GEOG 3120: Environmental/GIS Modeling (Spring Quarter 2025)

Class Time: Mon/Wed 2 – 3:50 PM
Classroom: Boettcher Center West (BW) 125

Instructor: Dr. Guiming Zhang
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Office hours: Mon/Wed 1 – 1:50 pm or by appointment.
Course materials are available on Canvas.

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Course Description

Facing challenges brought by the dramatically changing global environment, environmental modeling is increasingly used to support geographical and environmental decision making (e.g., spatial conservation prioritization). Environmental modeling is concerned with the characterization, modeling and simulation of environmental phenomena and processes using conceptual and mathematical models. Environmental phenomena and processes taking place in the geographic space are regulated by spatial principles. They also interact with other phenomena or processes in the attribute space. For example, species distribution is not only constrained by spatial factors such as proximity to other species, but also influenced by environmental factors such as terrain and climatic conditions. Due to its superior capabilities of handling spatial data and modeling spatial and attribute relationships, geographic information system (GIS) provides the ideal tools for environmental modeling.

This upper-level undergraduate/graduate-level course surveys the concepts and techniques of GIS supported environmental modeling in three general categories: 1) Modeling in the spatial domain where the focus is on modeling spatial principles (e.g., spatial autocorrelation); 2) Modeling in the attribute domain where the emphasis is on environmental correlations (e.g., environmental niche modeling); 3) Modeling in the combined spatial and attribute domain where both spatial principles and environmental correlations are exploited (e.g., geographically weighted regression). Throughout this course, several real-world applications are used to demonstrate the ideas, concepts, and techniques of GIS supported environmental modeling, including crime spatial pattern modeling, species distribution modeling, and soil-landscape modeling and mapping.

Learning Outcomes

Upon completion of this course, students should be able to:

- Understand the concepts and terms in GIS supported environmental modeling (e.g., spatial domain, attribute domain, spatial autocorrelation, environmental

correlation, etc.).

- Know the commonly used environmental modeling methods and their applications (e.g., kernel density estimation, kriging, Maxent, SoLIM, geographically weighted regression, regression-kriging, etc.).

- Be proficient in conducting environmental modeling using GIS software (e.g., ArcMap, ArcPro, QGIS and other specialized software packages).

- Comprehend the general steps of conducting environmental modeling.

- Apply the knowledge and skills of environmental modeling to real-world applications.

- Work individually or in a small team to conceive, plan and implement a final project, and effectively communicate findings.

- Appreciate the complexity of environmental phenomena and processes, and consciously assess the scientific validity of policies or claims pertaining to environmental issues.

Prerequisites

Students are expected to have taken GEOG 2100 - Introduction to Geographic Information Systems, and GEOG2000 - Geographic Statistics, or equivalent GIS/STATS/MATH courses.

Textbook

Required:

Fotheringham, Brunsdon, and Charlton. 2000. ***Quantitative Geography: Perspectives on spatial data analysis***. Thousand Oaks, CA: SAGE Publishing. ISBN: 9780761959489.

Students should have **access to the *electronic version* of this book through *DU library*.**

Additional readings will be posted on Canvas. Readings are journal articles and/or book chapters in the following *optional reference books*:

Barnsley. 2007. ***Environmental modeling: A practical introduction***. CRC Press. [A hard copy of this book is available at DU library]

Skidmore, ed. 2003. ***Environmental modelling with GIS and remote sensing***. CRC Press. [The electronic version of this book is available through DU library]

Brimicombe. 2010. ***GIS, environmental modeling and engineering***. CRC Press. [The electronic version of this book is available through DU library]

Isaaks and Srivastava. 1989. ***An Introduction to Applied Geostatistics***. New York: Oxford University. [The electronic version of this book is available through DU library]

Florinsky. 2016. ***Digital terrain analysis in soil science and geology***. Academic Press. [The electronic version of this book is available through DU library]

Franklin and Miller. 2009. ***Mapping species distributions: spatial inference and prediction***. Cambridge: Cambridge University Press. [The electronic version of this book is available through DU library]

Format

This course will run as a combination of lecture-discussion, and hands-on exercises. Each instructional period will take the following format:

- For each class period you are assigned a set of *readings* (to prepare for the new topic).
- At the beginning of each class, we can discuss any *questions* you may have on previous materials.
- Then we will discuss the new material for the day, led by the instructor or sometimes by students.
- After that you will work on in-class *exercises* to reinforce your learning.
- Time permitting, you may be given class time to work on the *assignments* or *projects*.

