onGEO Professional Certificate Course: ONGEO-SPST525, *Spatial Statistics*
Fall 2025-1 Session: *Syllabus*

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Course Description:

Spatial is Special!

This course introduces the fundamentals of spatial statistics and describes the main contexts where you need to use spatial tools to understand processes. Students should have a background in statistics at the level of regression, as well as in statistical computing. The course involves a great deal of computing. The goal of the course is to provide students with the background to explore and understand geographic data in a variety of situations. Many problems in the world focus on spatial data and patterns; this course will focus on examples and processes primarily from environmental management, public health, and urban planning/transportation. The modules will give students a broad overview of the three main areas of spatial statistics: point patterns, continuous (geostatistical) data, and lattice (areal) data. You should walk away from this course with the adequate foundation to explore more advanced tools in GIS.

Course Audience:

Professionals and students who are currently working in fields that use geospatial technologies and pursuing training opportunities (required or by choice), professionals and post-baccalaureates looking to advance or revamp their current career path, teachers pursuing continuing-education credits, and international students seeking an educational experience and certification from an American university.

Course Goals:

The purpose (goals) of this course is to develop students:

- Understanding of the basic concepts of spatial statistics,
- Understanding of sampling and analysis of point data,
- Understanding of a variety of geostatistical data,
- Understanding of areal data, and
- Understanding of how to use geospatial models.

Course Learning Outcomes (Objectives):

By completing this course, students will be able to:

1. Distinguish different types of spatial data (geostatistical, areal, point pattern) and understand how spatial autocorrelation plays a role in statistical modeling.
2. Use existing methods to investigate spatial autocorrelation in example datasets provided as exercises.
3. Determine which spatial methods students need to use in their research and implement them using statistical software and GIS.
4. Read and discuss new methods in the spatial statistics literature based on an understanding of the basic spatial statistics approaches, principles, and main assumptions.

Course Requirements and Recommendations:

Required

There are no required textbooks for this course. Instead, you will see links within the course material that will take you to helpful readings.

Recommended

- **Textbooks**:
    - N. A. C. Cressie. ***Statistics for Spatial Data*** (1993), John Wiley & Sons.
    - L.A. Waller and C.A. Gotway. ***Applied Spatial Statistics for Public Health Data*** (2004), John Wiley & Sons.
- **Online Resources**:
    - Spatial Data Science With Applications in R by E. Pebesma & R. Bivand
    - R for Data Science by Ç-R. Wickham & Grolemund
    - Geocomputation with R by R. Lovelace et al.
    - An Introduction to Spatial Data Analysis and Statistics: A Course in R by A. Paez
    - Spatial Statistics Resources (Esri)
- **Technological**:
    - Computer – A PC or Mac can be used to access D2L for lesson material.
    - Web browser, preferably Mozilla Firefox, Google Chrome, or Microsoft Edge. Use of other browsers may lead to activity malfunctions.
    - Applications/plugins (see the Computer Setup page in D2L for details).
        - Down R
        - Download RStudio (Recommended)
        - Probably the best resources for examples and ideas you will find on the web: https://www.statmethods.net/ by Robert Kabacoff. Absolutely excellent.
- **General**:
    - You are required to complete each lesson and are responsible for all of its associated components.
    - You are also required to submit assignments ON TIME.

Internet Requirements

- **HIGH-SPEED internet connection** - You will need a high-speed internet connection to take this course.

Please Note:
All course emails will be sent to your Michigan State (mail.msu.edu) or Community ID email account only via the D2L system. You will need to check this email account at least once a day for emails from your Instructor and Online Geography staff. If you need to, please set your Michigan State account to forward your emails to an account that you do check frequently.

Course Organization:

While a team of faculty and staff developed and continues to manage the course, an Instructor teaches each section. Moreover, this course is delivered through a series of online lessons, activities, and supplemental readings. Course assessments are accomplished through activities embedded in the lessons.

Your Instructor, Associated Staff, and Course Authors

This session, **Hyunseo Park** is responsible for this course, from the day-to-day management to the grading. Yousef will take care of instruction, any content/activity questions you may have, any questions about how to work through the course, activities, and final grades.

Dr. Yi Shi will supervise the course.

Dr. Yi Shi, Juliegh Bookout, and Beth Weisenborn are staff members of onGEO courses at Michigan State University, so you may receive notices from them occasionally. These Online Geography (onGEO) staff members are not involved in the day-to-day workings of the course -- your Instructor is responsible for course delivery and instruction.

Dr. Nathan Moore (MSU-GEO) is the author of the course content. Dr. Yi Shi and Ms. Beth Weisenborn produced the course. This course was created for the Department of Geography, Environment, and Spatial Sciences at Michigan State University. An earlier version of a similar course was authored by Dr. Ashton Shortridge (Chair, MSU-GEO).

Lessons

This course consists of **5 units containing 14 lessons** and **14 activities**.

