GEOG 566 - Advanced spatial statistics and GIScience
Spring 2018

Instructor: Dr. Julia Allen Jones (jonesj@geo.oregonstate.edu)
Teaching Asst: Laura Hempel
Meeting times: MW 12:00-13:20, Wilkinson 210 (Digital Earth)
Units: 4 credit hours. CRN 57185
Lab: F 13:00-13:50. CRN 57186

Objective: To provide advanced graduate students from a variety of disciplines in earth science and ecology the opportunity to structure and conduct spatio-temporal analyses using available software tools and their own datasets for their graduate research. By the end of the term students should have a working knowledge of how to:
1. Structure spatio-temporal analysis questions
2. Identify appropriate tools and conduct simple spatial and temporal analyses using readily available tools
3. Assess the applicability and limitations of available tools
4. Share incremental findings and study designs with other students on a course blog webpage
5. Build a collective knowledge base on practical applied spatio-temporal analysis

Course tools: Readings are listed under course tools, p. 4.

Course assessment: Assignments are described on p. 3.

<table>
<thead>
<tr>
<th>Assignment</th>
<th>% of total</th>
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<tbody>
<tr>
<td>My spatial problem</td>
<td>10</td>
</tr>
<tr>
<td>Exercises</td>
<td>30</td>
</tr>
<tr>
<td>Tutorial presentations</td>
<td>20</td>
</tr>
<tr>
<td>Comments on tutorials (2 @ 5 pts)</td>
<td>10</td>
</tr>
<tr>
<td>Final presentation</td>
<td>20</td>
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<tr>
<td>Comments on final presentation</td>
<td>10</td>
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Class blog site: http://blogs.oregonstate.edu/geog566spatialstatistics/
Previous class blog site: http://blogs.oregonstate.edu/geos99spatialstatistics/

Using this site, you will post your spatial problem, the exercises you complete, the tutorials you create and present, and your final project.
<table>
<thead>
<tr>
<th>Week</th>
<th>Date</th>
<th>Topic</th>
<th>Reading</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>4/2</td>
<td>Introduction to student research and data My spatial problem blog post (p. 3)</td>
<td>Reading A, B Reading C, D</td>
</tr>
<tr>
<td>1</td>
<td>4/4</td>
<td>Introduction to spatial statistics - overview My spatial problem, cont’d.</td>
<td>Reading C, D</td>
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<tr>
<td>1</td>
<td>4/6</td>
<td>Lab: Spatial problem blog post due</td>
<td>Exercise 1</td>
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<tr>
<td>2</td>
<td>4/9</td>
<td>Conceptualization of spatial relationships: Exercise 1</td>
<td>Readings A to D</td>
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<td>2</td>
<td>4/11</td>
<td>Autocorrelation, nearest neighbor, or hot-spot analysis Exercise 1</td>
<td>Readings A to D</td>
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<tr>
<td>2</td>
<td>4/13</td>
<td>Lab: Exercise 1 due. Comment on fellow student’s blog post due.</td>
<td>Exercise 1</td>
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<td>3</td>
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<td>Autocorrelation, nearest neighbor, or hot-spot analysis. Student presentations of Tutorial 1</td>
<td>Readings A-F</td>
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<td>Autocorrelation, nearest neighbor, or hot-spot analysis. Student presentations of Tutorial 1</td>
<td>Readings A-F</td>
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<tr>
<td>3</td>
<td>4/20</td>
<td>Lab: Exercise 2</td>
<td>Exercise 2</td>
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<td>4</td>
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<td>Exploratory regression, OLS Exercise 2: Exploratory or OLS regression</td>
<td>Readings A-G</td>
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<td>4</td>
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<td>Geographically weighted regression Exercise 2: Geographically Weighted Regression</td>
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<td>Readings A-G</td>
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<td>5/2</td>
<td>Regression: Student presentation of Tutorial 1</td>
<td>Readings A-G</td>
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<td>5</td>
<td>5/4</td>
<td>Lab: Exercise 3.</td>
<td>Exercise 3</td>
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<tr>
<td>6</td>
<td>5/7</td>
<td>Using Model Builder to link Arc GIS with R Exercise 3: Export to R, conduct analysis, import</td>
<td>Readings A-H</td>
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<tr>
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<td>5/9</td>
<td>Model Builder to link Arc GIS with R. Ex. 3, cont’d</td>
<td>Readings A-H</td>
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<td>5/11</td>
<td>Lab: Exercise 3</td>
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<td>Model Builder, Arc GIS, R. Student presentations.</td>
<td>Readings A-H</td>
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<td>Exercise 3</td>
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<td>5/21</td>
<td>Spatial analysis in networks Student presentations of Tutorial 2</td>
<td>Reading I</td>
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<tr>
<td>8</td>
<td>5/23</td>
<td>Spatial analysis in networks Student presentations of Tutorial 2</td>
<td>Readings A-I</td>
</tr>
<tr>
<td>8</td>
<td>5/25</td>
<td>Lab: Final Projects, blog posts Final Outline due</td>
<td>Final Outline due</td>
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<td>9</td>
<td>5/28</td>
<td>No class - Memorial Day</td>
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<tr>
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<td>5/30</td>
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<td>Integrated project design and completion</td>
<td>Readings A-I</td>
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<td>Student presentations</td>
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### Learning Outcomes

| Analyze spatial and temporal processes and formulate/articulate spatial and temporal problems | Assignment: “My spatial problem” |
| Analyze spatial and temporal pattern using available online tools | Individual exercises during lab sessions, tutorials |
| Apply spatio-temporal concepts to assess spatial and temporal patterns in data | Individual exercises during lab sessions, tutorials |
| Synthesize results of spatial and temporal pattern analysis to describe findings relative to a spatial and/or temporal problem | Student blog posts, final project |

