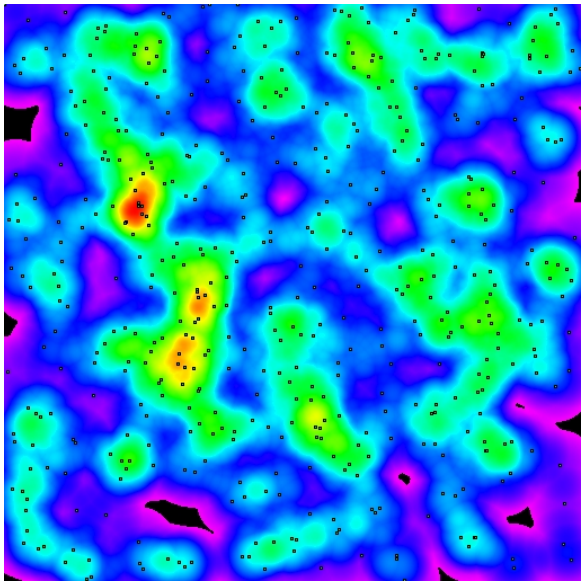
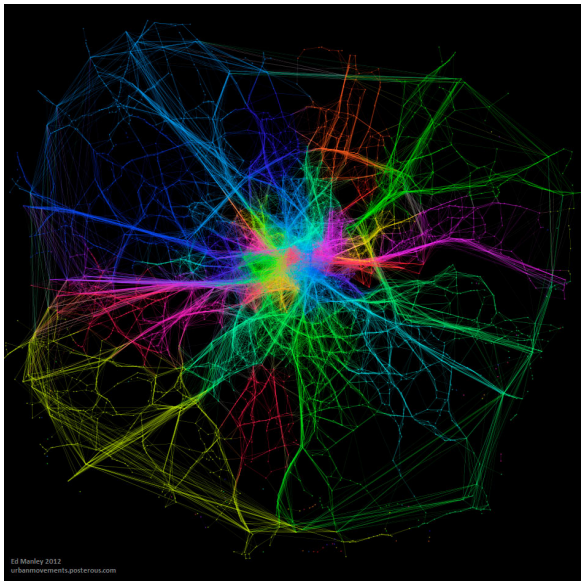
Geographic Information Science and Technology
Department of Geography, Texas A&M University

Geography 475 - **Advanced GIS** - 4 Hrs

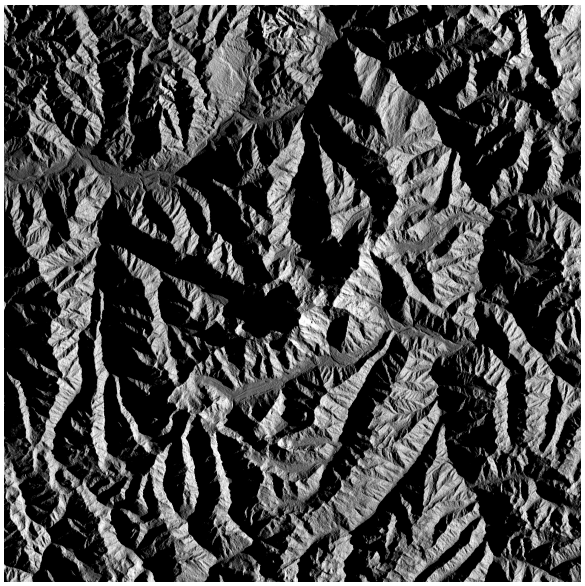


Point-Pattern Analysis



Spatial Analysis

Geocomputation



Spatial Modeling

1 Course & Laboratory Instructors

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2 Course Description

Geography 475 is an advanced undergraduate course designed to introduce students to fundamental GIScience concepts and topics in geographic information technology (GIT). This course focuses on important spatial concepts related to geospatial data, data/information representation themes, spatial analysis, spatial modeling, information synthesis and decision support. It also provides students with technical exposure to algorithms and workflows that can be used for producing quantitative and thematic information using geographic information systems (GIS). Furthermore, it emphasizes the concepts and limitations associated with empiricism and uncertainty, and the need for the use of the scientific method and domain knowledge to produce scientifically acceptable results for applied problem solving. Students will be best prepared for the course if they have taken GEOG 361 (Remote Sensing in Geosciences) and GEOG 390 (Principles of GIS). Nevertheless, students are required to have taken GEOG 390 or an equivalent course, or receive approval from the instructor.