Course Requirements & Grading

Readings: Come prepared for each class period having completed the assigned *readings*. Readings are ungraded.

Exercises: For each instructional period, a set of exercises will be given. Exercises reinforce learning and understanding of conceptual ideas and technical skills. Exercises constitute **20%** of your overall grade.

Assignments: There will be **three** assignments. The assignments constitute **30%** of your overall grade.

Quiz: There will be **two** quizzes testing student's understanding of the course materials. The quizzes constitute **20%** of your overall grade.

Presentation: **Each student** be required to summarize and present a paper/article from the reading list to the class through a presentation (10 minutes long). The presentation constitutes **10%** of the overall grade for undergraduate students and **5%** for graduate

students.

Term project: Students will apply the concepts and skills they learned in this course by completing a term project of their choosing. The project constitutes **20%** of the overall grade for **undergraduate** students and **25%** for **graduate** students. **Graduate students are expected to complete a project of higher quality**. *Instructions for the term project will be posted on Canvas.*

	Undergraduate	Graduate
Exercises (weekly)	20%	20%
Assignments (3)	30%	30%
Quizzes (2)	20%	20%
Presentation	10%	5%
Term project	20%	25%
Total	**100%**	**100%**

Grading criteria:

93-100%	A
90-92.99%	A-
87-89.99%	B+
83-86.99%	B
80-82.99%	B-
77-79.99%	C+
73-76.99%	C
70-72.99%	C-
67-69.99%	D+
63-66.99%	D
60-62.99%	D-
< 60%	F

Policies

[1] **AI use policy:** AI is an important new tool that will undoubtedly be playing a role in the workplaces of the future. However, the use of AI is not appropriate in this class, given its learning goals. In this class, you are expected to develop reading, writing, and technical skills that will be essential to your future careers, as well as your ability to wisely use AI tools in the future. As such, **we expect that all work students submit for this course will be their own. We specifically forbid the use of ChatGPT or any other generative artificial intelligence (AI) tools at all stages of the work process, including preliminary ones.** Violations of this policy will be considered academic misconduct and will be subject to the DU Honor Code.

[2] **Assignment submission**: You are encouraged to submit all work electronically through the Canvas course website. However, if you prefer to complete work on papers, you can also turn in handwritten work for grading.

[3] **Late submission of exercises and assignments will result in automatic 10% reduction per day. Any submission more than a week late will receive 0 points.** You are expected to complete each exercise during the scheduled class session.

[4] **Academic Misconduct.** Most work submitted in this class is to be an individual effort (except for team project). Although working collaboratively on exercises/assignments in small groups (2-3 people) is allowed, **each student must complete and submit their own work**. Submitting the work of others, in total or in part, or providing work to others to be submitted as their own, **will result in a zero for the exercise/assignment.** For the consequences of violating the Academic Misconduct policy, refer to the University of Denver website on the Honor Code. See Student Rights & Responsibilities websites for information on the Student Conduct Policies and Procedures.

[5] **Special accommodations for students with disabilities.** Students who have disabilities or medical conditions and who want to request accommodations should contact the Disability Services Program (DSP); 303-871-3241; 1999 E. Evans Ave.; 4th floor of Ruffatto Hall. Information is also available online at https://studentaffairs.du.edu/disability-services-program.

[6] **Religious Accommodations**. University policy grants students excused absences from class or other organized activities or observance of religious holy days, unless the accommodation would create an undue hardship. You must notify me by the end of the first week of classes if you have any conflicts that may require an absence. It is your responsibility to make arrangements with me in advance to make up any missed work or in-class material.

[7] **Student Athletes**. If you are a student-athlete, you should inform me of any class days to be missed due to DU sponsored varsity athletic events in which you are participating. Please provide me with an absence policy form by the end of the first week of class. You will need to make up any missed lectures, exercises, and/or assignments.

