GEOG 579: GIS and Spatial Analysis
Fall, 2018
Last Update: Sept. 04, 2018

Instructional team:

Lead instructor:

Name:	A-Xing Zhu
Title:	Professor
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Office hours:	Tuesdays from 2:30 p.m. to 3:30 p.m.
	Thursdays from 2:30 p.m. to 3:30 p.m.
	or by appointment

Teaching assistant:

Name:	Sulong Zhou
Title:	Graduate Student
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Introduction:

This is an advanced GIS course covering analytical methods used in GIS and spatial analysis. The course is intended to provide students with a firm understanding of the theoretical/conceptual side of algorithms found in GIS software. We are concerned with the assumptions and underlying mathematical basis for widely-used techniques, and the degree to which analytical capabilities are constrained by those assumptions. Among the topics covered are logic frameworks, terrain analysis, spatial interpolation, point pattern analysis, and network analysis. Other advanced topics such as fuzzy sets, and neural networks will also be covered. The emphasis is on the usefulness and limitations of competing algorithms.

Course Learning Objectives:

After completing this course, students will be able to:

- Identify the limitations of common GIS spatial analytical technique;
- Determine the usefulness of common GIS spatial analytical techniques;
- Select the proper GIS techniques without misusing or abusing it;
- Investigate the limitations of emerging GIS techniques to avoid misuse or abuse of these techniques.

Course Delivery Format:

The lecture component is given through online modules. I will release **one module per week on Wednesday**. All assignments (such as discussion and quizzes) related to this module are timed starting from the release date. You MUST watch out for these time lines and deadlines.

The lab component is given in face-to-face format. **You are expected to attend all lab sessions.** The lab session will start in the second week of class during which the TA will distribute lab syllabus. There will be times I will use the lab sessions for question and answer activities. I will announce these activities at appropriate times.

Course Materials:

- Textbook:

  There is no textbook for this class. Relevant references will be given with each module

- **Other books of Interest**

  Anselin, Luc, and Sergio J. Rey, (edtors). 2010. Perspectives on Spatial Data Analysis (Advances in Spatial Science). Springer, ISBN-13: 978-3642019753.

  Hanning, Robert, 2003. Spatial Data Analysis: Theory and Practice. Cambridge Press. ISBN-13: 978-0521774376.

  Isaaks, Edward, H. and R. Mohan Srivastava. 1989. An Introduction to Applied Geostatistics. Oxford University Press, New York, 561 p.

  Oyana, Tonny J. and Florence Margai, 2015. Spatial Analysis: Statistics, Visualization, and Computational Methods, CRC Press. ISBN-13: 978-1498707633.

- Additional Reading Material

  Additional reading material as required will be provided as needed in the modules.

Expectations:

What is expected of you, the student?

Students must actively participate throughout the course. You should maintain regular contact with the instructional team (shown above) and log on daily to keep up with the latest postings. The expectation is that **your contributions will be professional, timely, substantive, positive, and energetic**. If you face unexpected personal or professional difficulties that hinder your performance, please let us me know as soon as possible.

Most importantly, you are expected to maintain the highest level of academic integrity. You may neither give nor receive any help on your assignments except from your team if it is a term assignment or team project. Individual written assignments must represent your work and must not be byproducts of a joint work effort. WE HAVE ZERO TOLERANCE ON PLAGIARISM.

In this course we will use many tools to help you learn the materials. But it is up to you whether you actually engage or simply go through the motions. One of the most important components of learning is the degree to which a student engages with the materials. So for example, in a discussion forum you can think deeply about the questions, prepare carefully your comments and responses, and contribute multiple times; or you can pick a couple of easy spots to say

something that "fits" and meets the grading requirement. I strongly encourage you to do the former.

What can you expect of me, the instructor?

I will be online frequently during the week and once during each weekend to answer questions and respond to comments that you may have. It is my intent to respond to individual emails within 72 hours (and usually much sooner!). Please be understanding if I am occasionally late.

