

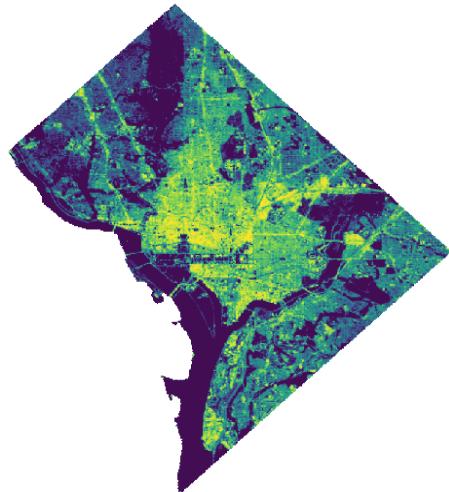


# Geographic Data in Program R

PPOL 683  
Fall 2022  
M 6:30 – 9:00 PM  
Dr Brian Evans

## Course overview

This course will provide students with a theoretical and applied understanding of geographic information systems and geospatial analysis using Program R. Topics covered will include projection systems, raster and vector data, database design, and modern methods in R coding. Special emphasis will be placed on visualizing spatial data through developing static and interactive maps.



## Learning goals

This course will help you develop the following foundational skills:

- Collaboration
- Critical Thinking
- Economic Analysis
- Engaging with Bias
- Evaluation
- Quantitative Reasoning
- Strategic Communication

## Learning outcomes

Upon completion of this course, you will be able to:

1. Read, project, and write shape & raster files in R
2. Conduct geospatial analyses (e.g., point pattern and network analyses)
3. Conduct spatial joins & geometric operations on geospatial files
4. Create informative & visually appealing static and interactive maps
5. Create interactive web applications for exploring geospatial data

## Meet your instructor



**Dr Brian Evans**  
Adjunct Professor – Biology  
Reiss 446

Dr Evans is a landscape ecologist and ornithologist, specializing in environment-bird interactions with a focus on the landscape ecology of Greater Washington, DC. Brian's research approach integrates field work, community science, GIS, and quantitative ecology.

Email: [evansbr@si.edu](mailto:evansbr@si.edu)

Office hours: By appointment

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## Course format and expectations

This course will cover five major topics:

1. Data science in R
2. Research design
3. Shapefiles (i.e., points, lines, and polygons)
4. Rasters (i.e., spatial grids)
5. Visualizing & communicating data

We will spend the first two weeks of the course honing our R skills, ensuring that you have the necessary understanding of modern data science workflows in R.



**Prerequisites:** None, however students are expected to have experience with R prior to enrolling in this course. Additional learning materials will be provided for students with beginner or early intermediate-level R skillsets.

**Expectations:** This will be a **flipped classroom** – each week you will receive up to one hour of instructional videos and R tutorials that cover the topics for the following week. Students should dedicate 5-6 hours every week to reviewing materials prior to class, completing assignments, and working on their final projects. Problem sets for this course are intended to be challenging and may take considerable time to complete, depending on your understanding of the material. Active learning necessitates participation – I therefore expect that each student will review all assigned materials prior to class, arrive to class on time, attend each class session, and contribute meaningfully to discussions.

# Assessments and grading

## Grading

Your performance will be assessed based on the following criteria:

- Problem sets: 40%
- Final project assignments: 50%
- Skill assessments: 10%

### Problem sets

There will be five problem sets in which you will answer a series of questions in an R Markdown document. The lowest scoring problem set will not be included in your final grade (i.e., it will be dropped). The points allotted to each question will be provided to you in the R Markdown document.

### Final project assignments

Your final project will be submitted in a series of stages, from development to finished product. A detailed rubric will be provided for each submission.

Grading scale	
A	93-100
A-	90-92
B+	87-89
B	83-86
B-	80-82
C+	77-79
C	73-76
C-	70-72
D	60-69
F	< 60

- **Annotated literature review (5 points):** You will conduct a targeted literature review to identify current literature on your research question and potential “holes” in the literature. 可以用 web of science, google scholar 替代
- **Proposal presentation (5 points):** You will give a 5-minute presentation that describes the GIS project you would like to undertake this semester. The talk will include five PowerPoint or Keynote slides and there will be a short question and answer session following each presentation.
- **Written project proposal (5 points):** You will produce a 500-word Word document that describes your intended project.
- **Data and wrangling (2 total, 5 points each):** You will submit project data and the code used to wrangle and clean the data.
- **Maps and plots (2 total, 5 points each):** You will produce static and dynamic maps to communicate spatial information about your project data and submit the assignment as an R Markdown file with all code.

