

GEOG 579: GIS and SPatial Analysis

Spring, 2016

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Instructional team:

Lead instructor:

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Teaching assistant:

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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 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, (editors). 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 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 accidentally lost in daily deluge of emails.

It is very easy to shoot an email to me when you are reading and run into a question. I strongly suggest that you hold back your urge to send an email to me whenever you run into a problem or 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 you 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 Assignments:

Quizzes

There will be several 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.

Discussion Forums

For some of the course topics, you will participate in online discussion forums relating to the topic we are currently studying. "Presence" is required for these discussions. In most cases, you are expected to logon to the discussions a minimum of two times per discussion period (generally runs over a 3-4 day period) and are expected to post substantive contributions to the discussion each time. All offerings add value to the discussion and hold the potential to greatly enhance everyone's learning experience as long as the posts are thoughtful, sincere, and address the case and/or questions posted. When possible, please post earlier rather than later in the open discussion period, allowing for a much richer discussion to develop.

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.

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
- 2) clarity of answers, ***NO BEATING AROUND THE BUSH***
- 3) concise and logical presentation, no one wants to flip through a messy assignment 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 assignment has 20 points and your answer is worth 18 points then you should see ***18/20*** on your marked assignment.

Due date and time:

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

Penalty for late assignments:

The penalty of a late assignment is based on the number of days late (***including weekends!***). If an assignment is late less than 24 hours, it is considered 1 day late. If an assignment 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 assignment 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 assignment will be considered to be turned in when the instructor takes it out of his mailbox.

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

$$\mathbf{Points_get = Points_scored - 0.1 * num_days_late * Points_scored}$$

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

Evaluation:**Components of Evaluation:**

Exercises (four)	40%
Quizzes (eight)	40%

Discussion participation 20%

Grade Assignment*:

Listed below are the minimum 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

**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 are due by 3 am Eastern Time early the next morning after the due date. This gives class members on the west coast until midnight Pacific Time to submit their work.

The course begins **January 20** and ends **May 6**.

Module 1 Logic Frameworks

Week	Topic	Assignments	Due Dates
1	Logic Frameworks <ul style="list-style-type: none"> • 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 <ul style="list-style-type: none"> • 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: <ul style="list-style-type: none"> • Aspects of spatial autocorrelation 	Quiz 2	Lab 1 due

	<ul style="list-style-type: none"> • Joint count statistics 		
4	Spatial Autocorrelation II: <ul style="list-style-type: none"> • Geary Index • Moran Coefficient • For other types of features and attributes 	Lab 2 (Measuring spatial autocorrelation including semivariogram)	
5	Spatial Autocorrelation III <ul style="list-style-type: none"> • Semivariogram 		

Module 4 Point Pattern Analysis

Week	Topic	Assignments	Due Dates
6	Point Pattern Analysis: <ul style="list-style-type: none"> • 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: <ul style="list-style-type: none"> • Process and Issue • Thiessen polygon (nearest neighbour) • Triangulation 	Quiz 3	
8	Spatial Interpolation II: <ul style="list-style-type: none"> • Moving average • Inverse distance weighting 		Lab 3 due
9	Spatial Interpolation III: <ul style="list-style-type: none"> • Kriging 	Lab 4 (Kriging)	
10	Spatial Interpolation IV <ul style="list-style-type: none"> • Spline 		
11	Spatial Interpolation V: <ul style="list-style-type: none"> • 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: <ul style="list-style-type: none"> • 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:	Quiz 6	

	<ul style="list-style-type: none"> Pathfinding (Shortest path analysis) 		
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Module 8 Data Mining

Week	Topic	Assignments	Due Dates
14	Data Mining: <ul style="list-style-type: none"> 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	<p>The following web browsers are supported for use with Learn@UW on a Windows or Mac OS system:</p> <ul style="list-style-type: none"> Internet Explorer 9, 10, or 11 Firefox (newest) Chrome (newest) Safari 5.1 or 6 <p><i>Note: There is currently no support for Safari on a mobile device.</i></p> <hr/> <p>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</p>
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

University Policies

The University of Wisconsin - Madison is dedicated to a safe, supportive and non-discriminatory learning environment. It is the responsibility of all undergraduate and graduate students to familiarize themselves with University policies regarding Network Use, Disability Accommodations, Misconduct, Religious Beliefs Accommodation, FERPA, and Copyright.

Network Use Policies

Please read the UW-Madison's [Responsible Use of Information Technology Policy](#).

Disability Accommodations

The University of Wisconsin - Madison is dedicated to a safe, supportive and non-discriminatory learning environment.

Students requesting special accommodations should contact the McBurney Disability Resource Center as soon as possible regarding a Verified Individualized Services and Accommodations plan (VISA). Once your accommodation plan has been determined and approved, you will need to contact your professor.

Additional information is available at the McBurney Disability Resource Center:

<http://www.mcburney.wisc.edu/students/howto.php>.

Academic Misconduct

The University believes that academic honesty and integrity are fundamental to the mission of higher education and of the University of Wisconsin System. The University has a responsibility to promote academic honesty and integrity and to develop procedures to deal effectively with instances of academic dishonesty. Students are responsible for the honest completion and representation of their work, for the appropriate citation of sources, and for respect of others' academic endeavors. Students who violate these standards are subject to disciplinary action. UWS Chapter 14 identifies procedures to be followed when a student is accused of academic misconduct. For additional information, please refer to the section in the Student Handbook entitled Student Academic Disciplinary Procedures.

Please review the [Student Academic Misconduct Policy and Procedures](#) and the [Student Nonacademic Misconduct Policy](#).

Religious Beliefs Accommodation

Board of Regents policy states that students' sincerely held religious beliefs shall be reasonably accommodated with respect to scheduling all examinations and other academic requirements. Students must notify the instructor within the first three weeks of the beginning of classes (or within the first week of summer session and short courses) of the specific days or dates on which they will request accommodation from an examination or academic requirement. For additional information, please refer to [Chapter UWS 22: Accommodation of Religious Beliefs](#).

FERPA

FERPA – the Family Educational Rights and Privacy Act of 1974, as amended – is a federal law that governs the privacy of student educational records, access to those records, and disclosure of information from them. For more information, please refer to [Student Privacy Rights \(FERPA\)](#).