GIS in R: Fundamentals and Economic Applications

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Table of contents

Welcome!

Figure 1: Alt text

This book was created in order to host all of the materials for AREC 493 class.

Spatial data is increasingly essential for understanding economic activity, policy and development. This course introduces students to the use of R as a Geographic Information System (GIS) for economic analysis. Students will learn core GIS concepts alongside the basics of R programming, with a focus on practical applications in economics. The course closely integrates *tidyverse* functions with GIS tools to develop efficient and intuitive coding. Topics include spatial data processing, covering the import, management, and manipulation of raster and vector data, as well as visualization of spatial data through maps to identify spatial patterns. By the end, students will have the skills to integrate spatial analysis into economic research, enabling them to work with powerful and flexible tools for investigating real-world economic questions.

Be aware that the book is currently being written and will be completed by the end of the semester. Let me know if you think any changes are necessary!

1 Syllabus

1.1 Course Information

Course: AREC 493

Instructor: Dr. Gaby Perez-Quesada

Email: gperezqu@utk.edu

Term: Spring 2026

Times: T & R, 2:30-3:45pm

Location: Morgan Hall 212B

Office Hours: T & R, 3:45-5:00pm

1.2 Learning Objectives

- Use R and ***tidyverse*** tools to import, clean, and manipulate spatial data efficiently and reproducibly
- Explain and apply core GIS concepts, including spatial data types, projections, and coordinate reference systems
- Work with vector and raster datasets, performing basic operations, analysis, and integration between data types
- Visualize spatial data effectively through maps to identify and interpret spatial patterns
- Access and process real-world spatial datasets from public sources for applied economic analysis

1.3 Prerequisites

AREC 270. Prior coursework in basic statistics or econometrics is recommended. Students should be comfortable with fundamental concepts such as descriptive statistics, regression analysis, and interpreting empirical results.

1.4 Lecture Topics

(*Subject to change based on progression through the material*)

Getting started with R

- Get started with running code
- Install and load libraries
- Load in data from files, the internet, or libraries
- Write good code and responsibly use AI in your coding
- Look at your data and get basic statistical results
- Manipulate your data and get it ready for analysis

GIS fundamentals

- Types of spatial data
- Projections and coordinate reference system

The basics of vector data handling using *sf* package

- Vector data (points, lines, polygons)
- Import and export vector data
- (re)projection of spatial datasets
- Single-layer geometrical operations (e.g., create buffers)

Spatial interactions of vector datasets

- Understand topological relations of multiple *sf* objects
- Spatially subset a layer based on another layer
- Extracting values form one layer to another layer

The basics of raster data handling using *raster* and *terra* packages

- Import and export raster data
- Stack raster data
- Quick plotting

Spatial interactions of vector and raster datasets

- Cropping a raster layer to the geographic extent of a vector layer
- Extracting values form a raster to a vector later

Creating maps using *ggplot2* package

- Visualizing spatial data with ggplot2

Download and process publicly available datasets

- USDA NASS QuickStat (*tidyUSDA*)
- PRISM (*prism*)
- Daymet (*daymetr*)
- Cropland Data Layer (*CropScapeR*)
- Census (*tidycensus*)

1.5 Course Materials

This course will follow a set of high-quality, freely available online resources, alongside DataCamp Classroom. Students are encouraged to consult these materials to complement lectures and exercises.

Introduction to R

- R for Data Science
- Introduction to Working with Data: R version

R for GIS

- R as GIS for Economists
- Spatial Statistics for Data Science: Theory and Practice with R

1.6 Grading

Assignments: 30%

Midterm Exam: 25%

Participation: 15%

Final Project: 30%

1.7 Academic Integrity

In accordance with the college's academic honesty policy, students are expected to submit original work for all assignments. Any form of academic dishonesty will not be tolerated. Plagiarism includes copying answers, phrases, sentence structures, or ideas from any source without proper attribution.

This also applies to the use of artificial intelligence tools such as ChatGPT. While you may use AI to assist with coding or to explore solutions, you must not simply feed it questions and submit the generated responses as your own work. All submitted assignments should reflect your understanding and effort.

1.8 Generative AI Tools in Coursework

Open Use Guidelines: Embrace and encourage AI use in assignments, with the requirement that students disclose any AI assistance.

AI policy: permitted in this course with attribution

In this course, students are allowed to use Generative AI Tools like ChatGPT to support their work. To maintain academic integrity, students must disclose any AI-generated material they use and properly attribute it, including in-text citations, quotations, and references.

