GIST 4302/5302: Spatial Analysis and Modeling

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Office hours: TR 1:30-2:30 or W 3:00-4:00pm, R 1:20-2:20pm or by appointment

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Prerequisites

Prerequisites of this course includes an understanding of basic algebra, general statistics (e.g., knowledge of statistical significance) and matrix manipulations, and working knowledge of at least one GIS software packages, e.g. ArcGIS, which could be fulfilled with GIST 3300/5300. However, students from different disciplines are welcome, please contact the instructor should there any question about the prerequisites.

Course description

With the continuing advances of technological development, spatial data have been easily and increasingly available in the past decades and becoming important information sources in daily decision makings. This class is intended for students (undergraduate and graduate students) from relevant disciplines (e.g., geography, geology, environmental science and social sciences) who are interested in working with spatial data analysis. Graduate students are encouraged to engage this course with their thesis/dissertation topics and research interests.

This course will introduce fundamental concepts and commonly used methods in quantitative analysis of spatial data. Specifically, this course includes:

- Representation of spatial data (fundamentals in spatial databases)
- Concepts in spatial analysis and spatial statistics
- Spatial analysis methods for various types of spatial data (spatial points, networks, and areal/lattice data), including overlay/suitability analysis, spatial statistical methods such as exploratory spatial data analysis (e.g., Moran’s I), spatial interpolation (e.g. kriging) and spatial regression.

A lab/discussion session (approximately 2 hours) follows the lecture for students to gain hands-on experiences on real-world datasets by using multiple software tools. The software packages utilized in lab sessions include ArcGIS, Open GeoDa, R or Matlab. Students (in particular) with expertise or interest in
the statistical package R or Matlab are encouraged to use them but it is not required.

**Course Schedule**

<table>
<thead>
<tr>
<th>Week</th>
<th>Lecture Dates</th>
<th>Lecture Topics</th>
<th>Readings</th>
<th>Lab/Discussion Topics</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Jan. 16</td>
<td>Overview of the course</td>
<td></td>
<td>No lab</td>
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<tr>
<td>2</td>
<td>Jan. 21, Jan 23</td>
<td>Introduction to spatial analysis</td>
<td>O’S &amp; U ch.1</td>
<td>Review of map projection and ArcGIS</td>
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<tr>
<td>3</td>
<td>Jan 29, Jan 31</td>
<td>Spatial representation: vector analysis</td>
<td>O’S &amp; U ch.1 and 10</td>
<td>Spatial query I</td>
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<tr>
<td>4</td>
<td>Feb 4, 6</td>
<td>Spatial representation: vector analysis</td>
<td>O’S &amp; U ch.1 and 10</td>
<td>Spatial query II</td>
</tr>
<tr>
<td>5</td>
<td>Feb 11, 13</td>
<td>Spatial representation: raster analysis</td>
<td>O’S &amp; U ch.1 and 10</td>
<td>Raster analysis I</td>
</tr>
<tr>
<td>6</td>
<td>Feb 18, 20</td>
<td>Geocoding</td>
<td>O’S &amp; U ch.1 and 10</td>
<td>Model builder</td>
</tr>
<tr>
<td>7</td>
<td>Feb 25, Feb 27</td>
<td>Statistics review; pitfalls and potential of spatial data</td>
<td>O’S &amp; U ch.2, 3 and Appendix</td>
<td>Geocoding</td>
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<td>8</td>
<td>Mar 3, 5</td>
<td>review; midterm</td>
<td></td>
<td>Project discussion</td>
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<td>9</td>
<td>Mar 10, 12</td>
<td>Point pattern analysis</td>
<td>O’S &amp; U ch.4 and 5</td>
<td>Homework assignment</td>
</tr>
<tr>
<td>10</td>
<td>Mar 17, 19</td>
<td>Spring break</td>
<td></td>
<td></td>
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<tr>
<td>Lecture Week Dates</td>
<td>Lecture Topics</td>
<td>Readings</td>
<td>Lab/Discussion Topics</td>
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<tr>
<td>11  Mar 24, 26</td>
<td>Point pattern analysis</td>
<td>O’S &amp;U ch.7</td>
<td>Point pattern analysis</td>
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<tr>
<td>12  Mar 31, 2</td>
<td>Spatial statistics of areal objects &amp; exploratory analysis</td>
<td>O’S &amp;U ch.7</td>
<td>Getting started with GeoDa; Proposal due</td>
<td></td>
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<tr>
<td>13  Apr 7, 9</td>
<td>Spatial statistics of areal objects &amp; exploratory analysis</td>
<td>O’S &amp;U ch.7</td>
<td>Exploratory analysis and cluster detection with GeoDa ; Proposal due</td>
<td></td>
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<tr>
<td>14  Apr 14, 16</td>
<td>Spatial Interpolation and 9</td>
<td>O’S&amp;U ch.8</td>
<td>Spatial interpolation</td>
<td></td>
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<tr>
<td>15  Apr 21, 23</td>
<td>Spatial Interpolation and 9</td>
<td>O’S&amp;U ch.8</td>
<td>Class project</td>
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<tr>
<td>16  Apr 28, 30</td>
<td>Kriging</td>
<td>O’S&amp;U ch.8 and 9</td>
<td>Class project</td>
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<tr>
<td>17  May 5</td>
<td>Review</td>
<td>O’S&amp;U ch.8 and 9</td>
<td>Project presentation</td>
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<tr>
<td>18  May 12 1:30-4:00pm</td>
<td>Final</td>
<td>O’S&amp;U ch.8 and 9</td>
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**Learning outcomes**

