Advanced Academic Programs
Zanvyl Krieger School of Arts and Sciences
Johns Hopkins University

AS.420.677.81 – Spatial Statistics
Fall 2018

Course and Instructor Information

Instructor Information
Instructor: Dr. Kimberly Gardner
Telephone Number: (919) 999-0191
Email Address: kvest3@jhu.edu
Office Hours: Please email for help. I’ll answer email during the week with 12 hours, and on the weekend within 24 hours.

Course Description
Spatial Statistics is a rapidly developing tool in the discipline of ecology that analyzes both 2-D and 3-D data that contain a spatial component. Many ecologists use continuous data (e.g., vegetation density and height, net aboveground primary production, percent of biomass killed by disturbance, etc...) that violates the assumption of spatial independence; therefore, necessitating the need to analyze the data using spatial statistics. Thus, spatial statistics provides concepts, tools, and approaches that will enhance the analyses of population data, sample data, partitioning of regions (patch and boundary), spatial interpolation, and data that are spatially autocorrelated. The goal of this course is to give students a firm grasp of the concepts of spatial statistics in ecology and of how they can be applied to analyze continuous data for environmental policy, management, and assessment. Uses of case studies, data analysis in the R spatial statistics package, and discussions help to examine and apply the concepts.

Course Goals & Learning Objectives
By the end of this course, you will be able to:
- Evaluate data sets for spatial autocorrelation
- Apply different spatial statistical methods and spatial analysis methods to answer questions in ecology
- Analyze these data sets to determine the benefits to environmental policy, management, and assessment.

Course Materials

Textbook/s
The following texts are required for this course:

Additional readings are listed in Appendix A.

Other equipment/software/websites/online resources
This course requires the use of the following resources:
- [R package](https://www.r-project.org), [R studio](https://rstudio.com), and [GRASS GIS](https://grassgis.osgeo.org) or [ArcGIS](https://www.arcgis.com).

Specific Technology Requirements & Skills for this Course
This course requires the use of a computer that complies with the following hardware specifications:
- Enough memory to run either [ArcGIS](https://www.arcgis.com) (2GB) or [GRASS GIS](https://grassgis.osgeo.org) (800MB). Both of these programs can be run on a Windows, MAC, and Linux operating systems.

Learning online requires some basic knowledge of computer technology. At a minimum, you need to be able to:
• Navigate in and use Blackboard; the Blackboard Student Orientation course on your “My Institution” page
• Create and save MS Word documents; review MS Word training and tutorials for PC users (all versions); Word Help for Mac users
• Find basic resources on the Internet
• Create and organize files & folders on your computer
• Send, receive, and manage email

Assignments and Grading Policy

Assignments
In the table below, you will find a brief description of the various assignments in this course including due dates assignment weights, and frequency.

<table>
<thead>
<tr>
<th>Assignments</th>
<th>Due Dates</th>
<th>Assignment Value</th>
</tr>
</thead>
</table>
| **Assignment 1:** Recognizing spatially autocorrelated data and importing and exporting spatial data  
  • The first purpose is to recognize when data is spatially autocorrelated and violates an assumption of parametric statistics  
  • The second purpose is to practice importing and exporting data sets into and out of R. This includes also exporting datasets to ArcGIS or GRASS GIS | 10/7/2018   | 10               |
| **Assignment 2:** Variograms, Kriging, and IDW  
  • The purpose of this assignment is to use the spatially autocorrelated data from the previous assignment and apply and interpret a variogram, perform kriging, and use the IDW method to analyze data in R.  
  • The second purpose is to take the data into ArcGIS or GRASS GIS and perform kriging and IDW using the spatial analyst toolbox. | 11/4/2018   | 10               |
| **Assignment 3:** Spatial Point and Pattern Analysis and Partitioning of Regions  
  • The purpose of this assignment is to use point, pattern, and regional data from the previous assignment and apply different methods of analysis to analyze this data in R  
  • The second purpose is to import this data into ArcGIS or GRASS GIS and perform these same analysis. | 12/3/2018   | 10               |
| **Assignment 4:** Course Engagement  
You are expected to have an active presence in course discussions, and complete course activities as noted in the assignment guidelines to maximize your learning. Participation in activities should be consistent, of high quality, and reflect both a high level of academic thinking and your own personal perspectives, opinion, and ideas. | Weekly by midnight Sunday | 15               |
| **Assignment 5:** Final Project  
You will combine the results from all of your previous assignments | 12/16/2018  | 15               |
into a complete story of the results from the data set. You will turn in all your assignments corrected in a complete document. Then, you will give a 10 min presentation over the methods and results for each assignment with a final comprehensive conclusion.