Item	Topic	Assigned Reading/Viewing
--	Getting Started, Getting to Know You, Course Introduction	--
Unit 1	*Introduction*	--
L1	Introduction to the Course	Section on Spatial Data
Unit 2	*Fundamentals of Spatial Stats*	--
L2	An Introduction to Spatial Statistics	Section on R for Spatial Data Science
L3	Spatial Exploratory Analysis	Chapter on Exploratory Data Analysis
L4	More Exploratory Data Analysis and an Intro to Point Patterns	Part 3: Analysis of Point Patterns
Unit 3	*Point Pattern Analysis*	--
L5	Point Pattern Analysis 1	Section on Point Pattern Analysis
L6	Point Pattern Analysis 2	Appendix on Point Pattern Analysis in R
L7	A Challenge	Video on Descriptive Spatial Statistics
Unit 4	*Geostatistical (Spatially Continuous) Analysis*	
L8	Continuous Data and Interpolation	Chapter on Spatially Continuous Data 1
L9	Spatial Correlation: Variograms & Kriging	Chapter on Spatial Interpolation
L10	Areal Data	Chapter on Proximity and Areal Data
Unit 5	*Areal Analysis*	--
L11	Spatial Autocorrelation	Chapter on Measures of Spatial Autocorrelation
L12	Spatial Lag & Error: Spatial Error Models	Lab on Spatial Regression
L13	Modifiable Areal Unit Problem	Article on The Modifiable Areal Unit Problem and GIS
L14	Assembling It All	Chapter on Spatial Regression Models

Activities

You will be required to complete ***entirely online activities*** and a ***final project*** and submit your answers in D2L by 11:59 p.m. (ET) on the date specified on the course schedule. The descriptions of these activities are embedded in your lesson material. All of your activity grades will count toward your final-grade calculation. *Flexibility on due dates for activities is an option, provided you contact your instructor ahead of time.*

As with any course, it is the responsibility of the Instructor to uphold the standards suggested by the grading rubrics provided by the course authors. While your grade is determined by assessing the quality of your answers compared to

the grading rubric, the grading process is subject to the rigor of the Instructor.

The activities will be based on the material you cover in the lesson in which they are located. When appropriate, spelling and grammar will count toward your score for written answers. Any form or degree of plagiarism will NOT be TOLERATED and will result in 0 points.

Activities are independent exercises; you are not to collaborate with fellow students on them. The time required to complete each activity will vary. Depending on your past experience, you may find some of the activities to be easier or more difficult than others. However, keep in mind that even professional programmers rely extensively on Google to search for solutions to problems. In fact, many ArcPy searches within Google will lead you to a single website - Geographic Information Systems Stack Exchange. This is a question and answer site for cartographers, geographers and GIS professionals. It is a niche site that is part of the larger Stack Exchange family of websites, of which Stack Overflow is the most popular for general-purpose programming questions. Consider creating accounts within both GIS Stack Exchange and Stack Overflow (you can easily link a pre-existing Google account) so that you can begin to engage with the community of programmers on these websites and get ready to start solving problems independently. Check out this tour of Stack Overflow to learn more.

It is strongly suggested that you start your activities early so that you have enough time to ask your instructor any questions you might have.

Course Policies:

Course Material in D2L

From the D2L Help Page (https://help.d2l.msu.edu/):

> "Know your rights and University Policy: MSU expects that you will respect the rights of faculty and other students as you participate in the educational process. Participating in an D2L course means that you may have access to personal information and academic work produced by other students and faculty members, such as discussion board postings, drafts of papers and other work produced in the course. **Academic norms and MSU policy require that you must not reveal any information about classmates, coursework, content, or its authors to anyone outside the course**."

ALL of our course material in D2L is copyrighted property of MSU. This means that ALL course material in the D2L course site is protected and, other than one copy of the material for your own personal use, this material should not be distributed or posted in any form.

Academic Integrity

You are expected to take this course in adherence to University and Department standards for Academic Integrity (The Office of the Ombudsman at Michigan State University). Please visit this site for a more detailed explanation of academic dishonesty and, especially, plagiarism -- two serious offenses from the viewpoint of onGEO, the Geography Department, and the University.

Grading:

Your ***final grade*** will be based on the following:

Assessment	Points
Getting To Know You	5
Activity 1. Intro to R and RStudio <Starting with R Studio>	10
Activity 2. Intro to Mapping in R <Basic Stats>	10
Activity 3. Spatial Exploratory Data Analysis (EDA)	10
Activity 4. More Exploratory Data Analysis + Intro to Point Patterns <Regression 1>	10
Activity 5. Point Pattern Analysis <Distance-based Measures>	10
Activity 6. Variograms & Distributions <Density-based Measures>	10
Activity 7. Challenge 1! <Ways To Sample Data>	10
Activity 8. Geospatial Data <Interpolation>	10
Activity 9. Variograms & Kriging <Regression 2>	10
Activity 10. Working With Areal Data	10
Activity 11. Spatial Autocorrelation	10
Activity 12. Spatial Error & Lag <Spatial Error Models; Regression 3>	10
Activity 13. The Modifiable Areal Unit Problem <MAUP>	10
Activity 14. Challenge 2! <Assembling It All Together>	10
Total points possible in the course =	**145**

Color Key= Point Process Geostatistical Areal

Students must complete all activities, at a level that demonstrates mastery of the material (at least 70% of the total points per activity). Activities may be resubmitted once to achieve a satisfactory score.

