NRM 5306
GIS, GPS, and Remote Sensing

Instructor: Justin French

Spring 2024

RAS 126
12:00 PM - 1:50 PM, Monday and Wednesday
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Office Hours: Fridays, 1:00 PM to 4:00 PM, or by appointment.

1 Course Overview

This course is intended to give the student a thorough introduction to programming-based GIS operations and advanced geospatial analysis. We will explore the latest developments in spatial data objects, spatial databases and their integration with GIS operations, and remote sensing methods. We will utilize open source software, including R and postgreSQL/PostGIS.

This course assumes you have at least a working familiarity with R. If you do not have at least vague familiarity with R objects (*i.e.* vectors, matrices, data frames, and lists), looping, and apply statements, this course will be exceedingly difficult.

The class is divided into 3 modules to cover each of the necessary skill sets to be effective and competitive in the rapidly advancing field of spatial ecology. We will start with the nuts and bolts of spatial data objects and associated packages in R. We will then transition to data management with spatially enabled relational databases, focusing in PostGIS. Finally, we will introduce essential topics in remote sensing for spatial ecologists. These will include image classification/segmentation, calculation of continuous indices (such as NDVI or Tasseled Cap metrics), fundamentals of geostatistics, and, if needed or time allows, spatial time series analysis.

By the end of the class you should be able to:

1. Manipulate spatial data in R
2. Automate complex GIS operations
3. Design and maintain spatial databases
4. Interact with web-based platforms to obtain data
5. Implement remote sensing techniques to solve management problems

2 Required Text

Lovelace, R., J. Nowosad, and J. Muenchow. 2022. Geocomputation with R. CRC Press, Boca Raton, FL, USA. Freely available online and for compilation in R at: https://geocompr.robinlovelace.net/index.html

3 Suggested Text

Obe, R. O. and L. S. Hsu. 2015. PostGIS in Action. 2nd Edition. Manning Publications Co., Shelter Island, NY, USA.

4 Assignments

All assignments in this class will be done in R, integrated with LaTeX. R is the most rapidly growing tool in our field and will soon be an essential skill, likely replacing ESRI's ArgGIS. It is best that you install both R and R Studio, which is a convenient interface. They are available for free download at:

- **R:** https://cloud.r-project.org/
- **R Studio:** https://rstudio.com/products/rstudio/download/

Appropriate LaTeXdistributions depend on your operating system. Windows users should consider MikTeX, TeXLive, or TinyTeX. Mac users may be better served with MacTeX. All are easy to find with a quick Google search. There are nuances to using each, which I am glad to assist with.

Each regular assignment will be made available on Monday of the week it is assigned and will be due the following Monday. Late submissions will not be accepted unless prior arrangements are made (implying there was a good, foreseen reason to be late), except under reasonable extenuating circumstances.

5 Grading Policy

Grades are based on weekly assignments and a semester project. Assignments and the project will each contribute 50% of your final grade.

Letter grades follow: $100 > A \geq 90 > B \geq 80 > C \geq 70 > D \geq 60 > F$. There is no curve.

6 Attendance

Showing up is the only way to get the material you need. If you don't come to class, your grade will reflect it with no penalty needed from me. In the event of an excused absence, make arrangements with me to go over material ahead of time.

7 Academic Dishonesty

Academic dishonesty includes copying, sharing, or obtaining information from an unauthorized source, attempting to take credit for the intellectual work of another person, falsifying information, and giving or receiving information about a test, quiz, or assignment to other students. Any student involved in academic dishonesty will receive no credit (0) for work done and/or may be penalized in accordance with published University Rules.

8 Counseling and Accessibility Services

Sul Ross State University is committed to equal access in compliance with the Americans with Disabilities Act of 1973. It is the student's responsibility to initiate a request for accessibility services. Students seeking accessibility services must contact Mary Schwartze, M. Ed., L.P.C., in Counseling and Accessibility Services, Ferguson Hall, Room 112. The mailing address is P.O. Box C-122, Sul Ross State University, Alpine, Texas 79832. Telephone: 432-837-8691. E-mail: mschwartze@sulross.edu.