I will participate in all discussion forums, but they will be mainly student-driven.

I will provide feedback and scores on all assignments within 10 days after the due date.

Communication:

In this course we will communicate mainly through email. I will send all course emails through Learn@UW. You can also go into your Learn@UW profile and add another email address and have course emails automatically forwarded there, if you want.

Email Protocol: You can use Learn@UW to send email to me or your classmates. If you use your own personal email to send me an email message, please use the following structure for your email subject. "GEOG579: your email subject here". This will help me in sorting the emails in my inbox and ensuring your email doesn't get accidently lost in daily deluge of emails.

It is very easy to shoot an email to me when you are reading and run into a problem. I strongly suggest that you hold back you urge to send an email to me whenever you run into a problem or have a question. The simple reason is that this form of contacting me deprives yourself of the chance to learn or to explore with this question or problem. Learning is about solving problems/answering questions and about resolving conflicts in your understanding. The most efficient way to learn is to resolve these conflicts and solve the problems on your own as much as possible. If you send me an email for solution or explanation whenever you run into a question or problem, you won't get the opportunity to do these on your own. There will be times that you cannot figure the problems out after you try very hard. In this case, you are certainly welcome to contact me for help. The trick in contacting me for help but still giving yourself the opportunity to learn is to phrase your questions in the form of seeking a "yes" or "no" from me. I bet that many of the problems or questions will be answered by yourself in the process of formulating the questions in this format. The reason is that this way of formulating the question is how humans are advancing knowledge. If you do that, ***you are learning how to learn***.

Course Work:

Quizzes

There will be several *timed* quizzes in this course, typically associated with each key lesson. They will usually consist of several multiple choice questions. Once you begin a quiz, you will have 30 minutes to complete it. So plan well before you start each quiz. Each quiz will have its starting date (the date of release) and ending date. Please watch out for these.

Discussion Forums

For every module, I will present about 5 questions. You are expected to participate in the online discussion on these questions. "Presence" is required for these discussions. You are expected to logon to the discussions a minimum of two times per discussion period, once early on in the period and once later on in the period (generally runs over one week period). You are expected to post substantive contributions to the discussion each time. Your discussion will be graded based on your participation (if you participated and when you participated) and the quality of your postings. Your contributions should add value to the discussion and hold the potential to greatly enhance everyone's learning experience. This will require you to be thoughtful and engaged. You can also post questions of your own, which also accounts for as participation in the discussion forum.

Each discussion forum is timed (has a closing date and time). It is typically available over a week period starting from the date of release. You will not be able to participate in a discussion forum once it is closed (you still be able to read the postings even after it has been closed for posting).

Exercises

There will be exercises for you to work on. The objective of these exercises is for you to examine these methods through hands-on experience. *These exercises are done in the lab sessions. See the lab syllabus for detail (which will be available in the first lab session, typically during the second week of class).*

Grading policy:

These exercises are graded based on the following parts:

1) completion of the tasks
2) the academic merit of your answers to the questions
3) clarity of answers, *NO BEATING AROUND THE BUSH*
4) concise and logical presentation, no one wants to flip through a messy exercise report looking for answers.

Here is a general format for your presentation:

> *Question:*
> *Your answer and discussion*
> *Your support documents (images, graphs, tables, etc.)*

The grade for each of the exercises and examinations is reported as *points_scored* / *total_points_of_exercise*. For example, an exercise has 20 points and your answer is worth 18 points then you should see *18/20* on your marked exercise report.

Due date and time:

Each of the exercises will have a due day clearly written underneath the title of the exercise. The due time is the beginning of the lab session on the due day. Any exercise that is turned after the due time on the due day is considered late.

