PPOL 6805 / DSAN 6750

Geographic Information Systems (GIS) for Spatial Data Science

Wednesdays 6:30-9pm, Car Barn 203

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Fall 2026, Georgetown University

Welcome to the Fall 2026 version of **Geographic Information Systems (GIS) for Spatial Data Science** at Georgetown University! Please note that the most up-to-date version of this syllabus will always be available at jjacobs.me/ppol6805

> **i** Course Numbering
>
> - For *Public Policy* students (McCourt): the course number is **PPOL 6805**
> - For *Data Science and Analytics* students: the course number is **DSAN 6750**

Course Staff and Office Hours

- **Prof. Jeff Jacobs**, jj1088@georgetown.edu: *Schedule office hours at jjacobs.me/meet*
  - Tues 4:30-7:00pm, Weds 3-4pm, Thurs 3-4pm
  - *(Please try to schedule at least 8 hours in advance, and let me know briefly in the "Additional Info" portion of the signup form what you'd like to discuss, so I have time to prepare!)*
- **TA Jackson Howes (Data Science and Analytics)**, jh2787@georgetown.edu
  - Office hours by appointment
- **TA Hermine Wilhelmsen (McCourt School of Public Policy)**, hw623@georgetown.edu
  - Office hours by appointment

Course Description

This course provides students with an overview of Geographic Information Systems (GIS), encompassing both general principles of geospatial data analysis and their applications for studying important issues of climate change, international conflict, economic development, and urban planning, among other areas of application.

The beginning of the course emphasizes fundamentals of GIS design and use, such as projection systems, raster and vector data, and efficient representation and storage of geospatial data. As students become more comfortable with these foundations, the course will shift to a greater

emphasis on applications during the second half of the semester. Particular emphasis will be placed on effective visualization of spatial data, through creation of static publication-quality maps as well as interactive maps for web applications and data dashboards.

The course will utilize libraries from R, Python, Stata, and JavaScript as needed, so experience using any of these languages will be helpful, but is not required.

Assignment Structure

On the basis of the guidelines we've developed for courses offered through DSAN, this course will have one in-class midterm but **no** final exam! Instead, you will work on a final project throughout the second half of the course. Each of the four units will involve a homework assignment, and final grades will be determined using the following weighting scheme:

Category	Percent of Final Grade
In-Class Midterm (Nov 4)	25%
Final Project	30%
Homeworks	45%
HW1: GIS Concepts: Fun with Vectors and Rasters	9%
HW2: Unary and Binary Operations, Spatial Joins	9%
HW3: Autocorrelation, Clustering, and Point Processes	9%
HW4: Spatial Regression	9%
HW5: Evaluating Spatial Hypotheses (Monte Carlo Simulation)	9%

The course does not have any "official" prerequisites, but a general comfort with **R** and/or **Python** is helpful: most of the code shown on slides is in R, but we will also discuss equivalent Python libraries you can use if you prefer!

If you have never used R or Python before, however (or if you haven't used it in a while and feel like your skills are rusty), you can:

- First **browse the materials on the Resources page**, and then
- Attend the weekly **coding workshops**!

Course Topics / Calendar

The following is a rough map of what we will work through together throughout the semester; given that **everyone learns at a different pace**, my aim is to leave us with a good amount of **flexibility** in terms of how much time we spend on each topic.

If I find that it takes me longer than a week to convey a certain topic in sufficient depth, for example, then I view it as a strength rather than a weakness of the course that we can then rearrange the calendar below by adding an extra week on that particular topic! Similarly, if it seems like I am spending too much time on a topic, to the point that students seem bored or impatient to move onto the next topic, we can move a topic intended for the next week to the current week.

Nonetheless, if you are able to do the recommended readings listed below *before* the start of each week's lecture, this will be a good indication that you are "on pace", relative to the overall set of topics I aim to cover by the end of the semester.

If you find any discrepancies between this schedule and Georgetown's official calendar, let us know!

