GGS 416: Satellite Image Analysis

Course Syllabus, Spring 2026, 3 Credits

Instructor: Ed Oughton

Email: eoughton@gmu.edu

Location: 2310 Exploratory Hall (in-person)

When: Monday 13:30 – 16:10

Teaching Assistant (TAs): Dante Groccia (dgroccia@gmu.edu)

Pre-requisites: 60 credits and/or GGS 366/412, or permission of instructor.

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

OVERVIEW & OBJECTIVES

Satellite imagery has become a primary data source in the natural sciences, economics, archaeology, sustainability, and many other domains which utilize geospatial intelligence. Indeed, the wide variety of imagery sources and the vast amounts of data being collected are now challenging our ability to manage, process, and derive useful insight from this information. Motivated by this, the primary objective of the course is to provide a systematic introduction to computer-based processing of satellite imagery, including techniques for enhancing, processing, and extracting spatial information from imagery. This course emphasizes the practical application of computer-based image processing (for total beginners) using programming techniques capable of analyzing large quantities of imagery.

LEARNING OUTCOMES

1. Understand practical computer programming techniques for processing satellite imagery.
2. Develop introductory Python script-based approaches for image segmentation, image classification, object detection and extraction.
3. Become proficient in using essential computer programming packages, tools and other software (Jupyter Notebooks, GitHub etc.).

TIME COMMITMENT

Generally, it is expected that students have some working knowledge of Python. If you do not, then there will be more of a 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 processing 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 word documents as a .pdf format from within the program).

OPTIONAL TEXTS

There are many open and free resources for learning satellite image processing using 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. Further readings, if any, will be announced in class or by e-mail.

COURSE RESOURCES

Content for GGS416 will be available on the course GitHub page. You will need to have access to a computer with a stable Internet connection. It may also be useful to have a web camera with a microphone in case any additional Zoom sessions are required. If you have a laptop, it is best to bring the same one to class each week for consistency.

OFFICE HOURS AND INSTRUCTOR INTERACTION

Office hours will be held on Mondays from 16.10 – 16.30 hrs. 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. Succinct emails are likely to increase the efficiency of an answer.

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 satellite image analysis related activities, or complement their academic studies with (non-)competitive exercise or mental health activities (to boost cognitive performance and wellbeing). These extra credit activities will include:

1. Engagement in a research conference, or some extra satellite image analysis external activity (beyond any existing 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).

FUNDING ACKNOWLEDGEMENT

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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.

STUDENT AI USE POLICY

This class recognizes the increasing role that AI tools play in everyday life. Consistent with the GMU AI Guidelines for Students 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

INSTRUCTOR AI USE POLICY

This course is compliant with the AI Guidelines for Instructors adapted from the George Mason AI Task Force (as of February 2nd, 2026). All instructional decisions are accountable to the instructor, even when AI supports course content creation. As expected in industry, given this is a computer programming class, Generative AI tools are used to help create code, from possible examples to possible exercises. However, all content is heavily adapted, checked and validated by the instructor to ensure a very high quality of delivery, using expert judgement honed over 15 years of experience in the higher education research sector. AI is used to enhance but not replace independent thought. Importantly, integrity is a core part of this class. Therefore, it is expected that students comply with George Mason student AI usage, in the same way it is essential for professors to comply with relevant instructor guidelines.

GMU EMAIL ACCOUNTS

Students must use their MasonLive 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.

STUDENTS AS SCHOLARS

Students as Scholars is GMU's award-winning initiative to give students the opportunity to conduct undergraduate research. If you are interested in conducting research or simply learning more about the program, check out oscar.gmu.edu or stop by the Office of Student Scholarship, Creative Activities, and Research to learn about the many programs available to GMU students. All students are encouraged to convert their projects into proposals for further student funding.

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 26th	Introduction and course overview. Jupyter notebooks, Python and loading an image.	Background reading
Week 2: Feb 2nd	Image operations and more introductory Python (basic data structures, functions, etc.).	Assignment 1
Week 3: Feb 9th	Image segmentation, part 1	Assignment 2
Week 4: Feb 16th	Image segmentation, part 2	Assignment 3
Week 5: Feb 23rd	Image classification, part 1	Assignment 4
Week 6: Mar 2nd	Image classification, part 2	N/A Spring Break
Spring Break		
Week 7: Mar 16th	Object detection, part 1	Assignment 5
Week 8: Mar 23rd	Object detection, part 2	Multiple-Choice Exam
Week 9: Mar 30th	Scaling satellite image analysis, part 1	Assignment 6
Week 10: April 6th	Scaling satellite image analysis, part 2	Coursework Project
Week 11: April 13th	Intro to the coursework project	Coursework Project
Week 12: Apr 20th	Coursework project	Coursework Project
Week 13: Apr 27th	Coursework project	Coursework Project
Week 14: May 4th	Coursework project	Coursework Project
Week 15: May 11th	Coursework project submission	-

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