All activities must be submitted complete, and at a satisfactory level (70% or above), within the seven week session in order to pass the course. You can view your grades for the activities by accessing your personal online gradebook (Assessments tab).

Extra Credit

Given the number of assessments and abbreviated length of the session, no extra credit work will be considered.

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Due dates for activities (*due by 11:59 PM (ET)* on the due date provided):

F, August 29	Activity. 1: Starting with RStudio <Installations>
F, August 29	Activity. 2: Intro to R and RStudio <Basic Stats>
F, Sept. 5	Activity. 3: Spatial Exploratory Data Analysis (EDA) <Trend Models (Linear Regression)>
F, Sept. 5	Activity. 4: More Exploratory Data Analysis + an Intro to Point Patterns <Regression 1>
F, Sept. 12	Activity. 5: Point Pattern Analysis <Distance-based Measures>
F, Sept. 12	Activity. 6: Variograms & Distributions <Density-based Measures>
F, Sept. 19	Activity. 7: Challenge 1! <Ways To Sample Data>
F, Sept. 19	Activity. 8: Geospatial Data <Interpolations>
F, Sept. 26	Activity. 9: Variograms and Kriging <Regression 2>
F, Sept. 26	Activity. 10: Working With Areal Data
F, Oct. 3	Activity. 11: Spatial Autocorrelation
F, Oct. 3	Activity. 12: Spatial Error Models <Spatial Error Models; Regression 3>
F, Oct. 10	Activity. 13: Modifiable Areal Unit Problem <MAUP>
F, Oct. 10	Activity. 14: Challenge 2! <Assembling It All Together>

Below is the schedule for the entire session. Rows are listed in order by assignment/due date. Two columns from left to right are date (assigned or due) and content item.

Date	***Content Item***
Assigned 8/25	**Units**: Getting Started; Getting To Know You; and Course Introduction
	Unit 1. Introduction
Assigned 8/25	**Lesson**: Introduction to the Course
Assigned 8/25	Activity. 1. Starting with RStudio <Installations>
	Unit 2. Fundamentals of Spatial Stats
Assigned 8/25	**Lesson**: An Introduction to Spatial Statistics
Assigned 8/25	Activity. 2. Intro to R and RStudio <Basic Stats>
Monday, Sept 1 -- University is closed.	
due Tuesday, Sept. 2	**Getting to Know You**
Assigned 9/3	**Lesson**: Spatial Exploratory Analysis
Assigned 9/3	Activity. 3. Spatial Exploratory Data Analysis (EDA) <Trend Models (Linear Regression)>
Assigned 9/3	**Lesson**: More Exploratory Data Analysis and an Intro to Point Patterns
Assigned 9/3	Activity. 4. More Exploratory Data Analysis + an Intro to Point Patterns <Regression 1>
	Unit 3. Point Pattern Analysis
Assigned 9/8	**Lesson**: Point Pattern Analysis 1
Assigned 9/8	Activity. 5. Point Pattern Analysis <Distance-based Measures>
Assigned 9/8	**Lesson**: Point Pattern Analysis 2
Assigned 9/8	Activity. 6. Variograms & Distributions <Density-based Measures>
Assigned 9/15	**Lesson**: A Challenge
Assigned 9/15	Activity. 7. Challenge Activity! <Ways To Sample Data>
	Unit 4. Geostatistical (Spatially Continuous) Analysis

Assigned 9/15	**Lesson**: Continuous Data & Interpolation
Assigned 9/15	Activity. 8. Geospatial Data <Interpolations>
Assigned 9/22	**Lesson**: Spatial Correlation: Variograms & Kriging
Assigned 9/22	Activity. 9. Variograms and Kriging <Regression 2>
Assigned 9/22	**Lesson**: Areal Data
Assigned 9/22	Activity. 10. Working With Areal Data
	Unit 5. Areal Analysis
Assigned 9/29	**Lesson**: Spatial Autocorrelation
Assigned 9/29	Activity. 11. Spatial Autocorrelation
Assigned 9/29	**Lesson**: Spatial Lag & Error: Spatial Error Models
Assigned 9/29	Activity. 12. Spatial Error & Lag <Spatial Error Models; Regression 3>
Assigned 10/6	**Lesson**: Modifiable Areal Unit Problem
Assigned 10/6	Activity. 13. Modifiable Areal Unit Problem <MAUP>
Assigned 10/6	**Lesson**: Assembling It All
Assigned 10/6	Activity. 14. Challenge 2! <Assembling It All Together>