<table>
<thead>
<tr>
<th>Quiz 1: Covers weeks 1 and 2</th>
<th>9/23/2018</th>
<th>8</th>
</tr>
</thead>
<tbody>
<tr>
<td>Quiz 2: Covers weeks 3, 4, and 5</td>
<td>10/14/2018</td>
<td>8</td>
</tr>
<tr>
<td>Quiz 3 Covers weeks 6, 7, and 8</td>
<td>11/4/2018</td>
<td>8</td>
</tr>
<tr>
<td>Quiz 4: Covers Weeks 9 and 10</td>
<td>11/18/2018</td>
<td>8</td>
</tr>
<tr>
<td>Quiz 5: Covers Weeks 11, 12 and 13</td>
<td>12/10/2018</td>
<td>8</td>
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<tr>
<td><strong>Total</strong></td>
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**Grading Policy**

<table>
<thead>
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<th>Letter Grade</th>
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<tr>
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<tr>
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<td>94% and less than 98%</td>
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<td>B+</td>
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<tr>
<td>B</td>
<td>84% and less than 88%</td>
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<tr>
<td>B-</td>
<td>80% and less than 84%</td>
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<tr>
<td>C</td>
<td>70% and less than 80%</td>
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<tr>
<td>F</td>
<td>0% and less than 70%</td>
</tr>
</tbody>
</table>

This course will follow the Advanced Academic Programs Grading Policies.

**Assignment Submission**

Students are required to adhere to the following guidelines when submitting written work:

- Use APA format
- Adhere to word limits for each assignment
- Cite sources properly

The instructor uses the SafeAssign tool for written assignments. Please review the JHU Ethics Statement below prior to submission.

**Assignment Feedback**

The instructor will aim to return assignments to you within 5-7 days following the due date, depending on the length of the assignment. You will receive feedback in the My Grades area of the course which can be accessed via the navigation menu.

**Late Policy**

You are expected to contact your instructor in advance if you think you cannot meet an assignment deadline. However, if an assignment is late and prior arrangements have not been made with the instructor, the assignment score will be 10 points/week.

**Extra Credit**

No extra credit
**Synchronous Sessions**
The instructor may hold live, synchronous sessions in Adobe Connect. Attendance for synchronous sessions, while not required, is highly recommended. If you cannot attend a synchronous session, you will be responsible for watching the recording at a later time.

**Time Management Expectations**
It is expected that you look ahead to schedule your time. Plan to complete coursework across several days of the week rather than all in one day. Be sure to consider how group activities impact your schedule as well. Some assignments require that you work on them for multiple weeks. Be sure to review the assignment directions at the beginning of the course so that you can plan your time accordingly. Please seek help before becoming frustrated and spending a significant amount of time to resolve an issue.

**Directions for Students**

**Next Steps:** Carefully review the remaining sections of the syllabus before beginning the first week’s activities, which are located in the Lessons area of the navigation menu in your online course.

Once you feel that you are ready to dive into the first week’s activities, select Lessons on the navigation menu. Then, select Week 1 to begin.