After completing this course, the undergraduate of this class are expected to learn how to:

- formulate real-world problems in the context of geographic information systems and spatial analysis
- apply appropriate spatial analytical methods to solve the problems
- utilize mainstream software tools (commercial or open-source) to solve spatial problems
- communicate results of spatial analysis in the forms of writing and presentation
In addition to the above, the **graduate** students of this class are expected to learn

- the concept of spatial uncertainty
- commonly used spatial statistical methods work and connect them to the thesis and dissertation work
- evaluation and assessment of the results of alternative methods

**Readings**

The main course text is:


The following book will be helpful for some topics of this class. Additional readings and handouts ill be suggested as the class progresses.


For the lab assignments, you have different options of software tools to choose from. If using ArcGIS, you might find the following book helpful:


if using R:


if using Matlab:


**Assessment**

There are two written exams in this course (a midterm and a final), lab exercises, and a final project that includes a project proposal and final report. **Graduate**
Students will have extra questions for the lab and the exams, and higher standard for the final project outcomes. The exams are used to assess your understanding of the basic concepts discussed in the lecture, and the format of the exams will consist of a combination of multiple choice, short answer and short essay questions.

The purpose of the final project is to provide experiences for students to apply the methods and tools learned from this class to real-world spatial problems. Topics of the final project could be related to the spatial aspect of a thesis or another course work. The proposal associated with the final project should include a clear description of the proposed problems with appropriate background literatures justifying the motivation, description of the collected data sources, and methodology adopted to address the problem. When the project proposal is due (Nov.3rd), students are expected to have collected the necessary data at hand. The final project will require a presentation of about 6-10 mins PechaKucha style or a poster session, and a final project report. Students are encouraged to start thinking of project ideas early in the semester, and communicate them with the instructor and the TA for feedbacks and comments.

Grading

Each exam, lab exercise and final project is worth 100 points, and the final points will be a combination of these three elements according to the following weights:

- two written exams: 40% (each 20%)
- ten lab exercises: 45%
- final project proposal (5%), presentation (10%): 15%

To ensure a specific grade in this course you must meet the following minimum requirements: A - 90%, B - 80%, C - 70%, D - 60%.

University policy

- Students with disabilities (OP 34.22): http://www.depts.ttu.edu/opmanual/OP34.22.pdf
- Students absence for observance of a religious holy day (OP 34.19): http://www.depts.ttu.edu/opmanual/OP34.19.pdf

Useful links:

- Map projection (lots of visuals)
• Story map competition
• Voronoi diagram for map generator; More details how was made
• Application of convex hull