UP 519, FALL 2019 Advanced Applications of GIS (CRN 71794)

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Lecture Time: M 10:30–11:50 AM (Room 227)
Lab Session: W 10:30–11:50 AM (Room 227)
Location: Temple Hoyne Buell Hall
Office Hours: After class or by appointment

COURSE DESCRIPTION

This course provides instruction in the application of many of the more sophisticated functions of geographic information systems (GIS) and introduces key spatial analysis concepts. Both GIS and related tools have become increasingly common resources for planning practice and research and are routinely leveraged for a variety of applications across the array of planning specializations. The course builds on basic concepts and principles of GIS, emphasizing the theory and tools of spatial analysis as well as hands-on exposure to software and real-world data. Completion of *UP 418: Introduction to GIS* or an equivalent introductory course is a prerequisite (the concepts and skills covered in UP 418 will not be repeated here and students are responsible for bringing those basic skills and knowledge to the table). Students who successfully complete this course will be able to:

- Explain the theoretical and technical aspects of common spatial data models;
- Apply many of the extensions and data analysis functionality available in ArcGIS to test hypotheses;
- Understand distinctions between quantitative and qualitative GIS;
- Perform basic (satellite) image processing tasks;
- Write and execute basic geoprocessing scripts;
- Manipulate tabular and spatial data to produce intelligible graphics;
- Understand how to use the Story Map to contextualize data and relate a narrative;
- Apply and interpret basic exploratory data analysis tools;
- Specify, estimate, and interpret basic spatial regression models.

The class is not intended as an in-depth treatment of GIScience or spatial econometrics. It instead, provides a further introduction to the functionalities available in ArcGIS that are particularly relevant for more sophisticated planning applications. As such, we will make every attempt to link the technical aspects of the course to planning practice and common applications within the field.

COURSE FORMAT

This course covers advanced concepts of spatial analysis and GIS use and provides a sufficiently broad coverage of topics so that students will feel comfortable with some of its more complex functions. The class time will be divided into lecture and laboratory sessions that focus on conceptual and practical topics of interest, respectively. Lab reports are due at the beginning of the subsequent class period and should be written independently.

The term projects for the course will focus on applying geospatial data analysis for community development, environmental planning, etc. and will focus on real-world questions and issues. Students will self-organize into teams and work together to define the scope of the project and to identify specific deliverables early in the semester.

REQUIREMENTS & EVALUATION

Students are expected to bring a laptop computer capable of running ArcGIS to class. General participation in class discussion and exercises comprises 10% of the final grade. Students are expected to attend both the lecture (Monday) and lab (Wednesday) components of the course. Poor attendance will not result in automatic failure, but will be reflected in the participation component of the course grade. Most weeks there will be a lab exercise on Wednesday. Each student is expected to submit a short report and the details will be specified in each of the assignments distributed at the beginning of the lab session.

There will also be a midterm examination (on October 21st) that focuses on the concepts covered in lecture and applied in the lab sessions. On Monday December 9th students will present their term projects to the class and interested members of the DURP community. The remainder of the grade is based on the term project report due on Wednesday December 18th during exam week. This report will be of professional quality and be supplemented with maps, spatial datasets, and other materials as appropriate. The weight assigned to each of these elements is shown in the table below:

ASSIGNMENT	DUE DATE	PERCENT
Participation	Ongoing	10%
Lab Exercises (12)	Ongoing	30%
Midterm Exam	October 21st	20%
Term Project Presentation	December 9th (11th)	10%
Term Project Report	December 18th	30%

In fairness to all students, ten points will be deducted for late assignments, with an additional ten points deducted for each subsequent day. No exceptions can be made without a written medical excuse from your doctor and a proposed new deadline. Due dates for assignments are not flexible, so please make your travel plans and schedule other commitments accordingly.

The overall assessment of student performance in this course is derived from the components listed above, subject to the percentage weights listed in the preceding table. All of these components are scored on a 100 point scale, which should make it easy for each student to gauge their standing as the semester progresses—grades are not curved.