**About Your Course**

**Course Structure**
This course is fast paced, so it is important to keep up with the presentations and assignments. It starts with a review of parametric statistics then it increases in complexity through the weeks. It is really important that you spend the first three weeks of the course getting acquainted with R and ArcGIS/GRASS GIS. After the first three weeks, the course will pick up in pace. Each lecture will include a short presentation over the topic(s) followed by a few examples of how to apply the topics in R, ArcGIS, and GRASS GIS. Each week will have a topic to answer in the discussion section of the class called R-café. Also, you will have a worksheet each week over the topic and how to apply it in R and/or ArcGIS/GRASS GIS. These worksheets are not graded, but it is strongly suggested that you complete these. There are three assignments that use the same data set and demonstrate different ways to analyze spatial data. The final project will build off of these assignments, so it’s really important that you understand the assignments. You will also have five short quizzes that will include topics covered between each quiz. There will be a discussion board to ask for help called “stump the chump”. If you need help, please ask as soon as possible. The most important thing is communication in this course.

**What To Expect in this Course**
This course is 14 weeks in length and includes individual and whole group activities in a weekly cycle of instruction. Each week begins on a Monday and ends on the following Sunday, with the exception of Week 1, which will run Wednesday - Sunday. Please review the course syllabus thoroughly to learn about specific course outcomes and requirements. Be sure to refer to the Checklist each week, which provides a week-at-a-glance and shows targeted dates for the completion of activities.

**Course Policies**

**Course Participation**

**Participation Requirements**
You are expected to log into Blackboard regularly throughout the week - a daily check-in is recommended. It is your responsibility to read all announcements and discussion postings within your assigned forums. You should revisit the discussion multiple times over the week to contribute to the dialogue.

**Group Work**
Group work may be assigned as part of this course. If group work is required, you are expected to work equitably within your group to complete collaborative group activities. If group work is assigned, you will have an opportunity to privately rate your own participation and that of your group-mates.

**Online Etiquette**
In this course, online discussion will primarily take place in our online discussion board. In all textual online communication, it is important to follow proper rules of online etiquette... communicating with others in a proper and respectful way. For helpful tips, please these [Ground Rules for Online Discussions](#).

**Course Protocols and Getting Help**

**Amendments to the Course**
Changes to the course will be posted in the Announcements section of your course. Please check announcements every time that you log into your online course.

**Course Communication**
You should communicate often with your classmates and the instructor. The majority of communication will take place within the Discussion forums. When you have a question about an assignment or a question about the course, please contact your instructor, or post your question in the course’s “Syllabus & Assignment Question” forum.

**Email Communication**
For questions regarding course activities and assignments that would be general interest to other students, please post those in the Discussion forum. If you have a question regarding course activities and assignments of a personal nature, please send an email message to the instructor and observe the following guidelines:

- Include the title of the course in the subject field (e.g., JHU Insert Name of Course).
- Keep messages concise, and check spelling and grammar.
- Sign your full name (the sender’s email is not always obvious).

Feel free to contact your instructor with comments, questions, and concerns. All email messages will be sent to you via your JHU email account, so you should be in the habit of checking that account every day or you should ensure that your JHU email account forwards messages to another account of your choice.

Email messages will be responded to within 24-48 hours.

**University Policies**

**General**
This course adheres to all University policies described in the academic catalog. Please pay close attention to the following policies:

**Students with Disabilities**
Johns Hopkins University is committed to providing reasonable and appropriate accommodations to students with disabilities. Students with documented disabilities should contact the coordinator listed on the [Disability Accommodations](#) page. Further information and a link to the Student Request for Accommodation form can also be found on the [Disability Accommodations](#) page.

**Ethics & Plagiarism**

**JHU Ethics Statement:** The strength of the university depends on academic and personal integrity. In this course, you must be honest and truthful. Ethical violations include cheating on exams, plagiarism, reuse of assignments, improper use of the Internet and electronic devices, unauthorized collaboration, alteration of graded assignments, forgery and falsification, lying, facilitating academic dishonesty, and unfair competition. Report any violations you witness to the instructor. Read and adhere to JHU’s [Notice on Plagiarism](#).
**Dropping the Course**
You are responsible for understanding the university’s policies and procedures regarding withdrawing from courses found in the current catalog. You should be aware of the current deadlines according to the Academic Calendar.