Penalty for late exercises:

The penalty of a late exercise is based on the number of days late (***including weekends!***). If an exercise is late less than 24 hours, it is considered 1 day late. If an exercise is late less than 48 hours but more than 24 hours, it is considered 2 days late, and so on. If you have to turn in an exercise late during the working hours and the instructor is not in his office, you can put it in the instructor's mail box. However, the exercise will be considered to be turned in when the instructor takes it out of his mailbox.

Late exercises are penalized 10% per day. Here is the formula for calculating the points of a late exercise:

$$Points\_get = Points\_scored - 0.1*num\_days\_late*Points\_scored$$

The minimum value of *Points_get* is 0. An exercise handed in after the instructor has returned the graded exercise to class (usually a week after the due date) will receive ***no points***.

Class Essays (*Graduate students only*)

Graduate students are required to complete an independent and additional class work in line with the requirement set by the Graduate School on graduate students who take undergraduate courses. The independent and additional class work for this class is an essay no longer than 10 pages and no less than 6 pages (double spaces and 12 font size). The essay is on how the specific GIS technique has been applied in the domain of the student interests. The specific technique can be chosen based on student individual interests but it must be advanced GIS techniques. You are more than welcome to discuss your choice of the specific technique for your essay. The essay should be focused the current status of the application of the particularly technique in the field and what are the challenges in using the technique (including theoretical limitations as well as misuse and abuses). ***The essay is due on the last day of class (December 12, 2018)***.

Evaluation:

Components of Evaluation:

Exercises (four)	Undergraduate: 40%, graduate: 30%
Quizzes (eight)	40%
Discussion participation	20%
Class essay (graduates only)	10%

Grade Assignment*:

Listed below are the general percentages required for each letter grade, after rounding.

A	> or = 90	BC	77-79
AB	87-89	C	70-76
B	80-86	D	60-69

The graduate students and undergraduate students will be graded on separate curves.

Please be advised that a minimum grade-point average of 3.00 for all graduate level coursework done at the University is required for graduation and to maintain good academic standing. In other words, a student who completes all course requirements for a degree program but who does not earn at least a 3.0 grade point average (in all graduate courses taken) will not be awarded the degree by the University.

Course Schedule:

The schedule on the next page is tentative and may change at the instructor's discretion. All assignments (except lab reports) are due by 3 am Eastern Time early the next morning after the due date. ***The due date and due time of lab exercise reports will be given in the lab syllabus***.

The course begins September 5 and ends December 12.

Module 1 Logic Frameworks

Week	Topic	Assignments	Due Dates
1	Logic Frameworks • Basic concepts • Boolean sets • Fuzzy sets • Applications	lab 1 (Logic framework) (note the lab schedule might be a bit different from what stated here)	Two weeks from the opening of the module

Module 2 Digital Terrain Analysis

Week	Topic	Assignments	Due Dates
2	Digital Terrain Analysis • Basic operations on DEM • Drainage network extraction • Slope partitioning	Quiz 1	The quiz is only available for 30 minutes once it is opened

Module 3 Spatial Autocorrelation

Week	Topic	Assignments	Due Dates
3	Spatial Autocorrelation I: • Aspects of spatial autocorrelation • Joint count statistics	Quiz 2	Lab 1 due
4	Spatial Autocorrelation II: • Geary Index • Moran Coefficient • For other types of features and attributes	Lab 2 (Measuring spatial autocorrelation including semivariogram)	
5	Spatial Autocorrelation III • Semivariogram		

Module 4 Point Pattern Analysis

Week	Topic	Assignments	Due Dates
6	Point Pattern Analysis: • Exploratory and descriptive methods • Modeling approaches • Point density estimation	Lab 3 (Point pattern analysis)	Lab 2 due

Module 5 Spatial Interpolation

Week	Topic	Assignments	Due Dates
7	Spatial Interpolation I: • Process and Issue • Thiessen polygon (nearest neighbour) • Triangulation	Quiz 3	
8	Spatial Interpolation II: • Moving average • Inverse distance weighting		Lab 3 due
9	Spatial Interpolation III: • Kriging	Lab 4 (Kriging)	
10	Spatial Interpolation IV • Spline		
11	Spatial Interpolation V: • Recent advances in spatial prediction/interpolation • Measures for evaluating spatial interpolation	Quiz 4	