## Assessments and grading, continued

- **Shiny app (5 points):** You will create an interactive Shiny app to communicate spatial information about your project data.
- **Final presentation (10 points):** You will give a 12-minute presentation that describes the reason for your study, the study design, methodology, and findings.

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**Skill assessments (10 points):** Some class sessions will begin with timed skill assessments that measure your degree of preparation for class and understanding of the material. Your final skill assessment grade will be based on the percentage of total points earned. Your lowest scoring assessment will not be included in this total.

**Please note:** You are expected to submit all work in a timely manner. All assignments are due by 11:59 pm on their due date. I will deduct 10% from an assignment's total score for each day in which it was late. Problem sets may not be submitted more than one day late because I will post a key at 12:00 am on the morning before class.

## Inclusivity and Diversity

I strive to create a learning environment that supports a diversity of thoughts, perspectives, and experiences, and honors your identities (including race, gender, class, sexuality, religion, ability). To help accomplish this:

- If you have a name and/or set of pronouns that differ from those that appear in your official records, please let me know.
- If you feel like your performance in the class is being impacted by your experiences outside of class, please don't hesitate to come talk with me. If you prefer to speak with someone outside of the course, your academic dean or the Office of Student Affairs are excellent resources.
- We are all on the continuum of learning about diverse perspectives and identities. If something was said in class (by anyone) that made you feel uncomfortable, please talk to me about it.

As a participant in course discussions, you should strive to honor the diversity of your classmates.

## Academic integrity

We expect that all students will abide by the Academic Honor Code and Code of Conduct. Please find more information here:

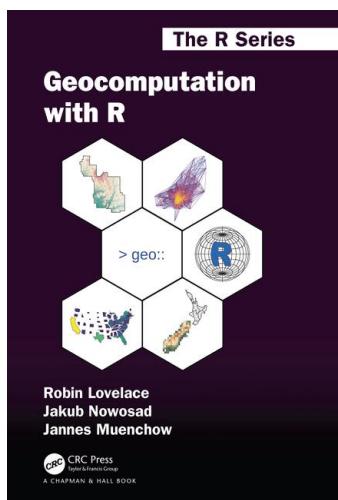
<https://honorcouncil.georgetown.edu/system/policies/#>

and here:

[https://studentconduct.georgetown.edu/code-of student-conduct/](https://studentconduct.georgetown.edu/code-of-student-conduct/)

We are required to report any suspected violations of the Honor Code. **Plagiarism will not be tolerated. Please make sure you cite other's ideas properly in all written assignments.**

## Course readings and materials



Throughout this course, we will use a combination of written and video tutorials developed for this course and a companion data science course. Optional, supplemental material will be provided through a peer-reviewed literature, online resources, and book chapters. All content will be posted using Canvas Learning Modules. I recommend purchasing the two textbooks for this course, as they will be a great reference for this course and for your future work with R and GIS.

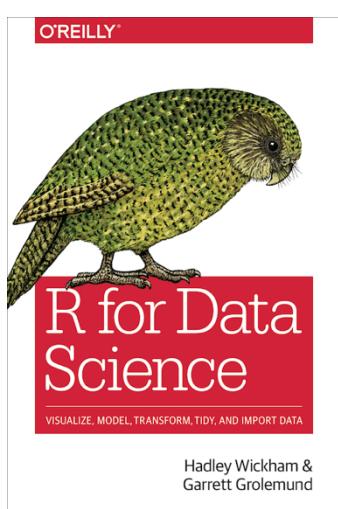
**Our primary textbooks for this course are:**

Lovelace R., Nowosad J., and Muenchow, J. (2019). Geocomputation with R. Chapman and Hall/CRC. A free online version of this book is available at <https://geocompr.robinlovelace.net/>.

Wickham, H., & Grolemund, G. (2022). *R for data science: import, tidy, transform, visualize, and model data*. O'Reilly Media, Inc. A free online version of this book is available at <https://r4ds.had.co.nz/>.