[8] **Inclusive Learning Environments**: In this class, we will work together to develop a learning community that is inclusive and respectful. Our diversity may be reflected by differences in race, culture, age, religion, sexual orientation, socioeconomic background, and myriad other social identities and life experiences. The goal of inclusiveness, in a diverse community, encourages and appreciates expressions of different ideas, opinions, and beliefs, so that conversations and interactions that could potentially be divisive turn instead into opportunities for intellectual and personal enrichment.

A dedication to inclusiveness requires respecting what others say, their right to say it, and the thoughtful consideration of others' communication. Both speaking up and listening are valuable tools for furthering thoughtful, enlightening dialogue. Respecting one another's individual differences is critical in transforming a collection of diverse individuals into an inclusive, collaborative and excellent learning community. Our core

commitment shapes our core expectation for behavior inside and outside of the classroom.

[9] **Title IX**: Gender violence can happen to anyone regardless of race, class, age, appearance, gender identity, or sexual orientation. The University of Denver is committed to providing an environment free of discrimination on the basis of sex (gender), including sexual misconduct, sexual assault, relationship violence, and stalking. The Center for Advocacy, Prevention and Empowerment (CAPE) provides programs and resources to help promote healthy relationships, teach non-violence and equality, and foster a respectful and safe environment for all members of the University of Denver community. All services are confidential and free of charge.

For assistance during business hours, call 303-871-3853 and ask to speak to the Director of CAPE. After hours, please call the Emergency & Crisis Dispatch Line at 303-871-3000and ask to speak to the CAPE advocate on call.

[10] **Communication**: For any questions, please either come to my office hour, post on the Canvas course discussion forum, send Canvas messages emails to the instructor. The instructor will closely monitor these channels and usually will respond within 24 hours.

Course Calendar (**E**: Exercise; **A**: Assignment; **P**: Project; **Q**: Quiz)

The following class schedule is subject to change. You are responsible for keeping up with the readings, lectures, quizzes, and assignments. Any changes to this schedule will be announced in class and posted to the course Canvas page.

Week	Topics	Readings	Learning Activities
Week 1	Course intro	On Canvas	
Mon Wed	Intro to Env/GIS modeling Environmental data		**E**: Environmental data acquisition
Week 2	Modeling in Spatial Domain	On Canvas	**A**: A1 posted
Mon Wed	Kernel density estimation (KDE) KDE (cont.)		**E**: Modeling occurrence probability of Lark Bunting in CO using KDE
Week 3	Modeling in Spatial Domain	On Canvas	
Mon Wed	Inverse distance weighting (IDW) IDW (cont.)		**E**: Modeling average hourly rainfall in CO
Week 4	Modeling in Spatial Domain	On Canvas	**A**: A2 posted
Mon Wed	Ordinary Kriging (OK) OK (cont.)		**E**: Modeling Soil Organic Carbon (SOC) using OK
Week 5	Terrain Analysis	On Canvas	
Mon Wed	Digital Terrain Analysis (DTA) DTA (cont.)		**Q: Quiz 1** **E:** Deriving terrain attributes from DEM
Week 6	Modeling in Attribute Domain	On Canvas	**A**: A3 posted
Mon Wed	Digital soil mapping (DSM) Species distribution modeling (SDM)		**E:** Soil mapping using SoLIM/iPSM **E:** Compute AUC

Week 7	Modeling in Attribute Domain	On Canvas	
Mon Wed	SDM (cont.) Geographically weighted regression (GWR)		**E:** MAXENT tutorial **E:** Modeling SOC using GWR
Week 8	Modeling in Spatial & Attribute Domain	On Canvas	
Mon	Regression-kriging (RK)		**E:** Modeling SOC using RK
Wed	**Q: Quiz 2**; **P**: Proposal presentation		
Week 9	Term Project		
Mon	No Class (Memorial Day)		
Wed	P: Project implementation		
Week 10	Term Project		
Mon	P: Project implementation		
Wed	**P**: Project presentation		
Week 11			

* All due dates are 11:59 PM Sunday in that week.