**Getting Help**
You have a variety of methods to get help. Please consult the help listed in the "Blackboard Help" link in the online classroom for important information. If you encounter technical difficulty in completing or submitting any online assessment, please immediately contact the designated help desk listed on the AAP online support page. Also, contact your instructor at the email address listed atop this syllabus.

**Copyright Policy**
All course material are the property of JHU and are to be used for the student's individual academic purpose only. Any dissemination, copying, reproducing, modification, displaying, or transmitting of any course material content for any other purpose is prohibited, will be considered misconduct under the JHU Copyright Compliance Policy, and may be cause for disciplinary action. In addition, encouraging academic dishonesty or cheating by distributing information about course materials or assignments which would give an unfair advantage to others may violate AAP’s Code of Conduct and the University’s Student Conduct Code. Specifically, recordings, course materials, and lecture notes may not be exchanged or distributed for commercial purposes, for compensation, or for any purpose other than use by students enrolled in the class. Other distributions of such materials by students may be deemed to violate the above University policies and be subject to disciplinary action.

**Code of Conduct**
To better support all students, the Johns Hopkins University non-academic Student Conduct Code has been integrated and updated to include all divisions of the University. In addition, it is important to note that all AAP students are still accountable for the Code of Conduct for Advanced Academic Programs.

**Title IX**

**Confidentiality and Mandatory Reporting**
As an instructor, one of my responsibilities is to help create a safe and inclusive learning environment on our campus. I also have mandatory reporting responsibilities related to my role as a Responsible Employee under the Sexual Misconduct Policy & Procedures (which prohibits sexual harassment, sexual assault, relationship violence and stalking), as well as the General Anti-Harassment Policy (which prohibits all types of protected status based discrimination and harassment). It is my goal that you feel able to share information related to your life experiences in classroom discussions, in your written work, and in our one-on-one meetings. I will seek to keep information you share private to the greatest extent possible. However, I am required to share information that I learn of regarding sexual misconduct, as well as protected status based harassment and discrimination, with the Office of Institutional Equity (OIE). For a list of individuals/offices who can speak with you confidentially, please see Appendix B of the JHU Sexual Misconduct Policies and Laws.

For more information on both policies mentioned above, please see: JHU Relevant Policies, Codes, Statements and Principles. Please also note that certain faculty and other University community members also have a duty as a designated Campus Safety Authority under the Clery Act to notify campus security of certain crimes, as well as a duty under State law and University policy to report suspected child abuse and/or neglect.
Appendix A (version 1)

Course Topics & Readings

The following are the selected readings for this course. All readings are required unless noted as optional. All readings unless otherwise noted are available from JHU ARES (eReserves) system.

Week 1: Review of parametric statistics in R and Overview of spatial data.

Week 2: The what, why, and how of spatial statistics

Week 3: Spatial Data Import and Export

Week 4: Spatial Data Visualization
3. Eubank, N. Making maps in R.

Week 5: Spatial dependence vs spatial autocorrelation

Week 6: Spatial Models: Kriging and Inverse Distance Weighted

Week 7: Variograms and covariance functions

Week 8: Fitting and Interpreting Variograms

Week 9: Spatial Regression and Smoothing methods
non-spatial regression.” *Ecography* 32 193-204

**Week 10: Spatial Point Processes**

**Week 11: Spatial Partitioning of Regions: Patch and Boundary**

**Week 12: Spatial Temporal Models**

**Week 13: Modeling Areal Data**

**Week 14: Spatial Analysis Wrap-up**
Appendix A (version 2)

Course Schedule
The following are the selected readings for this course. All readings are required unless noted as optional. All readings unless otherwise noted are available from JHU ARES (eReserves) system.

Week 1: Review of parametric statistics in R and Overview of spatial data
September 5 – 9

Overview
This week, we will review the assumptions of parametric statistics, and we will review how to perform parametric statistics in R. We will also talk about the definition of spatial data and why it is important.