**Recommended:**

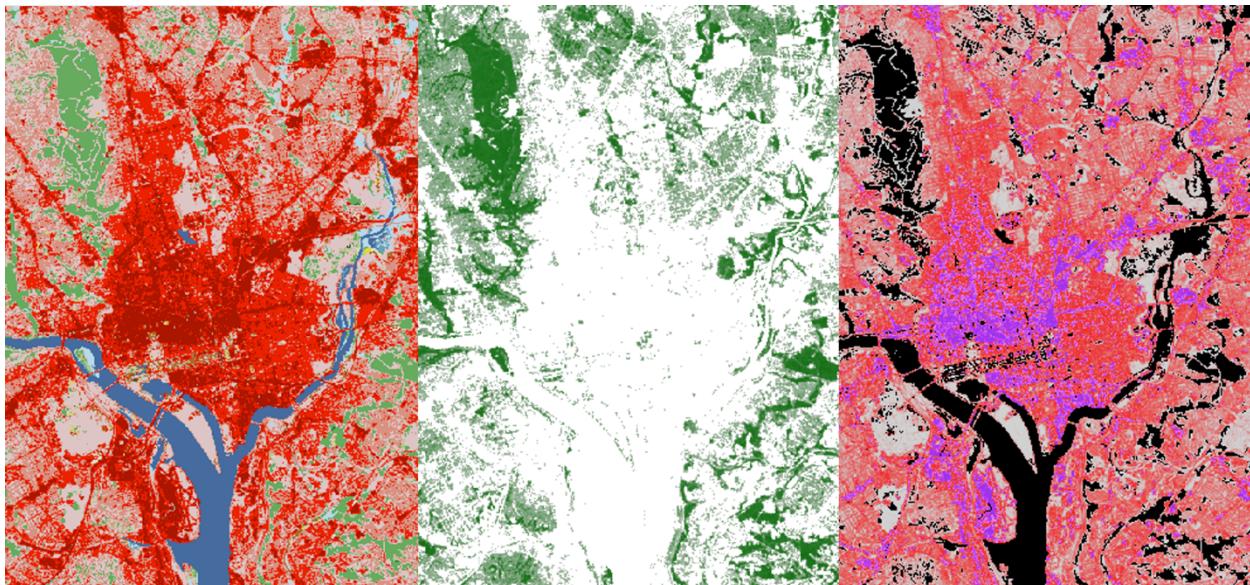
Wickham, H. (2019). Advanced R, Second Edition. Chapman and Hall/CRC. <https://adv-r.hadley.nz/>



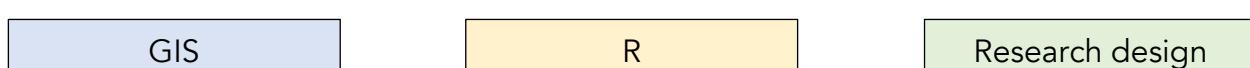
## Communication and instructional continuity

We will meet most or all class periods in person. If, for some reason, we are unable to meet in person, we will email you and post an announcement on Canvas and meet through a Zoom link found on Canvas.

Accommodations	Sexual misconduct
<p>Please contact us as soon as possible and by the first week of class at the latest if you are in need of any classroom accommodations.</p> <p>All accommodations should be arranged in advance with the Academic Resource Center</p> <p><a href="https://academicsupport.georgetown.edu/disability/#">https://academicsupport.georgetown.edu/disability/#</a></p>	<p>As faculty members we are committed to supporting survivors of sexual misconduct, including relationship violence, sexual harassment, and sexual assault. University policy requires faculty to report any disclosures about sexual misconduct to the Title IX Coordinator, whose role is to coordinate the University's response to sexual misconduct. Georgetown has a number of fully confidential professional resources who can provide support and assistance to survivors of sexual assault and other forms of sexual misconduct. More information about campus resources and reporting sexual misconduct can be found at</p> <p><a href="http://sexualassault.georgetown.edu.">http://sexualassault.georgetown.edu.</a></p>



Schedule			
Date	In-class Topic	Assignment	
Focus on R Fundamentals			
August	29-Aug	<ul style="list-style-type: none"> <li>Syllabus review</li> </ul>	<u>Due 4-Sept</u> <b>R Learning Material:</b> <ul style="list-style-type: none"> <li>R programming basics</li> <li>Data normalization</li> <li>Projects</li> </ul> <b>Communicating Data:</b> <ul style="list-style-type: none"> <li>R Markdown</li> <li>ggplot: GG elements</li> </ul> <b>Problem Set 1:</b> Getting to know you
		<ul style="list-style-type: none"> <li>Introduction to GIS</li> </ul>	
		<ul style="list-style-type: none"> <li>RStudio</li> <li>R Markdown</li> </ul>	
September	6-Sept	<ul style="list-style-type: none"> <li>Objects &amp; classes</li> <li>ggplot I – Intro</li> <li>The pipe</li> <li>Tidy data</li> </ul>	<u>Due 10-Sept</u> <b>R Learning Material:</b> Working with tidy data <b>Shapefiles:</b> Intro to sf <b>Problem Set 2:</b> Messy weather
		<ul style="list-style-type: none"> <li>Study design</li> </ul>	
	Focus on Shapefiles		
September	12-Sept	<ul style="list-style-type: none"> <li>Spatial objects</li> <li>Coordinate systems (CRS)</li> <li>Introduction to sf</li> </ul>	<u>Due 17-Sept</u> <b>R Learning Material:</b> Working with tidy data <b>Shapefiles:</b> Spatial joins <b>Research Project 1:</b> Annotated literature review
		<ul style="list-style-type: none"> <li>Literature searches</li> </ul>	