Unit	Week	Date	Topic
Unit 1: GIS Concepts	1	Aug 26	Introduction to GIS
			Recommended Readings
			1. Pebesma and Bivand (2023), Section 3.1: *Simple Feature Geometries* (pp. 29-33)
	2	Sep 2	How Do Maps Work?
			Recommended Readings
			1. Monmonier (2018), Chapter 2: *Elements of the Map* (pp. 5-26)
	3	Sep 9	Vector and Raster Representations
			Recommended Readings
			1. Pebesma and Bivand (2023), Section 1.3-1.4: *Raster and Vector Data* and *Raster Types* (pp. 8-11)
Unit 2: Geospatial Operations	4	Sep 16	Unary Operations
			Recommended Readings
			1. Pebesma and Bivand (2023), Section 3.2: *Operations on Geometries* (pp. 34-39)
	5	Sep 23	Binary Operations and DE-9IM
			Recommended Readings
			1. Moraga (2024), Chapter 3: *The `sf` Package for Spatial Vector Data* (pp. 27-39)
	6	Sep 30	Spatial Joins and Areal-Weighted Interpolation
			Recommended Readings
			1. Pebesma and Bivand (2023), Chapter 5: *Attributes and Support* (pp. 49-57)
Unit 3: Spatial Data Science I: Foundations	7	Oct 7	Spatial Data Science: Three Forms of Spatial Autocorrelation
			Recommended Readings
			1. Amazing video introduction to analyzing spatial autocorrelation for *epidemiology* using R: Xie (2022) 2. Three 'core' spatial-statistical datatypes: Schabenberger and Gotway (2004), Section 1.2: *Types of Spatial Data* (pp. 6-13) 3. Baddeley, Rubak, and Turner (2015), Chapter 5: *Point Process Methods* (pp. 127-154)
	8	Oct 14	Point Processes: Null Models, Clustering, and Regularity

Unit	Week	Date	Topic
			Recommended Readings
			1. Intensity Functions (First-order properties of point processes): Baddeley, Rubak, and Turner (2015), Chapter 6: *Intensity* (pp. 157-198) 2. Pair Correlation Functions (Second-order properties of point processes): Baddeley, Rubak, and Turner (2015), Chapter 7: *Correlation* (pp. 199-254)
Unit 4: Spatial Data Science II: Methods	9	Oct 21	Evaluating Spatial Hypotheses I: Point Data
			Recommended Readings
			1. Monte Carlo Simulation: Waller and Gotway (2004), Section 5.2.3: *Hypothesis Tests of CSR via Monte Carlo Methods* (pp. 125-126*ff*)
	10	Oct 28	Evaluating Spatial Hypotheses II: Areal Data
			Recommended Readings
			1. Ward and Gleditsch (2018), Chapter 2: *Spatially-Lagged Dependent Variables* (pp. 35-64)
	11	Nov 4	In-Class Midterm
Unit 5: Final Projects	12	Nov 11	Tools for Final Projects
	13	Nov 18	Visualizing Spatial Data
			Recommended Readings
			1. Monmonier (2018), Chapter 3: *Map Generalization: Little White Lies and Lots of Them* (pp. 27-44)
		Nov 26	*No Class (Fall Break)*
	14	Dec 2	Final Project Poster Session

Assignment Distribution, Submission, and Grading

The programming assignments for the course will be managed through a JupyterHub server, which you will connect to in order to work on assignments with more computing power than is possible on your laptops (and with the necessary GIS libraries pre-installed)! This means that, to work on and submit the assignments, you will use the workflow described in the Positron connection guide, which you can always find within the "Writeups" section linked in the sidebar.

Late Policy

After the due date, for each **homework** assignment, you will have a grace period of 24 hours to submit the assignment without a lateness penalty. After this 24 hour grace period, late penalties will be applied up until 66 hours after the due date. Specifically, late penalties will be applied based on the following scale (unless you obtain an excused lateness from one of the instructional staff!):

- **0 to 24 hours** after due date: no penalty
- **24 to 30 hours** after due date: 2.5% penalty
- **30 to 42 hours** after due date: 5% penalty
- **42 to 54 hours** after due date: 10% penalty
- **54 to 66 hours** after due date: 20% penalty
- **More than 66 hours** after due date: Assignment submissions no longer accepted (without instructor approval)

Excused lateness exceptions will be grounded in a policy where you can "pause" the class (due-date-wise, but also just, expectation-of-progress-wise more generally) to take the time you need to handle things happening in your life. Then, you can "resume" work once you feel more centered/once you find yourself back on stable ground. The "Maslow's hierarchy" model from psychology (Figure 1) provides a straightforward way to think about this approach.

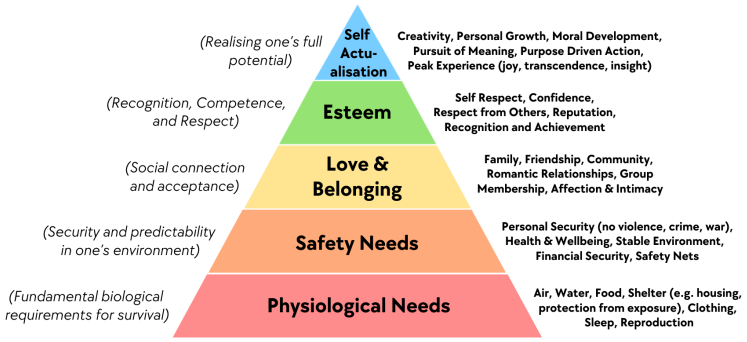

Figure 1: Maslow's Hierarchy of Needs, from Wikimedia

Learning GIS is way up there in the blue triangle, so, it's important that you feel like the first four levels are solidified before you turn your focus back to classwork. And, it's a win-win, because it means that once you're back in action you can be more engaged and receptive to new topics, rather than being forced to "simulate" being in the blue triangle while in reality struggling in other spots!