Learning Objectives
By the end of this week, students will be able to...
1. Describe the assumptions of parametric statistics
2. Perform an AVOVA and Linear regression in R while testing for the assumptions
3. Understand the terms: process and pattern

Lecture Topics
- What are the assumptions of parametric statistics?
- How do you perform an ANOVA in R?
- How do you perform a linear regression in R?
- What do the terms process and pattern mean?

Resources and Readings

Week 2: The what, why, and how of spatial statistics and spatial analysis
September 10 – September 16

Overview
This week, we will explore what constitutes spatial statistics. We will explore why spatial statistics are needed in ecology. Finally, we will look at how to use spatial statistics and spatial analysis data in ecology.

Learning Objectives
By the end of this week, students will be able to...
1. Describe the fundamentals of spatial statistics
2. Identify when spatial statistics are needed
3. Understand how to use spatial statistics and spatial analysis data

Lecture Topics
- What is spatial statistics and spatial data analysis?
- Why do we use R for Spatial Data Analysis and Spatial Statistics?
- How is spatial statistics and spatial data analysis used?

Resources and Readings
Week 3: Spatial Data Import and Export  
September 17 – September 23

Overview  
This week we will look at coordinate reference systems, and how to enter these in R, ArcGIS, and GRASS GIS. We will also look at how to import raster and vector files into R, ArcGIS, and GRASS GIS. We will then learn how to export coordinate reference systems from R into GRASS GIS and ArcGIS.

Learning Objectives  
By the end of this week, students will be able to...
1. Describe the differences in coordinate reference systems  
2. Understand how to import and export raster and vectors into R, ArcGIS, and GRASS GIS

Lecture Topics  
- What is a coordinate reference system?  
- How to import/export vector and raster files?  
- How do I import and export to GRASS GIS or Arc GIS?

Resources and Readings  

Week 4: Spatial Data Visualization  
September 24 – September 30

Overview  
This week, we will look at how to plot spatial data within a traditional plotting system. Next, we will tackle plotting in R with the spplot and ggplot2 packages. Finally, we will look at using interactive plots, color palettes, and class intervals in our plots.

Learning Objectives  
By the end of this week, students will be able to...
1. Understand how to plot spatial data in R  
2. Make interactive plots, color palettes, and class intervals in R

Lecture Topics  
- How do you plot spatial data in a traditional plotting system?  
- How do you plot with spplot and ggplot2 packages in R?  
- How do you use interactive plots, color palettes, and class intervals in plotting spatial data in R?

Resources and Readings  
3. Eubank, N. Making maps in R.

Week 5: Spatial dependence vs spatial autocorrelation  
October 1 – October 7

Overview  
This week, we will discuss the difference between spatial dependence and spatial autocorrelation. We will then discuss the importance of this distinction and how it will impact our decisions later in the semester.

Learning Objectives  
By the end of this week, students will be able to...
1. Describe the difference between spatial dependence and spatial autocorrelation
2. Understand the importance of this distinction as it relates to spatial statistics

Lecture Topics
- What is spatial dependence and how does it differ from spatial autocorrelation?
- Why is the difference important?

Resources and Readings

Week 6: Spatial Models: Kriging and Inverse Distance Weighted (IDW)
October 8 – October 14

Overview
This week, we will discuss the purpose of kriging and IDW. We will then look at how to use these methods on spatial data. We will then use these methods in R and ArcGIS/GRASS GIS

Learning Objectives
By the end of this week, students will be able to...
1. Describe the kriging and IDW methods
2. Understand when and why they should be used on spatial data
3. Describe how to use these two methods in R and ArcGIS/GRASS GIS

Lecture Topics
- Why and when should you use kriging?
- Why and when should you use IDW?
- How do you use these methods in R and ArcGIS/GRASS?

Resources and Readings

Week 7: Variograms and covariance functions
October 15 – October 21

Overview
This week, we will look at how to use variograms in spatial statistics. We will look at when variograms are needed to analyze spatial data. Finally, we will discuss the importance of using variograms in statistical analysis.

Learning Objectives
By the end of this week, students will be able to...
1. Describe the variogram equation and definition
2. Understand how to use variograms when analyzing spatial data
3. Identify the importance of variograms in statistical analysis

Lecture Topics
- What are variograms?
- How do we use variograms?
- Why are variograms important?