FINAL GRADE	TOTAL
A+	98 to 100
A	94 to 97
A-	91 to 93
B+	88 to 90
B	84 to 87
B-	81 to 83
C+	78 to 80

FINAL GRADE	TOTAL
C	74 to 77
C-	71 to 73
D+	68 to 70
D	64 to 67
D-	61 to 63
F	0 to 60

READING MATERIAL

All assigned readings have been placed on the Compass web site:

Compass: https://compass2g.illinois.edu

The instructor's presentation slides will be posted on *Compass* following the Monday lecture sessions.

SOFTWARE

Students are expected to bring a laptop computer capable of running ArcGIS to class. There are 16 desktop computers available in the in the classroom where we will meet, but ArcGIS 10.7 is available for free through the UIUC Webstore and via the DURP Applications Server.

COURSE POLICIES

Disability Services: This course will accommodate students with documented disabilities. Please refer to the Disability Resource Guide (http://disability.illinois.edu/disability-resource-guide) for more information and inform the instructor of any requests at the beginning of the semester.

Academic Integrity: The UIUC Student Code requires all students to support academic integrity and abide by its provisions, which prohibit cheating, fabrication, plagiarism, and facilitation of these and related infractions. According to Section § 1-401, "students have been given notice of this rule by virtue of its publication" and "regardless of whether a student has actually read this rule, a student is charged with knowledge of it." The provisions of the Student Code are applicable to this course. *In written work, all ideas (as well as data or other information) that are not your own must be cited.*

Diversity: The Department of Urban and Regional Planning (DURP) is committed to creating an environment of inclusion and opportunity that is rooted in the very goals and responsibilities of practicing planners. Conduct that interferes with the rights of another or creates an atmosphere of intimidation or disrespect is inconsistent with the environment of learning and cooperation that the program requires. By enrolling a course in the Department of Urban and Regional Planning, students agree to be responsible for maintaining a respectful environment in all DURP activities, including lectures, discussions, labs, projects, and extracurricular programs. We will be governed by the University Student Code. Please see the Student Code Article 1—Student Rights and Responsibilities for further details.

Counseling Services: The Counseling Center is committed to providing a range of services intended to help students develop improved coping skills in order to address emotional, interpersonal, and academic concerns. The Counseling Center provides individual, couples, and group counseling. All of these services are paid for through the health services fee. The Counseling Center offers primarily short-term counseling, but they do also provide referrals to the community when students could benefit from longer term services.

Irregular Attendance: Class attendance is expected of all students at the University of Illinois, however instructors must reasonably accommodate a student's religious beliefs, observances, and practices in regard to class attendance and work requirements if the student informs his or her instructor of the conflict within one week after being informed of the attendance or work requirements. It is the instructor's decision as to when a student's absences become excessive and should be reported. If in the opinion of an instructor the attendance of a student becomes so irregular that his or her scholarship is likely to be impaired, the instructor may submit an irregular attendance form to the Associate Dean of the student's college. A copy is forwarded to the student, who should contact the instructor immediately to work out a solution. If irregular attendance continues without excuse, the instructor may request the student be withdrawn from the course. This request for withdrawal would result in a grade of E for the course. Extenuating circumstances will always be considered when supporting evidence is presented. See Rule 1-501 and Rule 1-502 in the Student Code for more information.

