



## GIS 322: Programming Principles in GIS II

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### Course Information

#### Course Description:

This course will introduce advanced programming principles in GIS with cutting-edge tools and real-world examples. This includes revealing the mysterious veil of how GIS operations are implemented under the hood in commercial or open-source GIS software, handling geospatial data using open-source Python libraries, understanding and applying essential geoprocessing tools and spatial analysis methods to solve real-world problems, and visualizing data in the forms of static and interactive maps.

In this course, we learn to program using the most popular programming language for 2019: Python. A comprehensive programming training process including computer programming, programming syntax, data types, data structure, control structures, essential open-source libraries and an integrated interactive programming environment (Jupyter notebook) will be introduced. We will also examine several technical aspects of GIS related to algorithms. They include some fundamental concepts in computational geometry, computer graphics, common analytical algorithms used in the GIS environment, and features represented by points, lines, polygons, and volumetric objects. The course will provide hands-on experience by implementing some algorithms.

A term project and some short homework will help students develop the skill and capability to understand spatial data structure, implement spatial algorithms, learn popular open-source geospatial libraries and visualize spatial analytics via maps. Students will also develop a solid and in-depth understanding of the geographic system internal organization and operations related to spatial data handling and analysis. Potentially students will develop the ability to solve geographically related problems at the modeling & algorithm level.

**Credits:** 3

**Prerequisites:** GIS 222 with a grade of C or better

# Faculty Information

**Instructor:** Ziqi Li

**Contact Info:** [lziqi@asu.edu](mailto:lziqi@asu.edu) (<mailto:lziqi@asu.edu>)

**Office Hours:** By appointment


## Course Learning Outcomes

At the completion of this course, students will be able to:

1. Represent geographic phenomena and processes in GIS using Python.
2. Explain how GIS operations, such as proximity and intersection, are implemented in open-source software.
3. Conduct advanced geo-processing and spatial analysis in Python using popular open-source libraries.
4. Visualize spatial data to convey information.

## Course Materials

There is no required textbook. But the following books and websites will serve as references:

- Stephen Wise, GIS Basics, Taylor & Francis, 2002 (Recommended)
- Official Python Documentation: [Link](http://docs.python.org/tut/tut.html) (<http://docs.python.org/tut/tut.html>)
- **Zelle, J. (2010) Python Programming: An Introduction to Computer Science, Second edition. Franklin, Beedle & Associates.** (<https://mcsp.wartburg.edu/zelle/python/ppics2/index.html>)
- **(2015) Learning Geospatial Analysis with Python - Second Edition. Packt Publishing.** 
- User manuals of essential Python libraries: **geopandas** (<http://geopandas.org/>), **shapely** (<https://shapely.readthedocs.io/en/stable/manual.html>), **folium**, (<https://python-visualization.github.io/folium/>) and **bokeh** (<https://bokeh.pydata.org/en/latest/>)

## Course Access

Your ASU courses can be accessed by both [my.asu.edu](http://my.asu.edu) (<http://my.asu.edu>) and [myasucourses.asu.edu](http://myasucourses.asu.edu) (<http://myasucourses.asu.edu>); bookmark both in the event that one site is down.

## Computer Requirements

This course requires the following technologies:

- Web browsers ([Chrome](https://www.google.com/chrome/) (<https://www.google.com/chrome/>), [Mozilla Firefox](http://www.mozilla.org/en-US/firefox/new/) (<http://www.mozilla.org/en-US/firefox/new/>), or [Safari](http://www.apple.com/safari/) (<http://www.apple.com/safari/>))
- [Adobe Acrobat Reader](http://get.adobe.com/reader/) (<http://get.adobe.com/reader/>) (free)
- [Adobe Flash Player](http://get.adobe.com/flashplayer/) (<http://get.adobe.com/flashplayer/>) (free)
- Webcam, microphone, headset/earbuds, and speaker
- Microsoft Office ([Microsoft 365 is free](https://myapps.asu.edu/app/microsoft-office-2016-home-usage) (<https://myapps.asu.edu/app/microsoft-office-2016-home-usage>) for all currently-enrolled ASU students)
- Reliable broadband internet connection (DSL or cable) to stream videos.

