GGS 590: GeoAI

Course Syllabus, Spring 2026, 3 Credits

Instructor: Ed Oughton

Email: eoughton@gmu.edu

Location: 2103 Exploratory Hall (in-person)

When: Thursday 16:30 – 19:10 hrs

Learning Assistants (LAs): N/A

Prerequisites: None (but people without any coding experience may struggle)

Contact method: Canvas discussion board for content related queries (preferred) and/or direct email for anything personal (eoughton@gmu.edu).

OVERVIEW & OBJECTIVES

This GeoAI course examines artificial intelligence (AI) as a practical and applied tool for solving geospatial problems through code-based methods. Building on foundational programming and spatial computing skills, the course emphasizes how AI-assisted workflows can improve on traditional GIS analysis, rather than replace it. Students will explore how contemporary AI-tooling can be used to write, debug, refactor, test, and document geospatial code, enabling more efficient and flexible spatial analysis and automation. Throughout the course, students will use these techniques to address complex geographic questions involving spatial data analysis. Particular attention is given to evaluating the correctness and reliability of AI-assisted solutions, including the design of testing and validation strategies for GIS codebases to ensure workflows behave as intended and produce reproducible results. The course also encourages critical reflection on the limitations associated with AI tool usage in geospatial domains. By the end of the course, students will be prepared to responsibly integrate AI into geospatial workflows and to make informed methodological choices when addressing complex spatial problems.

LEARNING OUTCOMES

The key learning objectives of this class include:

1. Explain the role of AI in geospatial analysis, including how AI-assisted workflows differ from and extend traditional GIS and spatial computing approaches.
2. Use AI tools effectively to design, write, debug, and refactor geospatial code, demonstrating the ability to translate geographic problems into computational tasks.
3. Integrate AI-generated code with established geospatial libraries and platforms (e.g., Python-based GIS ecosystems) to automate GIS workflows.

4. Critically evaluate AI-assisted geospatial solutions, including assessing correctness, spatial validity, computational efficiency, and potential sources of error or bias.
5. Develop and implement testing and validation strategies for AI-augmented GIS spatial workflows.
6. Formulate geographic questions and solve them using AI-enhanced geospatial methods, selecting appropriate tools.
7. Reflect on the limitations of AI in geospatial practice, including issues of transparency, reliability, data quality, and over-reliance on automated solutions.

TIME COMMITMENT

Generally, it is expected that students have some working knowledge of Python. If you do not, then there will be a substantial time commitment. For example, when learning any new language (computer-based or natural), it takes significant effort to progress to fluency. Approximately 10-20 hours of weekly effort is expected outside of class (on assignments, exercises or further reading), with this effort hopefully rewarded later via the job market (as these skills usually translate to higher salaries). If you already have programming experience, this requirement is slightly minimized.

GGS COMPUTER LAB, ASSIGNMENTS, & EXPECTATIONS

GGS students have remote access to the GGS Virtual Computing Lab, although everything for this class should be available via the associated GitHub page (with content going up weekly). Affiliated Google Colab notebooks can be run via a web browser. Thus, all documents, notes and code are available from this single location.

If you do not intend to use the computer lab, then you will need a machine with at least 2 GB RAM, along with a fast and reliable broadband connection (e.g., > 10-20 Mbps). It may also be useful to have a web camera with a microphone in case any additional Zoom sessions are required (or if class is cancelled due to bad weather).

Students will also need to have access to a general piece of GIS software to quickly check/inspect any spatial processing, e.g., via ESRI ArcGIS Pro (licensed) or QGIS (open-source and preferred). Please be aware this is a coding-focused class that will use either of these pieces of software as secondary tools. Students should not expect or seek to use these tools primarily in this class. This is not a class which focuses on GIS analysis using graphical user interfaces (GUIs).

Assignments will be based on the lecture material you receive and will be administered via Canvas. Generally, assignments will be set on a Thursday and will be due the following Wednesday evening (except when noted in the Course Schedule). Late work will be penalized 20% for each day late. Late submissions will only go unpenalized for documented medical reasons or by previous agreement with the instructor (e.g., raised at the time the assignment is set).

Each student gets the opportunity to drop the two worst performing assignments from the overall score at the end of the semester. Take comfort in the fact that it is highly unlikely that three events justifying extenuating circumstances would occur in a single semester. Thus, the course grading criteria is already accounting for unfortunate events. No additional requests will be accommodated unless the extenuating circumstances are highly serious (in which case the university and course director will already be aware of the issue).

The overall grade is comprised of three key sets:

GRADING		
Assessment	**Points**	**%** (of final grade)
Assignments (6)	100 each	50%
Multiple-Choice Exam	250	25%
Coursework project	250	25%

The exam will consist of ~20 multiple-choice questions.

Grading will be based on the following cutoff values, although the instructor reserves the right to alter the values at the end of the course:

A (93%), A- (90%), B+ (87%), B (83%), B- (80%), C+ (77%), C (73%), C- (70%), D (60%)

The coursework project will include the use of techniques taught throughout the entire semester but applied to your own research topic. Students will be expected to submit assignments online through Canvas. Only Adobe PDF (.pdf) file formats will be accepted (students can save documents to a .pdf format for submission).