2.1 Course Objectives

This course is designed to introduce students to advanced concepts and topics in GIScience and geographic information systems (GIS). Students will receive an understanding of spatial concepts, conceptual and digital representation themes, preprocessing and spatial manipulations, spatial analysis for information extraction, spatial modeling for spatio-temporal prediction, and familiarity in information synthesis for problem solving and domain applications. It emphasizes mastering the theoretical and fundamental principles of GIS-based analysis and modeling, and science-based utilization of geospatial technologies and algorithms for applied problem solving. Students will receive exposure to the latest issues, concepts, information technologies, and application perspectives. Lectures, classroom discussions, reading assignments and laboratory exercises will provide students with hands-on software and problem-solving experience.

2.2 Learning Outcomes

At the end of the course, students will be able to:

1. Understand the advantages and limitations associated with GIS.
2. Understand numerous multi-faceted spatial concepts.
3. Apply spatial interpolation algorithms for generating data.
4. Spatially analyze raster and vector data.
5. Apply spatial analysis algorithms to extract information from geospatial data.
6. Develop and use models that enable spatio-temporal prediction.
7. Synthesize technical and application domain knowledge to address mapping problems.

8. Interpret results within the context of a problem.

9. Apply technical skills to solve a problem.

2.3 Course Textbook and Resources

- de Smith, M.J., Goodchild, M.F., Longley, P.A., 2018. *Geospatial Analysis: A Comprehensive Guide to Principles, Techniques and Software Tools*, Sixth Edition, Winchelsea Press, United Kingdom, 617 pp.
- Bishop, M.P., 2025 . Laboratory Exercises.
- Bishop, M.P., 2025 . Lecture Outlines, Graphics and Equations

2.4 Lectures & Reading

Lectures, chapter readings and discussion will be associated with each topic covered in the course. Student should read all assigned chapters to prepare for each lecture session. Chapter reading should focus on those topics covered in lecture. Lecture and discussion material may or may not be found in the reading assignments, so it is essential that students attend all lecture sessions, and read assigned book chapters before class. This also facilitates classroom participation, student questions and the completion of laboratory exercises. It should also be noted that lecture outlines in CANVAS should not be used as a substitute for lecture material, as they do not contain the information and examples of content that students will be tested on. Consequently, students should take detailed lecture notes during lectures on top of the outline structure. Students not able to attend lecture should contact the professor, teaching assistant and/or a student regarding presented information, as lecture material and readings serve as the basis for testing. Students are encouraged to ask questions during lecture presentations.

2.5 Laboratory Exercises

Undergraduate students **must** attend a scheduled laboratory meeting time and allocate additional laboratory time to work on, and complete laboratory assignments. Laboratory exercises vary in length and are designed to expose students to fundamental concepts and principles in GIScience and GIS, and reinforce lecture material. Laboratory assignments are also designed to expose students to fundamental topics, technical training and problem-solving experience. For each laboratory exercise, each students will receive an assignment document from the instructor that details laboratory tasks, activities and questions that serve as the basis for problem solving, technical training and experiential learning. Students will also receive a technical document from their laboratory instructor that provides hands-on experience of how to utilize software to accomplish the educational goals. Students will usually have 2 weeks to complete each laboratory exercise. All exercises should be submitted to the laboratory instructor. Hand-written work will not be accepted. In general, late laboratory assignments will not be accepted, except for an excused absence. Furthermore, it is important to note that there are multiple ways of accomplishing a particular task

using a GIS. Nevertheless, different algorithms and approaches do not necessarily produce identical results. Students have the option to follow laboratory instructions presented by the laboratory instructor, or they may develop their own approach or workflow to produce information to solve a particular problem. There is no one correct technical way to accomplish a particular problem, and students are encouraged to explore different algorithms or approaches for problem solving if they are so inclined.