*Note:* A smartphone, iPad, Chromebook, etc. will not be sufficient for completing your work in ASU courses. While you will be able to access course content with mobile devices, you must use a computer for all assignments, quizzes, and virtual labs.

## Student Success

Students are expected to spend about 6 hours for each credit each week. For three credits, students would then spend about 18 hours a week for a total of 144 hours for a 6-week course. To be successful:

- check the course daily
- read announcements
- read and respond to course email messages as needed
- complete assignments by the due dates specified
- communicate regularly with your instructor and peers
- create a study and/or assignment schedule to stay on track
- access **ASU Student Resources** (<https://eoss.asu.edu/resources>)

## Grading

Your grade will be determined based on the following grading schema:

Grade	Points
A+	95-100
A	90-94
B+	85-89
B	80-84
C	70-79
D	60-69
E/F	Below 59

## Assignments

We will have eight modules in total - Module 0 is for an overview of the class. Please take it before you start the class. Modules 1-6 contain main class materials. In each module, you will have a small quiz (**2.5pt**) along with a coding assignment (**10pt**). Detailed requirements and rubric can be found in each module. Submission of each week's assignment is also expected to be done here.

## Final Project

You will have a final project due in Module 7. This project is scaffolded and you will have two due dates throughout the

course:

- The project proposal due by **the end of Module 4 (Nov 13)**.
- The final report and code you developed for the project is due **by the end of Module 7 (Dec 4)**.

Visit [Module 0: Final Project - Overview](#) for more information about the project.

## Point Structure

Syllabus quiz	5 points
Module quiz X 6	2.5 points each, 15 points total
Module assignment X 6	10 points each, 60 points total
Final project proposal	5 points
Final project	15 points
Total	100 points

## Submitting Assignments

All assignments, unless otherwise announced, **MUST** be submitted to the designated area of Canvas. Do not submit an assignment via email. For the module assignment, you need to submit your iPython Jupyter Notebook (**with .ipynb extension, containing intermediate output results**) **as well as any other requested results (e.g. a map)**.

Assignment due dates follow Arizona Standard time. Click the following link to access the [Time Converter](http://www.thetimezoneconverter.com/) (<http://www.thetimezoneconverter.com/>) to ensure you account for the difference in Time Zones. Note: Arizona does not observe daylight savings time.

## Grading Procedure

Grades reflect your performance on assignments and adherence to deadlines. Grades on assignments will be available within **72** hours of the due date in the Gradebook.

## Late or Missed Assignments

Notify the instructor **BEFORE** an assignment is due if an urgent situation arises and the assignment will not be submitted on time. Published assignment due dates (Arizona Mountain Standard time) are firm. There will be a 10% deduction per 24-hour period after the assignment due date, but the best way to avoid issues is to be proactive with me and let me know if problems arise. Please follow the appropriate University policies to request an [accommodation for religious practices](http://www.asu.edu/aad/manuals/acd/acd304-04.html) (<http://www.asu.edu/aad/manuals/acd/acd304-04.html>) or to accommodate a missed assignment [due to University-sanctioned activities](http://www.asu.edu/aad/manuals/acd/acd304-02.html) (<http://www.asu.edu/aad/manuals/acd/acd304-02.html>). I will accept work up to five days late and grade it at 50% credit at that point, but will not accept anything beyond that without consulting with me ahead of time. For the final project, you must submit it by the due date, as final grades are due soon after the exam is turned in. This is a six-week compressed course, so I will strive to turn grades around with 48 hours.

# Communicating With the Instructor and TA

## Community Forum

This course uses a discussion topic called "Community Forum" for general questions and comments about the course. Prior to posting a question or comment, check the syllabus, announcements, and existing posts to ensure it's not redundant. You are encouraged to respond to the questions of your classmates.

Email questions of a personal nature to your instructor. You can expect a response **within 48 hours**.

## Email

Email questions of a personal nature to your instructor. You can expect a response within 48hours. When emailing me for help with coding and debugging, **please be as specific as possible in the question!** I am sure that questions and problems will arise, even with the most detailed of instructions, as bugs seems to always exist in beginner's code, and sometimes you may need some extra assistance. So, first, save your work frequently, and second, please do reach out for help if something is confusing or doesn't look right! Make sure, though, that your email to me includes **two things: 1) what your issue is (as best you can describe), and most importantly, some of the previous steps that you completed where all was working well before problems arose.** If I get an email that says something like "my code isn't working", it's going to be more difficult and time-consuming for me to be able to diagnose or troubleshoot your issue. Screenshots always help, too!