9 Course Schedule (Tentative)

Module 1: GIS Programing in R

- **Week 1 (1/15-1/19):** Introduction to Spatial Objects
  - Lecture: Off for MLK Day
  - Lecture: Class Intro and Setup
  - Lab: None this week
  - Semester Project: Schedule a time to meet with me about your project.

- **Week 2 (1/22-1/26):** Coordinate Reference Systems in R
  - Lecture: Introduction to Simple Features and the `sf` package
  - Lecture: CRS, EPSG Codes, and Tedium Minimization
  - Lab: Simple features in R
  - Semester Project: Identify questions and goals.

- **Week 3 (1/29-2/2):** Manipulating Spatial Objects
  - Lecture: Geoprocessing outside of ESRI
  - Lab: Geoprocessing in R
  - Semester Project: Compile vector data

- **Week 4 (2/5-2/9):** Cartography in R
  - Lecture: Grammar of graphics in space
  - Lab: Automating maps with `ggspatial`
  - Semester Project: Map vector data

Module 2: Database Design and Management

- **Week 5 (2/12-2/16):** Database Concepts 1
  - Lecture: Fundamentals – Spatial ain't special
  - Lab: Building and querying a PostGIS database
  - Semester Project: Transition vector data to a database

- **Week 6 (2/19-2/23):** Database Concepts 2
  - Lecture: Joins, DB bread and butter
  - Lab: Linking data with joins
  - Semester Project: Finalize questions and objectives

- **Week 7 (2/26-3/1):** Raster Data and Spatial Databases
  - Lecture: Scaling concerns, in- and out-of-DB options
  - Lab: Manipulating rasters in R
  - Semester Project: Identify needed raster data

- **Week 8 (3/4-3/8):** Data Interoperability and Out-of-Database Curation
  - Lecture: Scaling concerns, in- and out-of-DB options
  - Lab: Manipulating rasters in R
  - Semester Project: Identify needed raster data

- **Spring Break (3/11-3/15):** No class.

Module 3: Remote Sensing

- **Week 9 (3/18-3/22):** Fundamental Concepts in RS
  - Lecture: Goals, History, and Technologies in RS
  - Lab: Interacting with APIs
  - Semester Project: Acquire imagery

- **Week 10 (3/25-3/29):** Hyperspectral Imagery
  - Lecture: Landsat, MODIS, and Aster, Oh My!
  - Lab: Working with Landsat ARD
  - Semester Project: Acquire an image time series

- **Week 11 (4/1-4/5):** Image Classification
  - Lecture 1: Basic multivariate statistics
  - Lab: Principal components and clustering
  - Semester Project: Classify imagery

- **Week 12 (4/8-4/12):** Spectral Indices
  - Lecture 1: NDVI, Tasseled Cap Metrics, and More
  - Lab: Mapping the Green Wave
  - Semester Project: Calculate spectral indices

- **Week 13 (4/15-4/19):** Landscape Metrics
  - Lecture 1: Quantifying landscape configuration
  - Lab: Structure metrics for categorical and continuous spatial data
  - Semester Project: Conduct analyses

- **Week 14 (4/22-4/26):** Basics of Geostatistics
  - Lecture: Interpolation problems
  - Lab: Filling gaps, points to surfaces
  - Semester project: Finalize and write up findings

- **Week 15 (4/29-5/3):** Time to present!
  - Lecture: Project presentations
  - Lab: Project presentations
  - Semester Project: Incorporate anything pertinent that came up

- **Week 16 (5/6-5/8):**
  - Final Exam Week (No Class, you're done!)
  - Bonus Lab (Not Graded): Fun stuff with `plotly`!
  - Semester Projects Due `2022-05-04 17:00:00`