UP 519, SPRING 2018 Advanced Applications of GIS (CRN 37280)

Instructor: Bev Wilson
E-mail: bevwilso@illinois.edu
Phone: (217) 244-1761
Office: Temple Hoyne Buell Hall, Room 224

Lecture Time: M 9:00–10:20 AM (Room 223)
Lab Session: W 9:00–10:20 AM (Room 227)
Location: Temple Hoyne Buell Hall
Office Hours: Th: 9:00–10:00 AM (or by appt.)

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;
- Perform basic (satellite) image processing tasks;
- Write and execute basic geoprocessing scripts;
- Manipulate tabular and spatial data to produce intelligible graphics;
- Understand how online data repositories are configured and maintained;
- 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 functionality available in ArcGIS and free software packages like QGIS 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 first half of the semester will focus on building capacity and developing the technical skills needed to work on a term project in the second half of the semester. 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 and QGIS 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 March 12th) that focuses on the concepts covered in lecture and applied in the lab sessions. On Monday April 30th 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 Thursday May 10th 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 (10)	Ongoing	30%
Midterm Exam	March 12th	20%
Term Project Presentation	April 30th (or May 2nd)	10%
Term Project Report	May 10th	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

The primary text for this course is available as an e-Book through the UIUC library:

> Lloyd, Christopher D. 2010. *Spatial data analysis: An introduction for GIS users*. New York, NY: Oxford University Press. Available at http://vufind.carli.illinois.edu/vf-uiu/Record/uiu_7654987

All assigned readings that are not from the Lloyd text 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 and QGIS to class. The course will primarily focus on the ArcGIS suite, but interested students may also complete many of the lab exercises using QGIS, which is a free and open source alternative.

- ArcGIS 10.5.1 is available for free through the UIUC Webstore and is in the DURP computer lab and on the DURP Applications Server.
- QGIS is free, open source, and downloadable here. It is also in the DURP computer lab and on 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 – SPRING 2018
SUMMARY SCHEDULE OF SESSIONS

WEEK	SESSION	DATE	DAY	TOPIC
1	1	17-Jan	W	Course Overview & Refresher Exercises
2	2	22-Jan	M	Brainstorming & State of the Field (Outside Research Required)
2	3	24-Jan	W	**Term Project**: Scope, Goals, & Deliverables
3	4	29-Jan	M	Basic Hydrology & Landscape Ecology Concepts
3	5	31-Jan	W	Suitability Analysis: Spatial Analyst
4	6	5-Feb	M	What Is Remote Sensing & How Does It Work?
4	7	7-Feb	W	Remote Sensing Part I: Image Registration
5	8	12-Feb	M	Acquiring & Working with Satellite Imagery
5	9	14-Feb	W	Remote Sensing Part II: Image Classification
5	9	14-Feb	W	*** MIDTERM REVIEW GUIDE ***
6	10	19-Feb	M	**Term Project**: Data Collection & Analysis Strategy Session
6	11	21-Feb	W	**Term Project**: Data Collection & Storage Work Session
7	12	26-Feb	M	Analyzing & Presenting Data in Three Dimensions
7	13	28-Feb	W	3D Visualization with ArcScene & ArcGlobe
8	14	5-Mar	M	GIS in the Cloud: ArcGIS Online
8	15	7-Mar	W	Data Collection with Survey 123
9	16	12-Mar	M	*** MIDTERM EXAM (In Class) ***
9	17	14-Mar	W	**Term Project**: Work Session
		19-Mar	M	*** SPRING VACATION ***
		21-Mar	W	*** SPRING VACATION ***
10	18	26-Mar	M	Leveraging Open Data
10	19	28-Mar	W	Working with ArcGIS for Server
11	20	2-Apr	M	Spatial Point Pattern Analysis
11	21	4-Apr	W	ESDA with Point Data
12	22	9-Apr	M	Scripting Overview & Introduction to ModelBuilder
12	23	11-Apr	W	*** NO CLASS MEETING (Optional Scripting Lab Exercise) ***
13	24	16-Apr	M	Global & Local Measures of Spatial Autocorrelation
13	25	18-Apr	W	ESDA with Lattice Data
14	26	23-Apr	M	OLS Refresher & Spatially Lagged Variables
14	27	25-Apr	W	Geographically Weighted Regression
15	28	30-Apr	M	**Term Project**: Team Presentations
15	29	2-May	W	Course Wrap-Up & Evaluations
		10-May	Th	*** TERM PROJECT REPORTS DUE ***