ASU email is an official means of communication (<http://www.asu.edu/aad/manuals/ssm/ssm107-03.html>) among students, faculty, and staff. Students are expected to read and act upon email in a timely fashion. Students bear the responsibility of missed messages and should check their ASU-assigned email regularly.














*All instructor correspondence will be sent to your ASU email account.*

## Video Office Hours

We will organize office hours weekly for answering any assignment related questions. You can access to Zoom, a video conferencing software, directly in your Canvas homepage. Please have your specific questions ready so that we could make the meetings effectively.

## Course Summary:

Date	Details
Wed Oct 23, 2019	 <b>Module 1: Assignment 1</b> ( <a href="https://canvas.asu.edu/courses/36969/assignments/816884">https://canvas.asu.edu/courses/36969/assignments/816884</a> ) due by 11:59pm
	 <b>Module 1: Quiz</b> ( <a href="https://canvas.asu.edu/courses/36969/assignments/816880">https://canvas.asu.edu/courses/36969/assignments/816880</a> ) due by 11:59pm
	 <b>Module 2: Assignment 2</b> ( <a href="https://canvas.asu.edu/courses/36969/assignments/816885">https://canvas.asu.edu/courses/36969/assignments/816885</a> ) due by 11:59pm

Wed Oct 30, 2019	 <b>Module 2: Quiz</b> ( <a href="https://canvas.asu.edu/courses/36969/assignments/816883">https://canvas.asu.edu/courses/36969/assignments/816883</a> )	due by 11:59pm
Wed Nov 6, 2019	 <b>Module 3: Assignment 3</b> ( <a href="https://canvas.asu.edu/courses/36969/assignments/816886">https://canvas.asu.edu/courses/36969/assignments/816886</a> )	due by 11:59pm
	 <b>Module 3: Quiz</b> ( <a href="https://canvas.asu.edu/courses/36969/assignments/816879">https://canvas.asu.edu/courses/36969/assignments/816879</a> )	due by 11:59pm
Wed Nov 13, 2019	 <b>Module 4: Quiz</b> ( <a href="https://canvas.asu.edu/courses/36969/assignments/816882">https://canvas.asu.edu/courses/36969/assignments/816882</a> )	due by 11:59pm
	 <b>Module 4: Assignment 4</b> ( <a href="https://canvas.asu.edu/courses/36969/assignments/816887">https://canvas.asu.edu/courses/36969/assignments/816887</a> )	due by 11:59pm
	 <b>Module 4: Final Project - Proposal</b> ( <a href="https://canvas.asu.edu/courses/36969/assignments/834959">https://canvas.asu.edu/courses/36969/assignments/834959</a> )	due by 11:59pm
	 <b>Module 4: Final Project - Proposal (OLD))</b> ( <a href="https://canvas.asu.edu/courses/36969/assignments/816888">https://canvas.asu.edu/courses/36969/assignments/816888</a> )	due by 11:59pm
Wed Nov 20, 2019	 <b>Module 5: Assignment 5</b> ( <a href="https://canvas.asu.edu/courses/36969/assignments/816889">https://canvas.asu.edu/courses/36969/assignments/816889</a> )	due by 11:59pm
	 <b>Module 5: Quiz</b> ( <a href="https://canvas.asu.edu/courses/36969/assignments/816878">https://canvas.asu.edu/courses/36969/assignments/816878</a> )	due by 11:59pm
Wed Nov 27, 2019	 <b>Module 6: Assignment 6</b> ( <a href="https://canvas.asu.edu/courses/36969/assignments/816890">https://canvas.asu.edu/courses/36969/assignments/816890</a> )	due by 11:59pm
	 <b>Module 6: Quiz</b> ( <a href="https://canvas.asu.edu/courses/36969/assignments/816881">https://canvas.asu.edu/courses/36969/assignments/816881</a> )	due by 11:59pm
Wed Dec 4, 2019	 <b>Module 7: Final Project - Report</b> ( <a href="https://canvas.asu.edu/courses/36969/assignments/816891">https://canvas.asu.edu/courses/36969/assignments/816891</a> )	due by 11:59pm
	 <b>Participation</b> ( <a href="https://canvas.asu.edu/courses/36969/assignments/816892">https://canvas.asu.edu/courses/36969/assignments/816892</a> )	



