discuss why they pose threat to the validity of spatial analysis

- Spatial autocorrelation
- Modifiable areal unit problem
- Ecological fallacy
- Edge effect

8. 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.

Accommodations: Any student who requires assistance is asked to contact the University's Center for Students with Disabilities (CSD) (Phone 773/325-1677, TTY 773/325-7296, Fax 773/325-7396, http://studentaffairs.depaul.edu/studentswithdisabilities).They will be able to assist both student and faculty. If you have a condition that requires accommodation from the Productive Learning Strategies program (PLuS Program) please contact them at the Student Center room 370 (Phone 773/3251677 or online: http://studentaffairs.depaul.edu/plus/

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

GIS lab open hours

- Geography GIS Lab: http://las.depaul.edu/academics/geography/Pages/Geographical-Information-Systems.aspx
- GIS lab in SAC: http://qrc.depaul.edu/hours.htm or the GIS lab door.

Labs with ArcGIS: SAC GIS lab (SAC 224), Geography GIS lab (room # 3135 at 990 W Fullerton), SAC 268, Richardson Library, Loop Library, and Daley 1327.

To install ArcGIS in PC: ArcGIS for Desktop 10.5 free trial that is good for 60 days can be downloaded from http://www.arcgis.com/features/free-trial.html?origin=arcgiscom-Desktop. You can purchase a 1 year ArcGIS for Desktop Advanced for $ 100 with free ArcGIS online subscription at http://www.esri.com/software/arcgis/arcgis-for-home.

To access ArcGIS in both PC and Mac remotely: go to DePaul Virtual Lab http://vlab.depaul.edu

Department of Geography Learning Goals

Courses in the Department of Geography teach students-- GEO344 addresses # 1, 2, 5, 6, and 7.

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.