SESSION TOPICS AND READINGS

Session 1: Course Overview & Refresher Exercises (1/17)

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)

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 2: Brainstorming & State of the Field (1/22)

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 3: Term Project—Scope, Goals, & Deliverables (1/24)

Themes and Topics: We will meet in TBH 223 (lecture room) to continue the discussing term project opportunities and begin work on a "living" memo that outlines the project scope, goals, deliverables, etc.

No required readings. No lab exercise.

Session 4: Basic Hydrology & Landscape Ecology Concepts (1/29)

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 5: Suitability Analysis—Spatial Analyst (1/31)

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

Session 6: What Is Remote Sensing & How Does It Work? (2/5)

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 7: Remote Sensing Part I—Image Registration (2/7)

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 8: Acquiring & Working with Satellite Imagery (2/12)

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 9: Remote Sensing Part II—Image Classification (2/14)

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 10: Term Project—Data Collection and Analysis Strategy (2/19)

Themes and Topics: This session allows time for each team to discuss and finalize a data collection and data analysis strategy.

No required readings. No lab exercise.

Session 11: Term Project— Data Collection & Storage Work Session (2/21)

Themes and Topics: This session allows time for each team to begin downloading data and organizing storage in support of the term project.

No required readings. No lab exercise.

Session 12: Analyzing & Presenting Data in Three Dimensions (2/26)

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 13: 3D Visualization—ArcScene & ArcGlobe (2/28)

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 14: GIS in the Cloud—ArcGIS Online (3/5)

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, 109-22.

Session 15: Data Collection with Survey 123 (3/7)

Lab Exercise: This lab session focuses on collecting and visualizing data using the Survey 123 app.

Session 16: Midterm Exam (3/12)

The midterm exam will be administered during this session.

Session 17: Term Project Work Session (3/14)

We will meet and use the allotted time to work on the term project and consult with the instructor.

Session 18: Leveraging Open Data (3/26)

Themes and Topics: open data, information, knowledge, wisdom, data-driven science, computational social science.

Kitchen, R. 2014. "Conceptualising data" and "The reframing of science, social science, and humanities research." In *The data revolution: big data, open data, data infrastructures and their consequences*. Los Angeles, CA: SAGE. (pp. 1-26 and 128-149)

Sieber, R.E., and P.A. Johnson. 2015. Civic open data at a crossroads: Dominant models and current challenges. *Government Information Quarterly* 32(3): 308-315.

Session 19: Working with ArcGIS for Server (3/28)

Lab Exercise: This lab session focuses on configuring a stand-alone ArcGIS Server on Amazon Web Services.

Session 20: Spatial Point Pattern Analysis (4/2)

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 21: ESDA with Point Data (4/4)

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 22: Scripting Overview & Introduction to ModelBuilder (4/9)

Themes and Topics: scripting, ModelBuilder, geoprocessing.

ESRI. 2010. "ModelBuilder: Creating tools tutorial." Redlands, CA: ESRI.

Python Software Foundation. 2018. *Python tutorial: Release 3.6*. 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 23: Geoprocessing with Scripts—Python & IDLE (4/11)

***OPTIONAL** 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. We will not meet as a class on this date.*

Session 24: Global & Local Measures of Spatial Autocorrelation (4/16)

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 (4/18)

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 (4/23)

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 (4/25)

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 (4/30)

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 (5/2)

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 (5/10)

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