## ▼ Welcome and Start Here!

Complete All Items



### Welcome to GIS 322: Programming Principles GIS II!

Viewed



### Module 0: Academic Integrity Agreement

0 pts



### Module 0: Syllabus Quiz

Oct 23 | 5 pts



### Module 0: Set up Your Programming Environment - Introduction to Google Colaboratory



### Module 0: Final Project - Overview



### Community Forum: General Questions



### Office Hours



### all\_notebooks\_module1-6.zip

## ▼ Module 1: Review of Python Bas...

Prerequisites: Welcome and Start Here!

Complete All Items



### Module 1: Overview

View



### Module 1: Learning Materials - Data Types, Functions and Modules



### Module 1: Learning Materials - Conditions and Loop



### Module 1: Learning Materials - Review of Numpy for Basic Usage and File Read



## Module 1: Quiz

Oct 23 | 2.5 pts



## Module 1: Assignment 1

Oct 23 | 10 pts



## Module 1: Questions Go Here



## Linear Algebra (Matrix Operations)

### ▼ Module 2: Spatial Features and ...

Prerequisites: Module 1: Review of  
Python Basics

Complete All Items



### Module 2: Overview

View



### Module 2: Learning Materials - Vector Part 1



### Module 2: Learning Materials - Vector Part 2 (Shapely)



### Module 2: Quiz

Oct 30 | 2.5 pts



### Module 2: Assignment 2

Oct 30 | 10 pts



### Module 2: Questions Go Here

### ▼ Module 3: Geometry operatio...

Prerequisites: Module 2: Spatial Features  
and Data Structure

Complete All Items



### Module 3: Overview

View




### Module 3: Learning Materials - Geometry Collection in Shapely



 Module 3: Learning Materials - Spatial Relationship

 Module 3: Learning Materials - Matplotlib Display Shapely Object

 Module 3: Quiz  
Nov 6 | 2.5 pts

 Module 3: Assignment 3  
Nov 6 | 10 pts


 Module 3: Questions Go Here

## ▼ Module 4: Managing GIS D...

Prerequisites: Module 3: Geometry operations  
using Shapely

Complete All Items



 Module 4: Overview  
View


 Module 4: Data US\_lower\_48.zip

 Module 4: Learning Materials - Reading and Writing Spatial Data

 Module 4: Learning Materials - Map Projections

 Module 4: Learning Materials - Creating a GeoDataFrame from Coordinates

 Module 4: Quiz  
Nov 13 | 2.5 pts

 Module 4: Assignment 4  
Nov 13 | 10 pts

 Module 4: Questions Go Here

## ▼ Module 5: Geospatial Operations ...

Prerequisites: Module 4: Managing  
GIS Data in Python

Complete All Items





## Module 5: Overview

View



## Module 5: Learning Materials - Geometric Operations



## Module 5: Learning Materials - Table Join and Spatial Join



## Module 5: Learning Materials - Geocoding



## Module 5: Quiz

Nov 20 | 2.5 pts



## Module 5: Assignment 5

Nov 20 | 10 pts



## Module 5: Questions Go Here



## Module 5: A Real-World Example - Mapping Phoenix Crimes

### ▼ Module 6 - Advanced Geovis...

Prerequisites: Module 5: Geospatial Operations and Geoprocessing

Complete All Items



## Module 6: Overview

View



## Module 6: Learning Materials - Interactive Mapping with Bokeh



## Module 6: Learning Materials - Adding a Web Basemap using Folium



## Module 6: Quiz

Nov 27 | 2.5 pts






## Module 6: Assignment 6

Nov 27 | 10 pts



## Module 6: Questions Go Here

▼ **Module 7: Final Project**

	<b>Module 7: Overview</b>
	<b>Module 7: Final Project - Report</b> Dec 4   10 pts
	<b>Module 7: Final Project - Questions Go Here</b>

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**You are currently logged  
into Student View**

*Resetting the test student will clear all  
history for this student, allowing you to  
view the course as a brand new  
student.*

**Reset Student**

**Leave Student View**