GEOG 5222: GIS Programming and Algorithms

The Ohio State University
Spring 2021

Course URL

http://carmen.osu.edu

Instructors

Prof. Ningchuan Xiao | xiao.37@osu.edu

Ms. Polina Berezina | berezina.2@buckeyemail.osu.edu

Office hours

Day	Time and link	Passcode	Instructor
Monday	10-11 AM	399066	Dr. Xiao
Wednesday	10-11 AM	399066	Dr. Xiao
Thursday	1-3 PM	781992	Ms. Berezina

This class is about coding. More specifically we learn how to program a computer to handle spatial data. It is obvious, one may argue, that today's software are often quite easy to use and they are quite powerful too. So why should we do coding?

Coding is fun. In his book *The Mythical Man-month*, Frederick P. Brooks, Jr. talked about the reward of coding as the sheer joy of making things. Others agree. In a 1984 New York Times piece, Erik Sandberg-Diment gave three reasons of programming: "First, it allows you to develop software that is not available commercially, and in some cases it lets you customize purchased software to serve your specific needs better. Second, programming can be fun. If you enjoy working on puzzles, programming may well turn out to be more pleasurable than solving The Times crossword puzzle or Dr. Crypton's mind-bending puzzle page in Science Digest. Third, there is the intellectual exercise, the honing of logic skills and learning to learn, stressed by pedagogues as a perfect reason to have computers available in schools for pupils from kindergarten age on up." In a blog at Invent with Python, Al Sweigart pointed out that "Programming transforms your computer from a home appliance to a power tool." It is apparent that writing computer code is becoming an essential part of life. As Steve Jobs once put it, "everybody in this country should learn to program a computer...because it teaches you how to think."

In this class, we aim to help students gain freedom in dealing with spatial data. After completing this class, students will develop understanding on how spatial data works and how to write their own code to handle the data, instead of relying on existing (especially commercial) software packages. We use the powerful and most popular Python programming language in this class. We start from the basics of Python. About half way through the semester, we should have developed sufficient knowledge about programming with Python and will start to use it on spatial datasets. Most of the materials do not rely on existing software packages, which will provide an intuitive

way of understanding spatial data and spatial data processing. By the end of the semester, students should understand the fundamental considerations of computational issues in spatial data processing and should be able to write Python code to complete various tasks of using spatial data.

Course learning outcomes

By the end of this course, students should be able to:

- Understand and apply fundamental constructs and styles of programming using Python
- Understand the basics of computational issues such as time complexity and indexing
- Develop and test computer programs to handle spatial data sets
- Develop and test Python programs for basic geometric processing
- Understand basic spatial indexing methods for point data sets
- Write Python programs to conduct spatial analysis and visualization

How this course works

This is an asynchronous course, meaning students are not required to log in at any certain time.

Pace of online activities. This course is divided into weekly modules and each module is released before the start of the week. A module is organized around a specific topic (see course schedule for details) and may consist of introduction videos, coding tutorials, and other activities (see assignment information below). Students are expected to keep pace with weekly deadlines but may schedule their efforts freely within that time frame.

This course is delivered in hybrid mode. A "normal" hybrid course may have its own required hours and policies. However, due to the outbreak of COVID-19, we must closely follow OSU safety guidelines with extra caution to make sure all students and the instruction team are safe and healthy throughout the semester. Consequently, this course is mostly online and no students are required to come in person to the classroom. Students will have the option to sign up for in-person office hour meetings with Dr. Xiao. There will be no sign-up for the first two weeks, and availability for the following weeks will be announced whenever situations allow. It should be made clear that this course is fully ready for distance learning and we do not anticipate any issues that cannot be resolved through virtual office hours.

Credit hours and work expectations. This is a 3-credit-hour course. According to Ohio State policy, a 3 credit hour course comprises 3 hours of direct instruction (including online instruction content and Carmen activities) and 6 hours of homework/study time outside class per week, for a total of 9 hours per course per week, for the student to earn a C grade. Of this allocated time, one 50 minute session will be held in person.

Technical Requirements

The minimum technical requirements for this class include the following:

- Computer: current Mac or PC with high-speed internet connection
- Microphone: built-in laptop or tablet mic or external microphone
- Webcam: built-in or external webcam, fully installed

Your computer must be able to access Carmen online, which requires a modern web browser. In order to view the embedded images in the tutorials, you need to install FireFox on your computer. A recent version of Python 3 must also be installed. We will use video in this class, which should be supported by most modern web browsers. CarmenZoom will generally require a microphone and camera on the computer for best communication.

Reliable access to the internet is essential. Internet access may not be used as an excuse for late, missing, or incomplete submissions. It is students' responsibility to ensure reliable connections.

To familiarize with CarmenZoom, please visit https://resourcecenter.odee.osu.edu/carmenzoom/getting-started-carmenzoom.

Textbooks and Other Materials

Two textbooks are required for this class:

Allen B. Downey. 2016. **Think Python**. 2nd Edition. O'Reilly Media.
Ningchuan Xiao. 2016. **GIS Algorithms**. SAGE Publications.

A GitHub site repository at http://github.com/gisalgs will be used intensively for most part of the class. We will only access this repository through a web browser. This is a public website and everyone can access. The detailed accessibility statement of GitHub can be found at https://government.github.com/accessibility. The privacy statement of GitHub can be found at https://help.github.com/en/github/site-policy/github-privacy-statement.

Tutorials and lecture notes will be made available through the course schedule page on Carmen. There are also numerous useful online sources for learning Python. For example, The Hitchhiker's Guide to Python! (https://docs.python-guide.org/) has information that can be extremely practical for many beginners. The official Python Tutorial (https://docs.python.org/3/tutorial/) is a good place to find the details on most of the topics in Python coding (make sure to choose the right version on top of the page).