Final Letter Grade Determination

Once all assignments have been graded, we will compute your final **numeric grade** according to the above weighting, rounded to two decimal places. The **letter grade** that we report to Georgetown on the basis of this numeric grade will then follow the DSAN letter grade policy (updated Fall 2026) as follows, where start and end points for each range are **inclusive**:

Range Start	Range End	Letter Grade
93.50	100.00	A
89.50	93.49	A-
88.00	89.49	B+

Range Start	Range End	Letter Grade
81.50	87.99	B
79.50	81.49	B-
60.00	79.49	C
0.00	59.99	F

Title IX/Sexual Misconduct Statement

Georgetown University and its faculty are committed to supporting survivors and those impacted by sexual misconduct, which includes sexual assault, sexual harassment, relationship violence, and stalking. Georgetown requires faculty members, unless otherwise designated as confidential, to report all disclosures of sexual misconduct to the University Title IX Coordinator or a Deputy Title IX Coordinator.

If you disclose an incident of sexual misconduct to a professor in or outside of the classroom (with the exception of disclosures in papers), that faculty member must report the incident to the Title IX Coordinator, or Deputy Title IX Coordinator. The coordinator will, in turn, reach out to the student to provide support, resources, and the option to meet. [Please note that the student is not required to meet with the Title IX coordinator.]. More information about reporting options and resources can be found in the Sexual Misconduct Resource Center.

If you would prefer to speak to someone confidentially, Georgetown has a number of fully confidential professional resources that can provide support and assistance. These resources include:

- *Health Education Services for Sexual Assault Response and Prevention*: Confidential email `sarp@georgetown.edu`
- *Counseling and Psychiatric Services (CAPS)*: 202-687-6985 [After hours you can call 833-960-3006 to reach Fonemed, a telehealth service, and ask for the on-call CAPS clinician]

GSAS and McCourt Resources and Policies

You can find a collection of relevant resources and policies for students on the GSAS website, and the Provost's policy on accommodating students' religious observances on the Campus Ministry website.

You can also make use of the Student Academic Resource Center. In particular, within the Resource Center there is a link to Georgetown's Disability Support page. If you believe you have a disability, you can contact the Academic Resource Center (`arc@georgetown.edu`) for further information. The ARC is located in the Leavey Center, Suite 335 (202-687-8354), and it is the campus office responsible for reviewing documentation provided by students with disabilities and for determining reasonable accommodations in accordance with the Americans with Disabilities Act (ADA) and University policies.

McCourt Academic Integrity Policy

McCourt School students are expected to uphold the academic policies set forth by Georgetown University and the Graduate School of Arts and Sciences. Students should therefore familiarize themselves with all the rules, regulations, and procedures relevant to their pursuit of a Graduate School degree. The relevant policies are listed at this link.

McCourt Policy-Writing Center (MPWC)

The McCourt Policy-Writing Center (MPWC) offers services and resources for students to help improve policy-writing skills. These include workshops, peer review facilitation, open houses, lectures, online modules, and individual appointments. Click here for the full calendar of events, and email `mpwc@georgetown.edu` for general inquiries.

References

Baddeley, Adrian, Ege Rubak, and Rolf Turner. 2015. *Spatial Point Patterns: Methodology and Applications with R*. CRC Press.

Monmonier, Mark. 2018. *How to Lie with Maps*. University of Chicago Press.

Moraga, Paula. 2024. *Spatial Statistics for Data Science: Theory and Practice with R*. CRC Press.

Pebesma, Edzer, and Roger Bivand. 2023. *Spatial Data Science: With Applications in R*. CRC Press.

Schabenberger, Oliver, and Carol A. Gotway. 2004. *Statistical Methods for Spatial Data Analysis*. CRC Press.

Waller, Lance A., and Carol A. Gotway. 2004. *Applied Spatial Statistics for Public Health Data*. John Wiley & Sons.

Ward, Michael D., and Kristian Skrede Gleditsch. 2018. *Spatial Regression Models*. SAGE Publications.

Xie, Sherrie. 2022. "Analyzing Geospatial Data in R." In *R/Medicine Virtual Conference*.