UP 519 – FALL 2019
SUMMARY SCHEDULE OF SESSIONS

WEEK	SESSION	DATE	DAY	TOPIC
1	1	Aug-26	M	Course Overview
1	2	Aug-28	W	Refresher Exercises: Metadata & Map Projections
2		Sept-2	M	*** NO CLASS MEETING (Labor Day Holiday) ***
2	3	Sept-4	W	**Term Project**: Brainstorming & Team Formation
3	4	Sept-9	M	Vector Data Models & Network Analysis
3	5	Sept-11	W	Assessing Service Provision & Mapping Flows
4	6	Sept-16	M	GIS in the Cloud: ArcGIS Online
4	7	Sept-18	W	Survey 123 Data Collection (*** NO FACE-TO-FACE MEETING ***)
5	8	Sept-23	M	Qualitative & Participatory GIS
5	9	Sept-25	W	ArcGIS Story Maps (*** NO FACE-TO-FACE MEETING ***)
5	9	Sept-25	W	*** MIDTERM REVIEW GUIDE ***
6	10	Sept-30	M	Raster Data Models & Environmental Applications
6	11	Oct-2	W	Multicriteria Decision Analysis: Spatial Analyst
7	12	Oct-7	M	What Is Remote Sensing & How Does It Work?
7	13	Oct-9	W	Remote Sensing Part I: Image Registration
8	14	Oct-14	M	Acquiring & Working with Satellite Imagery
8	15	Oct-16	W	Remote Sensing Part II: Image Classification
9	16	Oct-21	M	*** MIDTERM EXAM (In Class) ***
9	17	Oct-23	W	**Term Project**: Work Session
10	18	Oct-28	M	ModelBuilder & Scripting Overview
10	19	Oct-30	W	Automation of Geoprocessing Tasks: Python Scripting
11	20	Nov-4	M	Analyzing & Presenting Data in Three Dimensions
11	21	Nov-6	W	3D Visualization with ArcScene & ArcGlobe
12	22	Nov-11	M	Spatial Point Pattern Analysis
12	23	Nov-13	W	ESDA with Point Data
13	24	Nov-18	M	Global & Local Measures of Spatial Autocorrelation
13	25	Nov-20	W	ESDA with Lattice Data
			M	*** FALL VACATION ***
			W	*** FALL VACATION ***
14	26	Dec-2	M	OLS Refresher & Spatially Lagged Variables
14	27	Dec-4	W	Geographically Weighted Regression
15	28	Dec-9	M	**Term Project**: Team Presentations
15	29	Dec-11	W	Course Wrap-Up & Evaluations
		Dec-18	W	*** TERM PROJECT REPORTS DUE ***

SESSION TOPICS AND READINGS

Session 1: Course Overview (8/26)

Themes and Topics: metadata, geodesy, datum, coordinate system, projection, geocoding.

ESRI. 2004. *Understanding map projections*. Redlands, CA: ESRI. (pp. 1-34)

Lloyd, Christopher D. 2010. "GIS." In *Spatial data analysis: an introduction for GIS users*. New York, NY: Oxford University Press. (pp. 6-23)

Session 2: Refresher Exercises (8/28)

Lab Exercise: This session presents basic concepts in geodesy and cartography and demonstrates how coordinate systems and map projections are managed within ArcGIS. The lab exercise focuses on practical aspects of managing coordinate systems and map projections in ArcGIS and geocoding.

Session 3: Brainstorming & State of the Field (9/4)

Themes and Topics: Students are expected to identify examples of GIS applications or geospatial data analysis that they find compelling and share those examples with the class. We will begin talking about possible term projects during this session.

No required readings. No lab exercise.

Session 4: Vector Data Models & Network Analysis (9/9)

Themes and Topics: vector dataset, topology, network relationships.

Lloyd, Christopher D. 2010. "Network analysis." In *Spatial data analysis: an introduction for GIS users*. New York, NY: Oxford University Press. (pp. 75-85)

Oh, K., and S. Jeong. 2007. Assessing the spatial distribution of urban parks using GIS. *Landscape and Urban Planning*, 82(1-2): 25-32.

Session 5: Assessing Service Provision & Mapping Flows (9/11)

Lab Exercise: This lab exercise focuses on exploring Network Analyst and visualizing urban mobility data.

Session 6: GIS in the Cloud—ArcGIS Online (9/16)

Themes and Topics: cloud computing, cyberGIS, mobile apps for data collection, spatial data infrastructures.

Drummond, W.J., and S.P. French. 2008. The future of GIS in planning: Converging technologies and diverging interests. *Journal of the American Planning Association*. 74(2): 161-174.

Armstrong, M.P., T.L. Nyerges, S. Wang, and D. Wright. 2011. Connecting geospatial information to society through cyberinfrastructure. In *The SAGE Handbook of GIS and Society*. London, UK: Sage Publications. (pp. 109-22).

Session 7: Data Collection with Survey 123 (9/18)

Lab Exercise: This lab session focuses on collecting and visualizing data using the Survey 123 app. Instructions will be given ahead of time and rather than meeting face-to-face, students will devise a strategy for collecting data around campus.

Session 8: Crowdsourcing, Participatory, & Qualitative GIS (9/23)

Themes and Topics: public participation, crowdsourcing, memory, storytelling.