Resources and Readings

**Week 8: Fitting and Interpreting Variograms**

**Overview**
This week, we will learn how to fit a variogram from raw data in R. We will then interpret the results of the variogram.

**Learning Objectives**
By the end of this week, students will be able to...
1. Describe how to fit a variogram from raw data
2. Understand how to fit a variogram in R
3. Interpret the results of the variogram

**Lecture Topics**
- How do we fit a variogram from raw data?
- How do we fit a variogram in R?
- How do we interpret the variogram?

**Resources and Readings**

**Week 9: Spatial Regression and Smoothing methods**

**Overview**
This week, we will test for autocorrelation in regression analysis. Then, we will look at how to handle spatially autocorrelated data in regression analysis. We will also look at the different smoothing methods that can be used in spatial regression. Finally, we will understand when these smoothing methods should be used.

**Learning Objectives**
By the end of this week, students will be able to...
1. Test for autocorrelation in regression analysis
2. Describe how to handle data when it is spatially autocorrelated
3. Identify the different smoothing methods in spatial regression
4. Understand when to use smoothing methods

**Lecture Topics**
- How to test for spatial autocorrelation in Regression analysis?
- If the data is spatially autocorrelated, how do you handle the situation?
- What are smoothing methods, and why would you want to use them?

**Resources and Readings**

**Week 10: Spatial Point Processes**

**Overview**

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Advanced Academic Programs Krieger School of Arts and Sciences
Johns Hopkins University
Overview
This week, we will look at spatial point pattern data. We will analyze this data in R using many different methods. We will also identify various applications of spatial point analysis.

Learning Objectives
By the end of this week, students will be able to...
1. Describe spatial point pattern analysis
2. Analyze spatial point patterns in R
3. Perform a statistical analysis of spatial point processes
4. Identify various applications of spatial point analysis

Lecture Topics
- What is spatial point pattern analysis?
- How do you analyze spatial point patterns?
- How do you do a statistical analysis of spatial point processes?
- What are some applications of spatial point analysis?

Resources and Readings

Week 11: Spatial Partitioning of Regions: Patch and Boundary
November 12 – November 18

Overview
This week, we will learn how to identify patches and boundaries in spatial data. Then, we will talk about the different types of boundary analysis between patches.

Learning Objectives
By the end of this week, students will be able to...
1. Identify patches and boundaries
2. Analyze boundary data between patches

Lecture Topics
- How do you identify patches?
- How do you identify boundaries?
- How do you analyze boundary data between patches?

Resources and Readings

Week 12: Spatial Temporal Models
November 26 – December 3

Overview
This week, we will learn about different types of spatial temporal models. We will use different methods to analyze spatial temporal models. Finally, will incorporate pattern and process into spatial temporal models.

Learning Objectives
By the end of this week, students will be able to...
1. Describe different types of spatial temporal models
2. Identify the different analyses needed for spatial temporal models
3. Incorporate spatial temporal models with pattern and process

Lecture Topics
- What are spatial temporal models?
- What type of analyses need spatial temporal models?
- How do you incorporate spatial temporal models with pattern and processes?

Resources and Readings

Week 13: Modeling Areal Data
December 4 – December 9

Overview
This week, we will learn about areal data. We will learn what constitutes areal data. Then, we will learn how to fit models of areal data in R, ArcGIS, and GRASS GIS.

Learning Objectives
By the end of this week, students will be able to...

1. Identify areal data
2. Describe areal data
3. Fit models of areal data in R, ArcGIS, and GRASS GIS

Lecture Topics
- What is areal data?
- How do you fit models of areal data?

Resources and Readings

Week 14: Spatial Analysis Wrap-up
December 10 – December 16

Overview
This week, we will be wrapping up spatial analysis. We will discuss the current trends in spatial analysis, and finally, we will discuss future directions in spatial analysis.

Learning Objectives
By the end of this week, students will be able to...