There will be four laboratory exercises during the semester. They are as follows:

1. Spatial Interpolation
2. Spatial Metrics and Statistics
3. Terrain Analysis
4. Criteria-Based Modeling

All student will need access to software in order to work-on their projects. Students should use the software system that they are most familiar with, however, software systems have different analytical capabilities, and it may be easier to solve a problem using programs in ENVI or ArcGIS depending upon the algorithms used or the design of the program.

All students in GEOG 475 automatically have access to the Trimble lab and Geosciences-specific VOAL virtual machines, where you can access ENVI and ArcGIS Pro software systems. If you register for the course after the first day of class, however, you will need to contact the help desk in Geosciences, so that they can provide you with access. To access the Geosciences-specific VOAL virtual machines, you will need to log into https://voal.tamu.edu. Please check the following link for detailed instructions regarding how to access this VM (https://www.youtube.com/watch?v=hzmgHEmiM8c&fe This option for software access is a good option because you can access the software on-campus or off-campus. To use the Geosciences VM off-campus, you will also need to install and log in using TAMU VPN: https://it.tamu.edu/services/network-and-internet-access/virtual-private-networks/virtual-private-network-vpn/.

Finally, another important issue regarding submitted work must be addressed. As you know, AI-based language models can now be used to generate text and papers for writing assignments. Use of any AI-based submissions will not be accepted and will result in a course grade of F, as each student must submit their own work, as use of an AI-generated document can be considered a form of plagiarism, and defeats the purpose of the course, which is to foster conceptual understanding, multidisciplinary thinking, and development of writing skills. Student assignments that are thought to be AI-generated, based upon a criteria list, will be subject to intense evaluation, and a student will need to prove that the document is the result of his/her work. This requires that all students document their work so that they can demonstrate that they are the sole authors of the document that was submitted. Students will be provided with information on how to document their work. This course policy is in accordance with the University's Academic Integrity Statement and Policy (see below).

2.6 Examinations

Course examinations will focus on testing topic content understanding. There will be three examinations that cover the topics and information from the three main sections of the course. None of the exams will be comprehensive in nature, and will only include material from the preceding section of the course.

All examinations will be objective in nature, consisting of T/F, multiple choice, and multiple response questions covering material presented in lectures. Students must take the examination in class using CANVAS. Consequently, students must bring a WIFI-enabled laptop to class to access the CANVAS system and take the exam. Students should make sure that they have their laptop fully charged before taking the exam.

In general, the first day of an exam week will be flex day, where we will attempt to present and finish up any material not yet presented. The second day of an exam week will consist of a study session, where students can ask questions, and the instructor can review material and provide students with a sense of the nature of the exam. This is done to assist students in understanding the material and promoting good grades. The last day of an exam week is the time that the exam will be taken, and this can occur on any day depending upon no class days and our progress in the presentation of material. Therefore, the examination date during a exam week is tentative, and the instructor will usually provide students with an advanced 1-2 week notification of the exact date of an exam. The final examination schedule is set by the University, and we will conform to the final exam schedule for our final examination time during finals week.

2.7 GIST Knowledge Exams

In order to improve the quality of the GIST program, the Department of Geography is involved with assessing students fundamental knowledge of GIST and the use of geospatial technologies for problem solving. Students graduating from the Department of Geography with a GIST B.S. degree should be able to comprehend fundamental concepts, be familiar with data and techniques, and have knowledge within important subdisciplines of GIST. These includes: 1) foundational concepts and topics in quantitative analysis, geographic information systems and remote sensing; 2) numerical/spatial analysis for the generation of quantitative and thematic information; 3) numerical/spatial modeling for spatial prediction of concepts or phenomena; and 4) remote sensing for landscape biophysical assessment and landcover/property thematic information.