Module 6 Spatial Indices and Landscape Measures

Week	Topic	Assignments	Due Dates
12	Spatial Indices and Landscape Measures: • Spatial centroids • Shape Analysis • Measures of landscape structures	Quiz 5	Lab 4 due

Module 7 Network analysis

Week	Topic	Assignments	Due Dates
13	Network analysis: • Pathfinding (Shortest path analysis)	Quiz 6	

Module 8 Data Mining

Week	Topic	Assignments	Due Dates
14	Data Mining: • Neural Network	Quiz 7	

Disclaimer: Please note that the specifics of this Course Syllabus are subject to change, and you will be responsible for abiding by any such changes. Your instructor will notify you of any changes.

Technical Requirements:

System Check	Please perform a System Check on your computer's settings first
Operating System	Windows 2000/XP, Vista, or Windows 7; Mac OS X 10.3 or higher (10.4 or higher recommended)
Processor	1 GHz or higher
Memory	2 GB of RAM
Hard Drive Space	500 MB free disk space
Browser	The following web browsers are supported for use with Learn@UW on a Windows or Mac OS system: · Internet Explorer 9, 10, or 11 · Firefox (newest) · Chrome (newest) · Safari 5.1 or 6 *Note: There is currently no support for Safari on a mobile device.* To determine if your browser fits this criteria and for advice on downloading a supported version, please refer to the following DoIT knowledgebase article: https://kb.doit.wisc.edu/luwmad/page.php?id=3210
Plug-ins	Adobe Reader [Download from Adobe] Flash Player (v7.0 or later) [Download from Adobe]
Additional Software	Microsoft Office (2003 or later) iTunes/Quicktime VLC Media Player(PC / Mac)
Internet Connection	Broadband (cable or DSL) connection required
Printer	Access to graphics-capable printer
DVD-ROM	Not-required
Sound Card, Microphone, and Speakers	Required
Monitor	Monitor (Capable of at least 1024 x 768 resolution)

If you need technical assistance at any point during the course, please contact the

RULES, RIGHTS & RESPONSIBILITIES

- See the Guide's Rules, Rights and Responsibilities

Network Use Policies

Please read the UW-Madison's Responsible Use of Information Technology Policy.

ACADEMIC INTEGRITY

By enrolling in this course, each student assumes the responsibilities of an active participant in UW-Madison's community of scholars in which everyone's academic work and behavior are held to the highest academic integrity standards. Academic misconduct compromises the integrity of the university. Cheating, fabrication, plagiarism, unauthorized collaboration, and helping others commit these acts are examples of academic misconduct, which can result in disciplinary action. This includes but is not limited to failure on the assignment/course, disciplinary probation, or suspension. Substantial or repeated cases of misconduct will be forwarded to the Office of Student Conduct & Community Standards for additional review. For more information, refer to studentconduct.wiscweb.wisc.edu/academic-integrity/.

ACCOMMODATIONS FOR STUDENTS WITH DISABILITIES

McBurney Disability Resource Center syllabus statement: "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 [me] 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 [I], will work either directly with the student [you] 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." http://mcburney.wisc.edu/facstaffother/faculty/syllabus.php

DIVERSITY & INCLUSION

Institutional statement on diversity: "Diversity is a source of strength, creativity, and innovation for UW-Madison. We value the contributions of each person and respect the profound ways their identity, culture, background, experience, status, abilities, and opinion enrich the university community. We commit ourselves to the pursuit of excellence in teaching, research, outreach, and diversity as inextricably linked goals.
The University of Wisconsin-Madison fulfills its public mission by creating a welcoming and inclusive community for people from every background – people who as students, faculty, and staff serve Wisconsin and the world." https://diversity.wisc.edu/