1. Describe current trends
2. Identify future directions

Lecture Topics
- What are the current trends in spatial analysis?
- What are future directions in spatial analysis?

Resources and Readings
Assignments

Assignment No. 1.
Recognizing spatially autocorrelated data and importing and exporting spatial data
- The first purpose is to recognize when data is spatially autocorrelated and violates an assumption of parametric statistics
- The second purpose is to practice importing and exporting data sets into and out of R. This includes also exporting datasets to ArcGIS or GRASS GIS

Assignment No. 2
Variograms, Kriging, and IDW
- The purpose of this assignment is to use the spatially autocorrelated data from the previous assignment and apply and interpret a variogram, perform kriging, and use the IDW method to analyze data in R.
- The second purpose is to take the data into ArcGIS or GRASS GIS and perform kriging and IDW using the spatial analyst toolbox.

Assignment No. 3
Spatial Point and Pattern Analysis and Partitioning of Regions
- The purpose of this assignment is to use point, pattern, and regional data from the previous assignment and apply different methods of analysis to analyze this data in R
- The second purpose is to import this data into ArcGIS or GRASS GIS and perform these same analysis.

Assignment No. 4
R-café [Discussion]
- Each week in the discussion section of blackboard, the professor will post a prompt that each student will respond to by midnight Thursday. Then by midnight Sunday, each student must respond to two of their peers. This will be graded according to the rubric on the discussion board.

Assignment No. 5
Final Project
You will combine the results from all of your previous assignments into a complete document and analysis of the data set. Then, you will give a 10 min presentation over the methods and results for each assignment with a final comprehensive conclusion.
## Appendix B

### Tentative Course Schedule

Activity and assignment details will be explained in detail within each week's corresponding learning module (Lessons in Blackboard). If you have any questions, please contact your instructor.

This schedule is subject to change with fair notice. Any changes will be posted via Announcements in Blackboard.

<table>
<thead>
<tr>
<th>Week</th>
<th>Dates</th>
<th>Topics</th>
<th>Activities &amp; Assessments</th>
<th>Due Dates</th>
</tr>
</thead>
</table>
| 1    | September 5 – September 9 | Review of parametric statistics in R and Overview of spatial data  
- What are the Assumptions of parametric statistics  
- How do you perform an ANOVA in R?  
- How do you perform a linear regression in R?  
- What do the terms process and pattern mean? | Reading:  
- Spatial Analysis textbook pages 1-6; 11-18.  
- Review of parametric statistics in R  
Activities:  
- Quick worksheet over parametric statistics to be completed in R (not graded).  
- R – café: (class participation grade). | R-café comment due September 9th by midnight |
| 2    | September 10 – September 16 | The what, why, and how of spatial statistics and spatial analysis  
- What is spatial statistics and spatial data analysis?  
- Why do we use R for Spatial Data Analysis and Spatial Statistics?  
- How is spatial statistics and spatial data analysis used? | Reading:  
- Spatial Analysis textbook pages 18-30.  
Activities:  
- Quick worksheet over recognizing spatial autocorrelation (not graded)  
- R-café: (class participation grade) | R-café comment due September 16th by midnight  
Handout Assignment 1. Due midnight October 7th |
| 3    | September 17 – September 23 | Spatial Data Import and Export  
- What is a coordinate reference system?  
- How to import/export vector and raster files?  
- How do I import and export to GRASS GIS or Arc GIS? | Readings:  
- GDAL/ORG (2018). The GDAL/OGR Geospatial Data Abstraction | Quiz 1 September 23rd  
R-café comment due by midnight September 23rd |
<table>
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<tr>
<th>Activities:</th>
<th>Readings:</th>
<th>R-café comment due midnight September 30</th>
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<tbody>
<tr>
<td>Quiz 1</td>
<td>Eubank, N. Making maps in R.</td>
<td></td>
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<td></td>
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<tr>
<td>● Why is the difference important?</td>
<td></td>
<td>R-café comment due October 7th</td>
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</table>

**Activities:**

- Worksheet over making maps in R using ggplot2 and spplot. (not graded)
- R-café (class participation grade)

**Readings:**

- Eubank, N. Making maps in R.

