

# Geog 560: Advanced Quantitative Analysis

**Credit: 3 units**

**Lectures (444 Science Hall): Tuesday & Thursday 9:30 AM-10:45 AM**

**Labs (380 Science Hall): Tuesday 9:30 AM – 10:45 AM (Dates will be announced during lectures)**

Instructor: Prof. Song Gao

Office Hours: Tuesday 1:00-2:00 PM, Thursday 1:00-2:00 PM, or by appointment (421 Science Hall)

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## Overview

Geography 560 (GEOG 560) is an advanced course in statistical methods and spatiotemporal data analysis covering techniques widely used in quantitative geography and Cartography/GIS. The primary emphasis is on data-driven predictive modeling, including multiple regression and extensions, geographically weighted regression, and categorical prediction. We also cover principal components analysis, (spatial) clustering, and computation-intensive analysis methods. In addition, we will introduce times series analysis and spatiotemporal statistical models if time permits. Moreover, this course utilizes R script programming tools to solve statistics and spatiotemporal analysis problems.

## Course Learning Outcomes

Upon completion of the course modules, the student is expected to:

- Understand statistical concepts, methods, and techniques
- Be able to conduct various statistical analyses on geographic data
- Be familiar with R script programming for (spatiotemporal) statistical analysis
- Be able to solve practical problems using statistics and spatiotemporal analysis methods

## Course Materials

Textbook:

- Burt, James E., Gerald M. Barber, and David L. Rigby. *Elementary statistics for geographers*. Guilford Press, 2009.
- James, Gareth, Daniela Witten, Trevor Hastie, and Robert Tibshirani. *An Introduction to Statistical Learning with Applications in R*. New York: springer, 2013. (Free PDF copy available at: <http://www-bcf.usc.edu/~gareth/ISL/ISLR%20Sixth%20Printing.pdf>)
- Bivand, Roger S., Edzer J. Pebesma, Virgilio Gomez-Rubio, and Edzer Jan Pebesma. *Applied Spatial Data Analysis with R (2<sup>nd</sup> ed)*. Vol. 747248717. New York: Springer, 2013.

### Recommended Readings:

- Brunsdon, Chris, and Lex Comber. *An introduction to R for spatial analysis and mapping*. SAGE, 2015.
- Cressie, Noel, and Christopher K. Wikle. *Statistics for Spatio-Temporal Data*. John Wiley & Sons, 2015.
- Everitt, Brian, and Torsten Hothorn. *An Introduction to Applied Multivariate Analysis with R*. Springer Science & Business Media, 2011.

All lecture slides and notes are available on the *Canvas*. Notice that our communication will be almost exclusively through the messaging platform on *Canvas*. It is advised that you set up your email alerts in *Canvas* to send you daily updates about assignments, communication from your instructors, TAs, and changes to the course. See instructions at:

<https://guides.instructure.com/m/4212/l/710344-how-do-i-set-my-canvas-notification-preferences-as-a-student>

### Grading

#### 50% Lab Assignments + 30% Exam + 20% Final Project

Course grades will be based on in-class quiz/midterm (30% of total grade), the laboratory assignments (50% of total grade), and one final project (20% of total grade). Quiz/midterm exam will be given in the class and will cover the material presented in the course lectures and notes with an emphasis on concepts and vocabulary. Lab assignments will require R programming based on lecture material. Lab assignments are not scheduled weekly and dates will be announced during the lectures. There is no final exam for this course. But you will have one final project to solve a problem related to your area of study or topic of interest using data-driven analysis methods that you learn in this course.

#### Grading Scale:

Score	Grade	Grade Points Per Credit
> or = 90	A (Excellent)	4
86 ~ 89.99	AB (Intermediate grade)	3.5
80 ~ 85.99	B (Good)	3
76 ~ 79.99	BC (Intermediate grade)	2.5
70 ~ 75.99	C (Fair)	2
60 ~ 69.99	D (Poor)	1
< 60	F (Failure)	0

More information: [https://registrar.wisc.edu/grades\\_and\\_gpa.htm](https://registrar.wisc.edu/grades_and_gpa.htm)

## Course Outline

The following is a tentative schedule. Please check the Canvas website for updates.

Modules	Lectures & Date	Labs
Module 1: Review	Lesson 1: Basic Statistical Concepts	
	Lesson 2: Hypothesis Testing and Confidence Intervals	
Module 2: Regression Analysis	Lesson 3: Statistical Relations and Bivariate Linear Regression	Lab 1: Descriptive Statistics and Regression Analysis
	Lesson 4: Simple Linear Regression	
	Lesson 5: Multiple Linear Regression	
	Lesson 6: Geographically Weighted Regression (GWR)	Lab 2: Spatial Data in R and GWR
Module 3: Categorical Prediction Methods	Lesson 7: Logit Models	
	Lesson 8: Bayesian Inference	Lab 3: Categorical Prediction
	Lesson 9: Support Vector Machines	
	Lesson 10: Classification and Regression Trees	Lab 4: SVM & Decision Trees
Module 4: Multivariate Methods	Lesson 11: Principal Components Analysis (PCA)	
	Lesson 12: Multidimensional Scaling	Lab 5: Multivariate Methods
	Lesson 13: Clustering Analysis ( optional, TBD)	
Module 5: Spatiotemporal Data Analysis	Lesson 14: Time Series Analysis	Final project proposal (4/19) Final project working time (4/30, 5/2) Due on May 10
	Lesson 15: Spatiotemporal Analysis Methods (optional, TBD)	
In-Class Exam	Midterm Date: 3/14 (Thur)	
Spring recess	Mar 16-24, 2019	

## Attendance (Required)

You must attend all lectures & lab sessions and complete all course assignments and quizzes on time. You should appropriately comment all code you submit for a grade. Please seek assistance when you have a question or problem through office hours and/or your peers.

## **Communication & Accommodation**

The University of Wisconsin-Madison supports the right of all enrolled students to a full and equal educational opportunity. The Americans with Disabilities Act (ADA), Wisconsin State Statute (36.12), and UW-Madison policy (Faculty Document 1071) require that students with disabilities be reasonably accommodated in instruction and campus life. Reasonable accommodations for students with disabilities is a shared faculty and student responsibility. Students are expected to inform faculty of their need for instructional accommodations by the end of the third week of the semester, or as soon as possible after a disability has been incurred or recognized. Faculty will work either directly with the student or in coordination with the McBurney Center to identify and provide reasonable instructional accommodations. Disability information, including instructional accommodations as part of a student's educational record, is confidential and protected under FERPA. If you face any personal or professional difficulties or require accommodation or a disability, please feel free to contact me as soon as possible.

## **Academic Integrity**

Academic Integrity is critical to the mission of the University of Wisconsin-Madison, a research institution with high academic standards and rigor. All members of the University community play a role in fostering an environment in which student learning is achieved in a fair, just, and honest way. Plagiarism is prohibited in lab assignments and quizzes. Any offense results in a zero for the grade and disclosure of the impropriety to the Department and University.