Minner, J., A. Roberts, M. Holleran, and J. Conrad. 2019. A Smart City remembers its past: Citizens as sensors in survey and mapping of historic places. In *Crowdsourcing: Concepts, Methodologies, Tools, and Applications*. Hershey, PA: IGI Global. (pp. 489-516).

Lung-Amam, W. S., and C. Dawkins. 2019. The power of participatory story mapping: Advancing equitable development in disadvantaged neighbourhoods. *Community Development Journal*. Forthcoming.

Session 9: ArcGIS Story Maps (9/25)

Lab Exercise: This lab session focuses on introducing the basic components of an ArcGIS Story Map and how existing templates can be used to contextualize and present geospatial information.

Session 10: Raster Data Models & Environmental Planning Applications (9/30)

Themes and Topics: raster data, hydrologic tools in ArcGIS, overland flow, watershed, connectivity, landscape metrics, scale and hierarchy.

Lloyd, Christopher D. 2010. "Analysis of grids and surfaces." In *Spatial data analysis: an introduction for GIS users*. New York, NY: Oxford University Press. (pp. 155-170)

Dramstad, W.E., J.D. Olson, and R.T.T. Forman. 1996. "Part one: Principles." In *Landscape ecology principles in landscape architecture and land-use planning*. Washington, DC: Island Press. (pp. 19-45)

Session 11: Multicriteria Decision Analysis—Spatial Analyst (10/2)

Lab Exercise: This lab exercise focuses on applying the hydrologic tools available in ArcGIS and working with raster data.

Session 12: What Is Remote Sensing & How Does It Work? (10/7)

Themes and Topics: types of sensors, geometric correction, georeferencing, ground control points, positional accuracy, spatial resolution.

Liu, J.G. and P.J. Mason. 2009. "Image geometric operations." In *Essential image processing and GIS for remote sensing*. Chichester, UK: Wiley-Blackwell. (pp. 105-119)

Session 13: Remote Sensing Part I—Image Registration (10/9)

Lab Exercise: Aerial photographs are one of the fundamental sources of information about urban areas. This exercise introduces the use of image data sources and the focuses on registering two aerial photographs from different time points to support change detection.

Session 14: Acquiring & Working with Satellite Imagery (10/14)

Themes and Topics: electromagnetic spectrum, band combinations, supervised and unsupervised classification, data acquisition, change detection, radiometric resolution, temporal resolution, object-based image analysis.

Liu, J.G. and P.J. Mason. 2009. "Image classification." In *Essential image processing and GIS for remote sensing*. Chichester, UK: Wiley-Blackwell. (pp. 91-103)

Optional:

Blaschke, T., Hay, G. J., Kelly, M., Lang, S., et al. (2014). Geographic Object-Based Image Analysis–Towards a new paradigm. *ISPRS Journal of Photogrammetry and Remote Sensing*. 87(100): 180–191.

Session 15: Remote Sensing Part II—Image Classification (10/16)

Lab Exercise: This session builds upon the previous session and provides an overview of how remote sensing works. As part of the lab exercise, we will perform a supervised classification of Landsat imagery from two time periods and identify areas of significant land use change.

Session 16: Midterm Exam (10/21)

The midterm exam will be administered during this session.

Session 17: Term Project—Work Session (10/23)

Themes and Topics: This session allows time for each team to take stock of the term project effort and to devise a strategy for completing it over the remaining 5 weeks of the semester.

No required readings. No lab exercise.

Session 18: ModelBuilder & Scripting Overview (10/28)

Themes and Topics: scripting, ModelBuilder, geoprocessing, workflow.

ESRI. 2019. "Creating tools with ModelBuilder tutorial." Redlands, CA: ESRI.

Python Software Foundation. 2019. *Python tutorial: Release 3.7*. Wilmington, DE: Python Software Foundation. Available at https://docs.python.org/3/tutorial/index.html
(scan the tutorial and pay closer attention to Chapter 3)

Session 19: Geoprocessing with Scripts—Python & IDLE (10/30)

Lab Exercise: Many common tasks performed in ArcGIS are simple, but can become tedious when repeated over and over again. This optional lab exercise focuses on the use of scripting to automate repetitive geoprocessing tasks, allowing the analyst to work more efficiently.