### Assignments

#### A. My Spatial Problem Blog Post

**Contents:**

1. A description of the research question that you are exploring.
2. A description of the dataset you will be analyzing, including the spatial and temporal resolution and extent.
3. Hypotheses: predict the kinds of patterns you expect to see in your data, and the processes that produce or respond to these patterns.
4. Approaches: describe the kinds of analyses you ideally would like to undertake and learn about this term, using your data.
5. Expected outcome: what do you want to produce -- maps? statistical relationships? other?
6. Significance. How is your spatial problem important to science? to resource managers?
7. Your level of preparation: how much experience do you have with (a) Arc-Info, (b) Modelbuilder and/or GIS programming in Python, (c) R?

#### B. Lab exercise blog posts and tutorial presentations.

Part 1. Each student is expected to complete at least 3 of the exercises assigned in the syllabus, and describe those exercises as added sections of your blog. For each exercise, create a blog post that describes what you did and what you found, written as a recipe so that a person reading the blog could repeat your analysis.

A useful format for these exercise reports:

1. Question that you asked
2. Name of the tool or approach that you used.
3. Brief description of steps you followed to complete the analysis.
4. Brief description of results you obtained.
5. Critique of the method - what was useful, what was not?

Part 2. For two of your completed exercises, prepare and deliver a 5-minute "tutorial" presentation demonstrating a tool you have experimented with.
C. Final project (Outline due May 25)

Contents:
1. The research question that you asked.
2. A description of the dataset you examined, with spatial and temporal resolution and extent.
4. Approaches: analysis approaches you used.
5. Results: what did you produce -- maps? statistical relationships? other?
6. Significance. What did you learn from your results? How are these results important to science? to resource managers?
7. Your learning: what did you learn about software (a) Arc-Info, (b) Modelbuilder and/or GIS programming in Python, (c) R, (d) other?
8. What did you learn about statistics, including (a) hotspot, (b) spatial autocorrelation (including correlogram, wavelet, Fourier transform/spectral analysis), (c) regression (OLS, GWR, regression trees, boosted regression trees), and (d) multivariate methods (e.g., PCA)?
Course tools:

A. Wikipedia list of spatial statistical software:
   http://en.wikipedia.org/wiki/List_of.spatial_analysis_software

B. Arc spatial statistical toolbox:
   spatial-statistics-toolbox.htm

   In Arc 10.2:

   Textbook on spatial statistics in Arc: (http://blogs.esri.com/esri/arcgis/2010/04/07/check-

C. Arc spatial statistics forum:

D. “Understanding Spatial Statistics in ArcGIS 9”
   (http://www.utsa.edu/lrsg/Teaching/EES6513/ESRI_ws_SpatialStatsSlides.pdf)

E. “Conceptualization of Spatial Relationships.” Inverse distance; fixed distance; zone of
   indifference; polygon continuity; K nearest neighbors; Delaunay triangulation; space-time
   window

F. Hotspot analysis: How to do it:
   https://www.arcgis.com/home/item.html?id=6626d5cc81a745f1b737028f7a519521
   http://www.arcgis.com/home/item.html?id=dea008bccc77d4fd485abdf81211170b82

   How it works:
   spatial-stat.htm

G. Regression analysis (10.0)
   http://www.arcgis.com/home/item.html?id=71a65d35688a4502b123c6bfc99afdee

H. Using R for spatial statistics.
   R library for spatial statistics:
   http://www.spatstat.org/spatstat/

   Using R in Arc GIS 10: Extending ArcGIS with R – presentation from the 2010 Users Conference
   http://www.arcgis.com/home/item.html?id=547085ee428f4141b2caeb338f8f61a3
RStudio:  https://www.rstudio.com

Using ModelBuilder to manage data downloaded from the Internet (Arc 10.2).
Using ModelBuilder tutorial in Arc 10.0
   http://www.arcgis.com/home/item.html?id=7180ba6e9d8845128eaadf70a4b6bf7e

K. Generate network spatial weights (Arc 10.2);

Miscellaneous other links:

1. Assorted training seminars on ESRI webpage,
   http://training.esri.com/gateway/index.cfm?fa=catalog.webCourseDetail&courseID=2586

2. TOOL: Linear Directional Mean:

3. Supplemental Spatial Statistics Toolbox:
   http://www.arcgis.com/home/item.html?id=694e0f97355740d7bba6bb8b356c0b925


   http://resources.arcgis.com/gallery/file/geoprocessing

ADDITIONAL LINKS:

Wavelet analysis in R: https://cran.r-project.org/web/packages/WaveletComp/index.html
Statement Regarding Students with Disabilities: Accommodations are collaborative efforts between students, faculty and Disability Access Services (DAS). Students with accommodations approved through DAS are responsible for contacting the faculty member in charge of the course prior to or during the first week of the term to discuss accommodations. Students who believe they are eligible for accommodations but who have not yet obtained approval through DAS should contact DAS immediately at 541-737-4098.

Source: Disability Access Services, Faculty and Staff Responsibilities Before the Term (6-4-15)

Student Conduct
For expectations of student conduct, please see:
http://studentlife.oregonstate.edu/studentconduct/offenses-0