CE/EAPS 50701: Geospatial Data Analytics

(Course Syllabus subject to changes when deemed necessary)

Course Information

Course name: Geospatial Data Analytics - 22541 – CE/EAPS 50701
Offered: Fall 2024
Time/date: 8:30 – 9:20am, MWF
Classroom: HAMP 2117
Credit: 3 credits
Website: Brightspace (lecture videos, notes, assignments, submissions, etc.)

Prerequisites

- Graduate standing; prior GIS course; prior programming experience; college statistics and linear algebra; or
- Consent from the instructor

Instructor Contact Information

- Jie Shan, *Professor of Civil Engineering, and EAPS (Courtesy), Purdue University*
  - Office Location: HAMP 4110
  - Office Phone Number: 494-2168
  - Purdue Email Address: jshan@purdue.edu
  - Office Hours:
    - 3:30 pm - 5:00pm ET on Mondays
    - 3:30 pm - 5:00pm ET on Wednesdays
    - or by appointment
    - https://purdue-edu.zoom.us/j/2857306102
  - Expected Response Time: For questions received via email, students should expect a response within one business day.

Course Description

The course will introduce fundamental theories, analytical methods and programming skills that are needed to work with geospatial data. Students will learn the theories, methods, and techniques to visualize, analyze and model various geospatial data through hands-on computer programming practice based on various opensource geospatial libraries. To be specific, the course will use R and its related packages as the basic tool for implementation. The goal is to enable the learners to develop their own geospatial analytical applications.

Course Learning Outcomes

By successfully completing the course, students should be able to

1. ***LO1:* Interpret and evaluate the theories and methods of geospatial data analytics.**
   - *LO 1.1:* Mathematically formulate representative methods in geospatial data analytics.
   - *LO 1.2:* Interpret the notations and conditions of an analytical formulation.
   - *LO 1.3:* Explain the properties and limitations of popular geospatial methods.
2. ***LO2:* Design and implement typical geospatial methods through programming.**
   - *LO 2.1:* Make a computer program to implement specified geospatial analytic methods with correct results.
   - *LO 2.2:* Discuss the uncertainty of the related implementation and calculation.
   - *LO 2.3:* Extend and combine basic analytic methods to solve a complex real world problem through programming.
3. ***LO3:* Effectively visualize and interpret the outcome of geospatial data analytics.**
   - *LO 3.1:* Access and visualize various geospatial data through a clean and comprehensive representation.
   - *LO 3.2:* Make spatial analysis over multiple geospatial data layers.
   - *LO 3.3:* Logically evaluate their mapping and analysis outcome based on the used methods and nature of the problem.

Learning Resources, Technology & Texts

- No required texts
- Lecture notes
- Personal computer/laptop with Windows
- Brightspace learning management system

Reference Materials:

1. Spatial Data Science with R
   - Introduction to R
   - 'terra' package is an update to 'raster'
   - Many other materials
2. Spatial Statistics for Data Science: Theory and Practice with R *by Paula Moraga, https://www.paulamoraga.com/book-spatial/index.html , 2023*
3. Using Spatial Data with R, Claudia A Engel, Last updated: February 21, 2024
4. Geocomputation with R, 2nd Edition, R. Lovelace, J. Nowosad, J. Muenchow, 2024
5. Introduction to Spatial Data Programming with R, https://geobgu.xyz/r/ Michael Dorman, 2024-07-28
6. Spatial Data Science with applications in R, Edzer Pebesma, Roger Bivand, Dec. 6, 2023
7. R for Data Science, H. Wickham and G. Grolemud, and many authors, 2017
8. Advanced R, http://adv-r.had.co.nz/ , by Hadley Wickham (2nd Edition is not free)

9. R Packages, 2nd edition, Hadley Wickham
10. 17 Best R Programming Books (June 12, 2024 Update)
11. Introduction to Spatial Network Forecast with R, Laurent L. Santos and Francisco S. Castillo, https://laurentlsantos.github.io/forecasting/ , 2019

12. Many more resources can be found via Google and YouTube

Grading

This course will be graded based on the following criteria:

Assessment/ Learning Type	Description	% of Final Grade
Project Assignments	There will be a total of nine (9) project assignments. They are designed for students to use R and its packages to experience both fundamental theories and practical applications. These projects will cover the entire range of subjects discussed in the lectures and will be assigned in conjunction with the lecture materials being delivered. It is expected that three (3) projects will be assigned for each five-week module.	80%
Participation	In-progress presentation discussion forums will accompany selected course projects. Students that are assigned to a particular project are expected to present their ongoing progress of the project.	5%
Lab tutorials	Lab tutorials are important and necessary materials in conjunction with the topics and projects. They provide learners with live examples on how to apply the fundamentals for geospatial development. Lab tutorials will not be graded.	0%
Reading and Resources	Reading and Resources can be in the form of readings and videos. They are provided for learners to extend their knowledge beyond what is covered in the class.	0%
Final Exam	The final exam will be closed-book. Exams should be completed independently. The exam is comprehensive and will cover all materials discussed in class. It will focus on fundamental theories and methods.	15%

Grading Scale

Your course grade will be based on the following grading scale:

Letter Grade	Percentage
A+	[97-100%]
A	[93-97%)
A-	[90-93%)
B+	[84-90%)
B	[77-84%)
B-	[70-77%)
C+	[64-70%)
C	[57-64%)
C-	[50-57%)
F	<50%

- Late submissions may cause an up-to 20% deduction per day (no late submissions will be accepted after 48 hours).
- The first instance of academic plagiarism will cause a reduced grade for the related assignment/project. The max grade you may receive is 50%, depending on the severity of the plagiarism.
- The second instance of academic plagiarism will cause failure of the course.
- Cases of plagiarism may be reported to the relevant offices.