A student should include the following statement in assignments to indicate use of a Generative AI Tool: "The author(s) would like to acknowledge the use of [Generative AI Tool Name], a language model developed by [Generative AI Tool Provider], in the preparation of this assignment. The [Generative AI Tool Name] was used in the following way(s) in this assignment [e.g., coding, brainstorming, grammatical correction, citation, which portion of the assignment]."

1.9 Accommodations for Students with Disabilities

I am available to discuss appropriate academic accommodations that may be required for student with disabilities. The University of Tennessee, Knoxville, is committed to providing an inclusive learning environment for all students. If you anticipate or experience a barrier in this course due to a chronic health condition, a learning, hearing, neurological, mental health, vision, physical, or other kind of disability, or a temporary injury, you are encouraged to contact Student Disability Services (SDS) at 865-974-6087 or sds@utk.edu. An SDS Coordinator will meet with you to develop a plan to ensure you have equitable access to this course. If you are already registered with SDS, please contact your instructor to discuss implementing accommodations included in your course access letter.

1.10 Online@UT

Students are required to routinely access their UTK email account and the course website located on the Online@UT (Canvas) portal

2 Getting Started with R

2.1 Why use R?

As stated on the R Project website, R is a programming language and environment for statistical computing and graphics. It's flexible, easy to build on, and supported by a large, welcoming community.

Cost

R is free and open-source for everyone.

Reproducibility

Using a programming language for data management and analysis, rather than relying on Excel or other point-and-click tools, makes your work easier to reproduce, helps you catch mistakes more quickly, and can save you a lot of time and effort.

Community

The R community is huge and supportive. New packages and tools to tackle real-world problems are developed all the time, and the community helps test, improve, and share them.

2.2 Installation: R and RStudio

To get started, you'll need to have R running on your computer. There are a few options, but **RStudio** is a popular choice that makes working with R much easier.

Installing RStudio takes two steps. First, you'll need to install the R language itself.

How to install R

Visit this website https://www.r-project.org and download the latest version of R suitable for your computer. *Note*: Any mirror will work fine, but perhaps pick one close to you.

Once that's done, you can **install RStudio**

Go to this website https://posit.co/download/rstudio-desktop/ and download the latest free Desktop version of RStudio suitable for your computer.

2.3 Navigating RStudio

Open RStudio. RStudio is divided into four main *panes*, each showing different information like your code, console, and files.

The source pane

By default, this pane appears in the upper-left corner. It's where you can write, run, and save your scripts (your scripts are basically the sets of commands you want R to execute. You can also use this pane to view your datasets (data frames) while working.

The R console pane

The R Console (usually in the lower-left pane) is where the R "engine" lives. When you run commands here, you'll see results, warnings, or error messages right away. You can type commands directly in the Console, but unlike scripts, these commands won't be saved for later, so it's best for quick tests or checks.

The environment pane

By default, this pane appears in the upper-right. It's mainly used to get a quick look at the objects in your R environment during the current session. These objects can include datasets you've imported, created, or modified, as well as parameters or vectors and lists you've defined. You can click the little arrow next to a data frame to explore its variables.

Plots, Viewer, Packages, and Help pane

The lower-right pane contains several useful tabs. The *Plots* tab displays your charts, graphs, and maps, while the *Viewer* tab shows interactive or HTML outputs. The *Help* tab gives access to R documentation and help files, and the *Files* tab works like a mini file explorer, letting you open, move, or delete files. Finally, the *Packages* tab lets you see which R packages are installed, add new ones, update or remove them, and load or unload them for your session.

2.4 Scripts

Scripts are a fundamental part of programming. They're files that store the commands you want R to run, like creating or modifying datasets and generating visualizations. You can save a script and run it again later, which comes with some big advantages:

Portability: you can easily share your work with others by sending them your script.

Reproducibility: using scripts makes it clear exactly what steps you took, so you, or anyone else, can repeat your analysis with confidence.

Example script

```r
3 + 4
```

```
[1] 7
```

```r
a <- 3 + 4 # you can annotate around your code!
```

2.5 Quarto

Quarto is a tool that lets you combine your R code, text, and visualizations in a single document. It's perfect for creating reports, tutorials, or assignments where you want your analysis and explanations to live side by side. With Quarto, you can run your code, include the results, and produce a polished document; all in one place, making your work easy to share and easy to reproduce.

Free online resources:

Tutorial: Hello Quarto

R for Data Science: Quarto

References