Session 20: Analyzing & Presenting Data in Three Dimensions (11/4)

Themes and Topics: triangulated irregular networks, 3D rendering, viewsheds, LiDAR, scenario planning.

Lai, P.C., K-H. Kwong, and A.S.H. Mak. 2010. Assessing the applicability and effectiveness of 3D visualisation in environmental impact assessment. *Environment and Planning B: Planning and Design*. 37: 221-233.

Optional:

Gill, L., E. Lange, E. Morgan, and D. Romano. 2013. An analysis of usage of different types of visualisation media within a collaborative planning workshop environment. *Environment and Planning B: Planning and Design*. 40: 742-754.

Session 21: 3D Visualization—ArcScene & ArcGlobe (11/6)

Lab Exercise: There are a variety of tools available that support 3D visualization and some evidence suggests a link between visualization and increased public engagement in the planning process. We will use both ArcScene and ArcGlobe to manipulate spatial data and inform planning decisions.

Session 22: Spatial Point Pattern Analysis (11/11)

Themes and Topics: kernel estimation (intensity), stationarity, complete spatial randomness, spatial clustering, quadrat analysis, nearest neighbor indices, Poisson processes, working with point data, geocoding.

Lloyd, Christopher D. 2010. "Exploring spatial point patterns." In *Spatial data analysis: an introduction for GIS users*. New York, NY: Oxford University Press. (pp. 86-105)

Optional:

O'Sullivan, D. and D.J. Unwin. 2010. "Practical point pattern analysis." In *Geographic information analysis, 2nd edition*. Hoboken, NJ: John Wiley & Sons. (pp. 157-186)

Session 23: ESDA with Point Data (11/13)

Lab Exercise: This session introduces many of the exploratory spatial data analysis techniques applicable to point data. The lab session provides an opportunity to apply these techniques to epidemiological data using the Spatial Statistics functionality available in ArcGIS.

Session 24: Global & Local Measures of Spatial Autocorrelation (11/18)

Themes and Topics: spatial weights matrix, global and local measures of spatial association, permutation versus randomization significance testing, modifiable areal unit problem.

Lloyd, Christopher D. 2010. "Spatial data analysis" and "Exploring spatial patterning in data values." In *Spatial data analysis: an introduction for GIS users*. New York, NY: Oxford University Press. (pp. 43-64 & pp. 106-128)

Session 25: ESDA with Lattice Data (11/20)

Lab Exercise: Basic exploratory spatial data analysis techniques are introduced and applied for lattice data (polygons and grid cells). The lab session involves testing for evidence of a spatial pattern in the distribution of opioid overdose fatalities as well as Census data across varying scales.

Session 26: OLS Refresher & Spatially Lagged Variables (12/2)

Themes and Topics: impact of spatial autocorrelation on parametric statistics, spatial regression in the OLS context, tests and diagnostics, GWR.

Fang, C., H. Liu, G. Li, D. Sun, and Z. Miao, Z. 2015. Estimating the impact of urbanization on air quality in China using spatial regression models. *Sustainability*. 7(11): 15570-15592.

Optional:

Lloyd, Christopher D. 2010. "Statistics." In *Spatial data analysis: an introduction for GIS users*. New York, NY: Oxford University Press. (pp. 24-42)

McMillen, D.P. 2003. Spatial autocorrelation or model misspecification? *International Regional Science Review*. 26 (2): 208-217.

Session 27: Geographically Weighted Regression (12/4)

Lab Exercise: The presence of spatial autocorrelation is problematic within a regression context. However, there are established procedures that allow for sound statistical inference despite evidence of its presence. The lab session applies the spatial econometric concepts and techniques discussed in class to examine the spatial distribution of various demographic and environmental factors.

Session 28: Term Project—Team Presentations (12/9)

Themes and Topics: Each team will present their work and findings to the rest of the class and interested members of the DURP community..

No required readings. No lab exercise.

Session 29: Course Wrap-Up & Evaluations (12/11)

Themes and Topics: This entire session is set aside to finish the term project presentations (if necessary), clarify revisions to be made to the final paper based on the presentation, reflect on the semester, complete team peer reviews, and complete the course evaluations.

No required readings. No lab exercise.

TERM PROJECT REPORTS DUE (12/18)

Please submit your final materials for the term project (via Compass) by 5:00 pm.