# GIST 5302: Spatial Analysis and Modeling

| **Instructor:** | **Dr. Guofeng Cao** | **TA: Congliang Zhou** |
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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

| Week | Lecture Dates | Lecture Topics | Readings | Lab/Discussion Topics |
|---|---|---|---|---|
| 1 | Aug 28, Aug 30 | Overview of the course; Introduction to spatial analysis | O'S & U ch.1 | Review of map projection and ArcGIS |
| 2 | Sept 4, 6 | Spatial representation: vector analysis | O'S & U ch.1 and 10 | Spatial query I |
| 3 | Sept 11, 13 | Spatial representation: vector analysis | O'S & U ch.1 and 10 | Spatial query II |
| 4 | Sept 18, 20 | Spatial representation: raster analysis | O'S & U ch.1 and 10 | Raster analysis |
| 5 | Sept 25, 27 | Spatial representation: raster analysis, geocoding | O'S & U ch.1 and 10 | Model builder |
| 6 | Oct 2, 4 | Statistics review; pitfalls and potential of spatial data | O'S & U ch.2, 3 and Appendix A-B | Geocoding and homework assignment |
| 8 | Oct 9, 11 | Student project discussion; midterm review | | Project discussion |
| 7 | Oct 16, 18 | Point pattern analysis | O'S & U ch.4 and 5 | Point pattern analysis |
| 9 | Oct 23, 25 | Spatial statistics of areal objects & exploratory analysis | O'S &U ch.7 | Getting started with GeoDa |
| 10 | Oct 30, Nov 1 | Spatial statistics of areal objects & exploratory analysis | O'S &U ch.7 | Mapping and cluster detection with GeoDa ; Proposal due |
| 11 | Nov 6, 8 | Spatial interpolation | handouts | Spatial interpolation I |
| 12 | Nov 13, 15 | Spatial interpolation | handouts | Spatial interpolation II |

| Week | Lecture Dates | Lecture Topics | Readings | Lab/Discussion Topics |
|---|---|---|---|---|
| 13 | Thanksgiving | Fall break | | |
| 14 | Nov 27, Nov 29 | Spatial interpolation | O'S&U ch.8 and 9 | Class project |
| 15 | Dec 4 | Review | | Project presentation |
| 16 | Dec 8 1:30-4:00pm | Final | | |

## 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:

- O'Sullivan, David and David J. Unwin (2010), *Geographic Information Analysis, 2nd Edition*, John Wily & Sons. The first edition of this book works in the most cases as well.

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

- de Smith, Michael J., Paul A. Longley and Michael F. Goodchild (2013), *Geospatial Analysis: A Comprehensive Guide to Principles, Techniques and Software Tools, 4th Edition.* Available in both print and web () version at http://www.spatialanalysisonline.com

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

- Allen, David W. (2011), *GIS Tutorial 2, Spatial Analysis Workbook for ArcGIS 10*, Esri Press.
- Mitchell, A. (2009), *The ESRI Guide to GIS Analysis, vol. 2: spatial measurements and statistics*, ESRI Press.

if using R:

- Bivand Roger S., Pebesma, Edzer J., and Gómez-Rubio, Virgilio (2008), *Applied Spatial Data Analysis with R*, Springer.

if using Matlab:

- Martinez, W.L. and Martinez, A.R. (2007), *Computational Statistics Handbook with MATLAB, 2nd Edition*, Taylor & Francis – Chapman & Hall/CRC.

## 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: 30% (each 15%)
- six (out of ten) lab exercises: 40% (each ~ 6.6%)
- final project proposal (5%), presentation (10%) and paper (15%) : 30%

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

- Academic honesty (OP 34.12): http://www.depts.ttu.edu/opmanual/OP34.12.pdf
- 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