Students have the option to participate in the assessment process by taking four objective examinations in CANVAS towards the end of the semester (on or off campus). Students who participate in assessment will receive extra-credit points that will improve their performance and standing in the course. Students are not obligated to participate, although the assessment exams enable students to receive professional feedback regarding their knowledge of GIST, and what areas of GIST may need further study. Consequently, participating in the assessment process has it's inherent advantages. Furthermore, it is important to note that assessment exam outcomes will not be used in the grading process (other than extra credit points), such that assessment performance does not govern, in any way, a students performance in the class. Consequently, there are no negative consequences associated with taking the assessment examinations. In order for students to receive

extra-credit points, four examinations must be taken on: 1) foundational GIScience concepts; 2) remote sensing; 3) numerical/spatial analysis; and 4) numerical/spatial modeling. A student taking less than 4 assessment examinations will will not receive any extra-credit points. Each exam will consist of approximately 25 questions, and will take approximately 30-45 minutes to complete.

2.8 Assignments & Grading

Students will be required to complete laboratory exercises and take examinations. The course grade will be determined based upon the following categories. **Students taking all 4 knowledge exams will be given 50 extra-credit points that will contribute to their cumulative point score**.

Assignments/Exams	Points	Percentage
Examination I	200	20
Examination II	200	20
Final Examination	200	20
Lab Exercises	400	40
Total Points	1000	100

Final course grades will be determined by relative ranking of cumulative point scores. This usually equates to a scale of 90-100%(A), 80-89%(B), 70-79%(C), 60-69%(D), and $\leq$59%(F). Students should note that CANVAS scores and percentages do not account for assignment weightings associated with final grades, and should not be used to assess your status in the course.

3 Tentative Schedule

Week	Course Topic	Lab	Reading
1	Introduction to GIST		Chapter 1
2	Conceptual & Digital Representations		Chapter 2, 3, 9
3	Spatial Preprocessing & Manipulation I	Lab 1	Chapter 4
4	Spatial Preprocessing & Manipulations II		Chapter 6
5	Examination I		
6	Spatial Analysis: Metrics & Filtering	Lab 2	Chapter 4, 5
7	Spatial Analysis: Point Pattern Analysis		Chapter 4, 5
8	Spatial Analysis: Terrain Analysis		Chapter 6
9	Spatial Analysis: Object-Oriented Analysis	Lab 3	Chapter 8
10	Examination II		
11	Spatial Modeling : Regression and GWR		Chapter 5
12	Spatial Modeling: Criteria-Based Modeling	Lab 4	
13	Spatial Modeling: Agent-Based Modeling		Chapter 8
14	Spatial Modeling: Numerical Simulations		
15	Final Examination	Final	

This is a tentative list of topics and assignments. I reserve the right to make changes to the course schedule at any time.

4 Course Administrative Policies

4.1 Mode of Instruction

The mode of instruction for the Geography 475 course will be Face-to-Face. Laboratory instruction will also be conducted in this mode. The course will make use of the CANVAS learning management system to disseminate information and course content to students. Students should regularly check CANVAS for announcements, assignments and resources that will facilitate the learning objectives for the course. Tape-recording of lectures will not be allowed except in accommodation of a student disability, per Student Disability Services advisement.

4.2 Copyright Policy Statement

All materials used in this class are copyrighted. These materials include but are not limited to syllabi, quizzes, exams, laboratory exercises, in-class materials, review sheets, project assignments, and additional problem sets. Because these materials are copyrighted, you do not have the right to copy the handouts/data, or post materials to the internet unless permission is explicitly granted in writing.

4.3 Grading and Make-Up Policy

All assigned quizzes and exams will be graded on student effort and accuracy. All students will be required to complete quizzes and examinations during assigned times. In general, late quizzes and examinations will not be accepted and there will be NO MAKEUP EXAMS!!, unless a student has an excused absence. If you know that you will not be available for an examination, contact the instructor before the exam to reschedule it. The instructor reserves the right to decline scheduling for reasons that are deemed inappropriate (e.g., entertainment events).

For laboratory exercises, all students MUST attend the first laboratory meeting in order to receive credit for a lab. Laboratory instructors will establish due dates for all lab exercises, and they have the flexibility to extend due dates for students based upon a students situation or circumstances. Students should effectively communicate with their laboratory instructor. Late laboratory exercises will not be graded by the laboratory instructor.