Course Schedule

Modules	Topics	Week	Projects
1 – Geospatial Data Visualization ***Week 1-5 (Aug 19-Sep 20)***	1. R Basics	1	• Project 1 Available (Wed)
	2. Temporal Exploration	2	• Project 1 due (Sat)
	3. Spatial Exploration	3	• Project 2 Available (W)
	4. Thematic Mapping	4	• Project 2 Due (S) • Project 3 Available (W)
	5. Coordinate Systems and Transform	5	• Project 3 Due (S)
2 – Geospatial Data Analysis ***Week 6-10 (Sep 23 – Oct 25; Oct 7-8 Oct break)***	1. Spatial Point Patterns	6	• Project 4 Available
	2. Spatial Clustering - Part I	7	• Project 4 Due
	3. Spatial Clustering - Part II	8	• Project 5 Available
	4. Spatial Autocorrelation	9	• Project 5 Due • Project 6 Available
	5. Spatial Operations and Query	10	• Project 6 Due
3 – Geospatial Data Modeling ***Week 11-16 (Oct. 28 – Dec 7)***	1. Geographically Weighted Regression	11	• Project 7 Available
	2. Spatial Interpolation I	12	• Project 7 Due
	3. Spatial Interpolation II	13	• Project 8 Available
	4. Kriging Methods	14	• Project 8 Due • Project 9 Available
	5. Machine learning based methods	15	
	6. Review	16	Project 9 Due
Final Exam Week (Dec. 9-13)			• **Final Exam**

Estimated Effort

- ~10 hours/week
- 16 weeks total

Course Help

To get help with the course content, I recommend that you begin by doing your own research - Google and YouTube are excellent resources. If you are not able to find the answers you need and still have questions, then you can approach the instructor through email and/or designated office hours. You may ask questions of and interact with your peers through a course-wide discussion forum (NOTE: the instructor will not monitor this forum; it is for students to interact with their peers only). In-progress presentations and discussions will also be arranged for the projects so that you can share your experiences with each other in a timely manner.

Discussion Guidelines

Please follow the Discussion Guidelines when contributing to discussions in this course. Here are a few of the key points you should remember:

- Do not use offensive language. Present ideas appropriately.
- Be cautious in using Internet language. For example, do not capitalize all letters since this suggests shouting.
- Avoid using vernacular or slang language. This could possibly lead to misinterpretation.
- Do not hesitate to ask for feedback.
- Be concise and to the point.
- Think and edit before you push the "Send" button.

Academic Integrity

Academic integrity is one of the highest values that Purdue University holds. Individuals are encouraged to alert university officials to potential breaches of this value by either emailing integrity@purdue.edu or by calling 765-494-8778. While information may be submitted anonymously, the more information is submitted the greater the opportunity for the university to investigate the concern. More details are available on our course Brightspace table of contents, under *University Policies*.

Nondiscrimination Statement

Purdue University is committed to maintaining a community which recognizes and values the inherent worth and dignity of every person; fosters tolerance, sensitivity, understanding, and mutual respect among its members; and encourages each individual to strive to reach his or her potential. In pursuit of its goal of academic excellence, the University seeks to develop and nurture diversity. The University believes that diversity among its many members strengthens the institution, stimulates creativity, promotes the exchange of ideas, and enriches campus life. A hyperlink to Purdue's full Nondiscrimination Policy Statement is included in our course Brightspace under *University Policies*.

Accessibility

Purdue University is committed to making learning experiences accessible. If you anticipate or experience physical or academic barriers based on disability, you are welcome to let me know

so that we can discuss options. You are also encouraged to contact the Disability Resource Center at: drc@purdue.edu or by phone: 765-494-1247.

Mental Health/Wellness Statement

If you find yourself beginning to feel some stress, anxiety and/or feeling slightly overwhelmed, try WellTrack. Sign in and find information and tools at your fingertips, available to you at any time.

If you need support and information about options and resources, please contact or see the Office of the Dean of Students. Call 765-494-1747. Hours of operation are M-F, 8 am- 5 pm.

If you find yourself struggling to find a healthy balance between academics, social life, stress, etc. sign up for free one-on-one virtual or in-person sessions with a Purdue Wellness Coach at RecWell. Student coaches can help you navigate through barriers and challenges toward your goals throughout the semester. Sign up is completely free and can be done on BoilerConnect. If you have any questions, please contact Purdue Wellness at evans240@purdue.edu.

If you're struggling and need mental health services: Purdue University is committed to advancing the mental health and well-being of its students. If you or someone you know is feeling overwhelmed, depressed, and/or in need of mental health support, services are available. For help, such individuals should contact Counseling and Psychological Services (CAPS) at 765-494-6995 during and after hours, on weekends and holidays, or by going to the CAPS office on the second floor of the Purdue University Student Health Center (PUSH) during business hours.

Basic Needs Security

Any student who faces challenges securing their food or housing and believes this may affect their performance in the course is urged to contact the Dean of Students for support. There is no appointment needed and Student Support Services is available to serve students 8 a.m.-5 p.m. Monday through Friday. Considering the significant disruptions caused by the current global crisis as it related to COVID-19, students may submit requests for emergency assistance from the Critical Needs Fund.

Emergency Preparation

In the event of a major campus emergency, course requirements, deadlines and grading percentages are subject to changes that may be necessitated by a revised semester calendar or other circumstances beyond the instructor's control. Relevant changes to this course will be posted onto the course website or can be obtained by contacting the instructors or TAs via email or phone. You are expected to read your @purdue.edu email on a frequent basis.

Disclaimer

This document is subject to change during the semester when deemed necessary.