Schedule

The overall course contents are divided into a few major topics:

Weeks 1-6: Python programming language
Weeks 7-10: Geometric algorithms
Weeks 10-14: Spatial indexing
Weeks 15-16: Applications

A detailed schedule can be found on the course page on Carmen. Students should check this page frequently as it will be updated whenever new materials are made available. Important notes regarding the course will also be posted on the home page.

Grading and faculty response

Assignment category	Percent
Exercises	30

Assignment category	Percent
Homework	20
Final projects	20
Quizzes	20
Participation	10
Total	100

Assignment information

The assignments are organized to provide multiple lower stakes opportunities. While they will build of learning from various modules. There are no cumulative high stakes assignments.

- **Exercises:** There are some questions after finishing each online tutorial. These are typically reflection questions that are used to make sure students have completed the contents. Quick feedbacks will be provided to students. Exercises are due by the end of module, which is typically on a Sunday.

- **Homework:** For each major topic on the course schedule, there will be a homework assignment that includes some more in-depth questions. These questions typically require more intensive coding efforts and students have about two weeks to finish.

- **Quizzes:** Quiz will be given after we finish a major topic. These are open-book quizzes that will require students use the computer to answer. These quizzes are intensive coding exercises that require students to finish in a fixed timeframe of 60 minutes.

- **Final projects:** A list of guided questions will be provided in the middle of the semester and each student will choose to answer one of these questions. The questions will be based on the topics covered in the semester. Only sufficient information will be provided, which means I will not provide all the implementation details for the questions and students must find solutions by themselves. There will also be open questions that give students a lot of freedom to choose their own project. The open questions will require a short proposal from the students.

- **Participation:** At the end of each module, we will post questions on the discussion board and students are required to post their responses. In addition, some discussions may also require students to peer-review each other's work.

- **Before you go...:** There is also an online and open-book quiz at the end of each module. This quiz is not graded and students must correctly answer all the questions in that quiz to finish the module. Students can take multiple rounds to pass that quiz.

Faculty feedback and response time

The following list outlines the intended availability of the instruction team throughout the course. (Remember that you can call 614-688-HELP at any time if you have a technical problem.)

Grading and feedback For the exercises, students should be able to see the grade and feedback in 2 to 5 days after the due dates. For large assignments (homework and projects), the timeframe to expect feedback is generally 7 to 14 days.

E-mail E-mails will be replied within 48 hours, and we aim for 24 hours during school days.

Discussion board We will check and reply to messages in the discussion boards regularly on school days.

Office Hours In addition to the virtual office hours, students may request other times to meet with the instruction team. Please give at least 24 hours notification and it will only be offered during school days.

Important Class Policies

Late assignments: Late submissions will be accepted up to a week past the due date. One day late will incur a 10% penalty. Two days late will incur 20% penalty. Three days will incur a 30% penalty. Four days late will incur a 40% penalty. Five to seven days late will only receive 50% credit of the grade you would have received if it was submitted on time. If you contact me ahead of time for deadline adjustments you will not incur any penalty. Please refer to Carmen for due dates.

- **Deliverables**. All deliverables must be submitted on Carmen as specified in the homework/project instructions. There will be absolutely **no email submissions**. Email submissions of work for this class will not be acknowledged and will not be accepted.

- **Do your own work**. Collaboration is healthy and often necessary, but each student should definitely finish the work individually. Please see below for more information about academic misconduct.

- **Communication**. The only official way to communicate with the TA and myself is through our OSU email addresses as listed on the top of the syllabus. We cannot guarantee that we will reply messages through any other methods. We normally will reply emails in a day (except weekends or holidays).

Student with Disabilities

The University strives to make all learning experiences as accessible as possible. If you anticipate or experience academic barriers based on your disability (including mental health, chronic or temporary medical conditions), please let me know immediately so that we can privately discuss options. You are also welcome to register with Student Life Disability Services to establish reasonable accommodations. After registration, make arrangements with me as soon as possible to discuss your accommodations so that they may be implemented in a timely fashion. The web site of SLDS is slds.osu.edu, and its contact information is slds@osu.edu, 614-292-3307, 098 Baker Hall, 113 W. 12th Avenue.

Health and Safety Requirements

Health and safety requirements: All students, faculty and staff are required to comply with and stay up to date on all university safety and health guidance (https://safeandhealthy.osu.edu),

which includes wearing a face mask in any indoor space and maintaining a safe physical distance at all times. Non-compliance will be warned first and disciplinary actions will be taken for repeated offenses.

Policy on Plagiarism and Academic Misconduct

If I suspect that a student has committed academic misconduct in this course, I am obligated by University Rules to report my suspicions to the Committee on Academic Misconduct. The term "academic misconduct" includes all forms of student academic misconduct wherever committed, illustrated by, but not limited to, cases of plagiarism and dishonest practices in connection with examinations. It is the responsibility of the Committee on Academic Misconduct to investigate or establish procedures for the investigation of all reported cases of student academic misconduct. Instructors shall report all instances of alleged academic misconduct to the committee (Faculty Rule 3335-5-487). For additional information, see the Code of Student Conduct at http://studentlife.osu.edu/csc/.

The following is a list of other useful sources of information on academic misconduct and academic integrity:

- The Committee on Academic Misconduct web pages: COAM Home
- Ten Suggestions for Preserving Academic Integrity
- Eight Cardinal Rules of Academic Integrity
- How to Avoid Plagiarism