Pratt
School of Information
144 West 14th Street, 6th Floor
New York, NY 10011

Spatial Statistics for GIS

Section: INFO-615-01
Semester: Spring 2022
Class Hours: Tuesdays, 6:30-9:20pm
Dates: January 18-May 10, 2022
Credits: 3

Professor: William Geary
Office Hours: By appointment
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Course Description

This course covers specialized methods and models that have been created for performing statistical analysis on geospatial data. Students will learn basic statistical concepts and how to apply them to geographical data through computation and coding. Course exercises and assignments will focus on practical applications for spatial statistical methods including spatial clustering, spatial regression and hypothesis testing, as well as communicating findings via analytical output, such as charts, tables and maps.

Course Goals & Learning Outcomes

The goals of this course are to:

- Introduce foundational statistical methods
- Explicitly introduce space or geographical context into the statistical framework
- Build coding skills in Python
- Learn proper visualization methods for statistical graphics and maps
- Explore cutting-edge, free & open source geospatial tools and data sources

By the end of this course, students will be able to:

- Use Python to wrangle, clean, analyze and visualize geospatial data
- Understand the nuances and complexities inherent in geospatial data
- Compare, select and implement spatial statistical methods
- Analyze and test a hypothesis on GIS data using spatial statistics
- Produce well-designed graphics and maps to communicate findings

Course Schedule

Week 1
Introduction to Spatial Statistics
We introduce the course, the syllabus, the semester's expectations and schedule. We cover motivations underlying statistics and the scientific method in general, and motivations for spatial statistics in particular. Finally, we set up a scientific computing environment with Python.

Week 2
Introduction to Python, Introduction to Data
We introduce the foundations of Python in the context of data analysis and scientific computing. We cover basic python language basics, data structures & variable types.

Week 3
Working with Data in Python
We use Python to load, view, and manipulate data with the pandas library. We cover loading various file formats in addition to wrangling, exploring and cleaning data.

Week 4
Plotting in Python
We use Python to visualize non-spatial data. We cover methods for exploratory data analysis and visualization.

Week 5
Loops and Functions
We cover programming concepts such as loops and functions, and implement them using Python as part of a data analysis project.

Week 6
Spatial Data
We use Python to load, analyze and visualize spatial data. We introduce and implement geospatial concepts including map projections, spatial data joins, geometric manipulations, set operations and spatial aggregation.

Week 7
Statistics Review
We introduce qualitative and quantitative variables, vector math, probability distributions, population sampling, measures of central tendency and dispersion, central limit theorem.

Week 8
Linear Regression

We cover non-spatial linear regression, fitting curves to data, interpreting model coefficients, measuring goodness of fit, the fit vs. complexity trade-off, regression to the mean, heteroskedasticity.

Week 9
Analyzing Spatial point data
We cover visualization, binning, kernel density estimation, central tendency and dispersion, randomness, clustering, creating spatial neighborhoods with point data, spatial correlation.

Week 10
Auto-correlation
We introduce spatial auto-correlation, how geographic patterns may invalidate traditional, non-spatial statistical assumptions of independence, global vs. local statistics, spatial weights, distance bands, adjacency models, types of contiguity.

Week 11
Spatial Regression
We bring space into the regression framework. We cover proximity variables, spatial heterogeneity, spatial regimes, spatial dependence, spatial lag, spatial error.

Week 12
Raster data analysis
We cover loading, visualizing, manipulating and querying raster data. We improve on our spatial regression models by incorporating raster data.

Week 13
Advanced topics
We introduce advanced modeling techniques, including agent-based modeling, machine learning, computer vision and AI.

Textbooks, Readings and Materials

While there are no required textbooks for this course, we will rely heavily on:

- Rey, Arribas-Bel, Wolf. 2021. *Geographic Data Science with Python*. Direct link.
- Loonis, Bellefon. Eurostat. 2018. *Handbook of Spatial Analysis*. Direct link.

Other required weekly readings will be provided to students each week.

Assignments

Assignments will be given in class each week and will be due at the beginning of the following class.

Final Project

Each student will be responsible for completing a statistical analysis on spatial data for their final project. Individual topics for this project will be approved by the instructor and all students will present their final projects to the class.

Assessment and Grading

Students will be assessed for the quality of their assignments (50%) and final project (40%), and for class participation (10%).

Excellent	A	93-100	A-	90-92.99		
Above Average	B+	87-89.99	B	83-86.99	B-	80-82.99
Acceptable	C+	77-79.99	C	73-76.99	C-	70-72.99
Failure	F	0-69.99				

Pratt Institute-Wide Policies

This Course's Attendance Policy

Students with extensive absences (three or more for any reason) may be required to drop the course or may receive a failing grade at the discretion of the instructor.

Academic Integrity Code

Academic integrity at Pratt means using your own and original ideas in creating academic work. It also means that if you use the ideas or influence of others in your work, you must acknowledge them. For more information on Pratt's Academic Integrity Standards, please visit http://bit.ly/prattacademicintegrity.

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If you inform me (your professor) of an issue of harassment, discrimination or bias, or sexual misconduct I will keep the information as private as I can, but I am required to bring it to the attention of the institution's Title IX Coordinator. You can access Title IX services by emailing titleix@pratt.edu. You can also speak to someone confidentially by contacting our non-mandatory reporters: Health Services at 718-399-4542, Counseling Services 718-687-5356 or Campus Ministries 718-596-4840.

In cases of Bias, this information may go to our Bias Education & Response Taskforce (BERT). You can contact BERT by either reaching out directly via bert@pratt.edu or by contacting the BERT Co-Chair and Title IX Coordinator, Dr. Esmilda Abreu.

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