Schedule		
Date	In-class Topic	Assignment
September	Focus on Shapefiles, continued	
	19-Sept	<ul style="list-style-type: none"> <li>Joining spatial data</li> </ul>
		<ul style="list-style-type: none"> <li>WWTD – Mutation</li> <li>WWTD – Subsetting</li> <li>WWTD – Joins</li> </ul>
		<ul style="list-style-type: none"> <li>QHPT workshop</li> </ul>
	26-Sept	<ul style="list-style-type: none"> <li>Geometric operations</li> <li>tmap</li> </ul>
		<ul style="list-style-type: none"> <li>Grouped data (summarize, filter &amp; mutate)</li> </ul>
	3-Oct	<ul style="list-style-type: none"> <li>Iteration with dplyr &amp; purr</li> </ul>
		<ul style="list-style-type: none"> <li>Lightning talks</li> </ul>
	17-Oct	<ul style="list-style-type: none"> <li>Geometric operations</li> </ul>
		<ul style="list-style-type: none"> <li>web API</li> </ul>
October	Focus on Rasters	
	24-Oct	<ul style="list-style-type: none"> <li>Intro to the raster &amp; terra packages</li> </ul>
		<p><u>Due 24-Sept</u>  <b>R Learning Material:</b> Grouped data operations  <b>Shapefiles:</b> <ul style="list-style-type: none"> <li>Geometric operations</li> <li>tmap</li> </ul> <b>Problem Set 3:</b> Populations and CO<sub>2</sub></p> <p><u>Due 1-Oct</u>  <b>R Learning Material:</b> Iteration  <b>Research:</b> Winning presentations  <b>Research Project 2:</b> Lightning talk</p> <p><u>Due 15-Oct</u>  <b>R Learning Material:</b> Data gathering with web API  <b>Communicating Data:</b> Winning research proposals  <b>Problem Set 4:</b> District crime</p> <p><u>Due 22-Oct</u>  <b>Rasters:</b> Intro to rasters  <b>Research Project 3:</b> Written proposal</p> <p><u>Due 29-Oct</u>  <b>R:</b> if_else() and case_when()  <b>Rasters:</b> Raster classification  <b>Problem Set 5:</b> Environmental equity</p>

GIS

R

Research design

Schedule			
	Date	In-class Topic	Assignment
October	Focus on Rasters, continued		
	31-Oct	<ul style="list-style-type: none"> <li>• Classifying rasters</li> </ul>	<u>Due 5-Nov</u> <b>Rasters:</b> Spatial patterns <b>Research Project 4:</b> Spatial data
November	7-Nov	<ul style="list-style-type: none"> <li>• Interpolation &amp; spatial density</li> </ul>	<u>Due 12-Nov</u> <b>Communicating Data:</b> Focus on cartography <b>Research Project 5:</b> Spatial wrangling
	Focus on Communication		
November	14-Nov	<ul style="list-style-type: none"> <li>• Cartographic considerations</li> </ul>	<u>Due 19-Nov</u> <b>Communicating Data:</b> Interactive maps with Leaflet <b>Research Project 6:</b> Static maps
	21-Nov	<ul style="list-style-type: none"> <li>• Interactive maps</li> </ul>	<u>Due 26-Nov</u> <b>R:</b> Control flow: if(...) {...} else {...} <b>Communicating Data:</b> Shiny applications <b>Research Project 7:</b> Interactive maps
	28-Nov	<ul style="list-style-type: none"> <li>• Intro to shiny</li> </ul>	<u>Due 2-Dec</u> <b>Research Project 8:</b> Shiny application <b>Research Project 9:</b> Final presentation
Dec	4-Dec	Final Project Presentations	

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R

Research design