5 University Policies

5.1 Attendance Policy

The University views class attendance and participation as an individual student responsibility. Students are expected to attend class and to complete all assignments. Please refer to Student Rule 7 in its entirety for information about excused absences, including definitions, and related documentation and timelines (http://student-rules.tamu.edu/rule07).

5.2 Make-up Work Policy

Students will be excused from attending class on the day of a graded activity or when attendance contributes to a students grade, for the reasons stated in Student Rule 7, or other reason deemed appropriate by the instructor. Please refer to Student Rule 7 in its entirety for information about makeup work, including definitions, and related documentation and timelines. Absences related to Title IX of the Education Amendments of 1972 may necessitate a period of more than 30 days for make-up work, and the timeframe for make-up work should be agreed upon by the student and instructor (Student Rule 7, Section 7.4.1).

The instructor is under no obligation to provide an opportunity for the student to make up work missed because of an unexcused absence (Student Rule 7, Section 7.4.2).

Students who request an excused absence are expected to uphold the Aggie Honor Code and Student Conduct Code. (See Student Rule 24)

5.3 Academic Integrity Statement and Policy

Academic dishonesty is regarded as a serious offense by the University, the Department of Geography, and the faculty. Academic dishonesty will result in a course grade of failure, regardless of the form of dishonesty. These include, but are not limited to, copying of laboratory assignments, copying of exam answers, plagiarism and cheating on taking examinations.

"An Aggie does not lie, cheat or steal, or tolerate those who do."

Texas A&M University students are responsible for authenticating all work submitted to an instructor. If asked, students must be able to produce proof that the item submitted is indeed the work of that student. Students must keep appropriate records at all times. The inability to authenticate your work, should the instructor request it, may be sufficient grounds to initiate an academic misconduct case (Section 20.1.2.3, Student Rule 20). You can learn more about the Aggie Honor System Office Rules and Procedures, academic integrity, and your rights and responsibilities at http://aggiehonor.tamu.edu.

5.4 Americans with Disabilities Act (ADA) Policy

Texas A&M University is committed to providing equitable access to learning opportunities for all students. If you experience barriers to your education due to a disability or think you may have a disability, please contact Disability Resources in the Student Services Building or at (979) 845-1637 or visit http://disability.tamu.edu. Disabilities may include, but are not limited to attentional, learning, mental health, sensory, physical, or chronic health conditions. All students are encouraged to discuss their disability related needs with Disability Resources and their instructors as soon as possible.

5.5 Title IX and Statement on Limits to Confidentiality

Texas A&M University is committed to fostering a learning environment that is safe and productive for all. University policies and federal and state laws prohibit gender-based discrimination and sexual harassment, including sexual assault, sexual exploitation, domestic violence, dating violence, and stalking.

With the exception of some medical and mental health providers, all university employees (including full and part-time faculty, staff, paid graduate assistants, student workers, etc.) are Mandatory Reporters and must report to the Title IX Office if the employee experiences, observes, or becomes aware of an incident that meets the following conditions (see University Rule 08.01.01.M1):

1. The incident is reasonably believed to be discrimination or harassment.
2. The incident is alleged to have been committed by or against a person who, at the time of the incident, was (1) a student enrolled at the University or (2) an employee of the University.

Mandatory Reporters must file a report regardless of how the information comes to their attention including but not limited to face-to-face conversations, a written class assignment or paper, class discussion, email, text, or social media post. Although Mandatory Reporters must file a report, in most instances, you will be able to control how the report is handled, including whether or not to pursue a formal investigation. The University's goal is to make sure you are aware of the range of options available to you and to ensure access to the resources you need. Students wishing to discuss concerns in a confidential setting are encouraged to make an appointment with Counseling and Psychological Services. Students can learn more about filing a report, accessing supportive resources, and navigating the Title IX investigation and resolution process on the University's Title IX webpage.

5.6 Statement on Mental Health and Wellness

Students who need someone to talk to can contact Counseling & Psychological Services (CAPS) or call the TAMU Helpline (979-845-2700) from 4:00 p.m. to 8:00 a.m. weekdays and 24 hours on weekends. 24-hour emergency help is also available through the National Suicide Prevention Hotline (800-273-8255) or at suicidepreventionlifeline.org.