OPTIONAL TEXTS

There are many open and free resources for learning Python. Importantly, all the information you require will be provided in the course. However, should you require additional information, for example relating to programming languages, there are many options. Check out Al Sweigart's Automate the Boring Stuff with Python which is free to read and provides practical programming for total beginners. You can also check out Ed's YouTube channel for videos on Python-based GIS.

OFFICE HOURS AND INSTRUCTOR INTERACTION

Office hours will be held on Thursdays from 16.00 – 16.30 hrs prior to each class. Each student is expected to attend office hours at least once per semester. When emailing, a timely response is expected during office hours Monday-Friday. If you have a course-related question, the first port of call will be to place it on the Canvas discussion board. This is because other people may ask similar questions, so this becomes a shared knowledge base everyone can access. If you need to speak about something more

personal with the instructor, then you can reach out via email. Drop-in virtual Q&A sessions can also be held by request (e.g., Monday, Tuesday or Wednesday 8pm) to seek advice on assignments and coursework.

PROBLEM SOLVING

It is inevitable that problems will arise, especially when working on Python coding problems. Therefore, it is essential that students follow a set of key procedures when dealing with any coding issues encountered. These are as follows:

1. Copy and paste any error messages into a search engine (e.g., Google) or GenAI. Someone else will already have had the same problem, so investigate how other researchers solved similar issues.

2. If you still cannot solve the problem, then consider posting a public question on the Canvas discussion board.

EXTRA CREDIT

Extra credit will be awarded for students who either take on extracurricular GeoAI-related activities, or complement their academic studies with (non-)competitive exercise or mental health activities. These extra credit activities will include:

1. Engagement in a research conference, or some extra GeoAI external activity (beyond any existing GRA responsibilities), which expand your understanding of the topic (20 points).

2. 100% class completion rate of the course evaluation survey (10 points).

3. Either (i) a 10% improvement in a sporting activity or (ii) at least six nature walks over the semester of 45 minutes. To be eligible for (i) you need to post starting and ending evidence, and for (ii) you need to post evidence from each walk (photo, fitness watch data, smartphone screengrab etc.). Find the discussion topic on Canvas to post your extra credit activities (20 points).

ACADEMIC INTEGRITY

GMU has an Honor Code with clear guidelines regarding academic integrity. Three fundamental and rather simple principles to always follow are that: (1) all work submitted be your own; (2) when using the work or ideas of others, including fellow students, give full credit through accurate citations; and (3) if you are uncertain about the ground rules on a particular assignment, ask for clarification. No grade is important enough to justify academic misconduct (e.g., plagiarism). Another aspect of academic integrity is the free play of ideas. Vigorous discussion and free speech debate are encouraged, with the

expectation that all aspects of the class will be conducted with civility and tolerance for differing ideas, perspectives, and traditions.

AI USE POLICY

This class recognizes the increasing role that AI tools play in everyday life. Consistent with the GMU AI Guidelines for Instructors and University academic integrity expectations, you are expected to use AI tools responsibly, transparently, and in ways that support your own learning and the course learning outcomes. Here, you may use AI tools to support your assignments and coursework project, but these tools will not be allowed in the exam. To ensure you comply with GMU policies on this topic, make sure you read and understand the AI guidelines for students: https://www.gmu.edu/ai-guidelines/ai-guidelines-students

GMU EMAIL ACCOUNTS

Students must use their Mason email account to receive important University information, including messages related to this class. See http://masonlive.gmu.edu for more information. Please do not email the instructor from a non-GMU email account.

OFFICE OF DISABILITY SERVICES

If you are a student with a disability and you need academic accommodations, please contact the instructor and the Office of Disability Services (ODS) at 993-2474, http://ods.gmu.edu. All academic accommodations must be arranged through the ODS.

GMU RESOURCES

The Writing Center: https://writingcenter.gmu.edu
University Libraries, Ask a Librarian: https://library.gmu.edu/ask
Counseling and Psychological Services: https://caps.gmu.edu
University Catalog: https://catalog.gmu.edu
University Policies: https://universitypolicy.gmu.edu

COURSE OUTLINE

Week	Topic	Coursework
Week 1: Jan 22nd	Introduction and course overview. What is GeoAI. AI as a coding partner. Python refresh and Colab.	Background reading
Week 2: Jan 29th	Problem formulation for GeoAI workflows.	Assignment 1
Week 3: Feb 5th	Code generation for GeoAI workflows.	Assignment 2
Week 4: Feb 12th	Debugging and refactoring for GeoAI workflows	Assignment 3
Week 5: Feb 19th	Spatial results validity for GeoAI workflows (e.g., techniques for producing correct results)	Assignment 4
Week 6: Feb 26th	Testing and validation for AI-augmented GeoAI workflows	Assignment 5
Week 7: Mar 5th	AI-supported automation for GeoAI workflows	N/A Spring Break
Spring Break		
Week 8: Mar 19th	Uncertainty and bias for GeoAI workflows	Multiple-Choice Exam
Week 9: Mar 26th	System design for GeoAI workflows	Assignment 6
Week 10: April 2nd	Coursework Project Introduction	Coursework Project
Week 11: Apr 9th	Coursework Project	Coursework Project
Week 12: Apr 16th	Coursework Project	Coursework Project
Week 13: Apr 23rd	Coursework Project	Coursework Project
Week 14: Apr 30th	Coursework Project	Coursework Project
Week 15: May 7th	Coursework Project Submission	-

Note: The course schedule is tentative and is subject to revision by the instructor