**R-café comment due midnight September 30**
<table>
<thead>
<tr>
<th></th>
<th>October 8 – October 14</th>
<th>Spatial Models: Kriging and Inverse Distance Weighted</th>
</tr>
</thead>
</table>
|  |  | ● Why and when should I use kriging?  
● Why and when should I use IDW?  
● How do I use these methods in R and ArcGIS/GRASS on my data? |
|  |  | Activities:  
● R-café (participation grade) |
|  |  | Readings:  
|  | Quiz 2 October 14th  
R-café comment due midnight October 14th |
|  | October 15 – October 21 | Variograms and covariance functions |
|  |  | ● What are variograms?  
● How do we use variograms?  
● Why are variograms important? |
|  |  | Activities:  
● Worksheet over Kriging and IDW in R and ArcGIS/GRASS GIS. (not graded)  
● R-Café (participation grade) |
|  | R-café comment due October 21st |
|  | October 22 – October 28 | Fitting and Interpreting Variograms |
|  |  | ● How do we fit a variogram from raw data?  
● How do we fit a variogram in R?  
● How do we interpret the variogram? |
|  |  | Activities:  
● R-café (participation grade) |
|  |  | Readings:  
<p>|  |  | R-café comment due October 28th |</p>
<table>
<thead>
<tr>
<th>Date</th>
<th>Topic</th>
<th>Readings</th>
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</table>
| October 29 – November 4 | Spatial Regression and Smoothing methods | - How to test for spatial autocorrelation in Regression analysis?  
- If the data is spatially autocorrelated, how do you handle the situation?  
- What are smoothing methods, and why would you want to use them? | - Worksheet: fitting variograms in R. (not graded)  
- R-café (class participation grade) |
| Handout: Assignment 3 due December 3rd  
Quiz 3 November 4th  
R-café comment due midnight November 4th | | | |
| November 5 – November 11 | Spatial Point Processes | - What is spatial point pattern analysis?  
- How do you analyze spatial point patterns?  
- How do you do a statistical analysis of spatial point processes?  
- What are some applications of spatial point analysis? | - Worksheet over smoothing and spatial regression (not graded)  
- R-café (class participation grade) |
<p>| R-café comment due midnight November 11th | | | |</p>
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<thead>
<tr>
<th>Week</th>
<th>Dates</th>
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<th>Activities</th>
<th>Quiz/R-café Comment Due</th>
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</table>
| 11   | November 12 – November 18 | Spatial Partitioning of Regions: Patch and Boundary | - How do you identify patches?  
- How do you identify boundaries?  
R-café comment due midnight November 18th |
|      | November 19 – November 25 | Thanksgiving Holidays! | | | |
| 12   | November 26 – December 3 | Spatial Temporal Models | - What are spatial temporal models?  
- What type of analyses need spatial temporal models?  
R-café comment due midnight December 3rd |
<table>
<thead>
<tr>
<th>Date</th>
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<tr>
<td>December 4 – December 9</td>
<td><strong>Modeling Areal Data</strong> &lt;br&gt; - What is areal data? &lt;br&gt; - How do you fit models of areal data?</td>
<td>- Maria-Josee Fortin and Mark Dale (eds.) (Cambridge, 2005).  &lt;br&gt; <em>Spatial Analysis: A Guide for Ecologists.</em>  &lt;br&gt; Cambridge.  &lt;br&gt; “Spatial analysis of population data” 64-75.  &lt;br&gt; - Bivand, R.S. et al., (2nd eds.) (Springer, 2013).  &lt;br&gt; <em>Applied Spatial Data Analysis with R.</em>  &lt;br&gt; Springer.  &lt;br&gt; “Modeling areal data” 263. &lt;br&gt; Activities: &lt;br&gt; - Worksheet over modeling areal data (not graded) &lt;br&gt; - R-café: (class participation grade)</td>
<td>R-café comment due midnight December 9th</td>
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