

# GEO 345/445: Programming in Python for GIS

Spring 2019 (3/30/2019-6/14/2019) | Department of Geography | DePaul University

**Time:** Tue/Thurs 4:20-5:50 pm

**Location:** SAC 224, LPC

**1. Course Description:** Knowledge of a scripting language is a valuable skill for GIS analysts. Students will learn the basics of Python (a programming language), including script writing and implementation. By completing this course, students should be able to manipulate GIS data, automate GIS work flows, and develop customized GIS tools by writing script in Python with ArcGIS. The class is largely conducted through hands-on activities in a GIS laboratory. Prerequisites: GEO141 for GEO345; GEO441 for GEO445.

## 2. Instructors' Contact and Office Hours

	Instructor	Teaching Assistant	GIS Coordinator
Name	Sungsoon (Julie) Hwang	Rebecca Weiss	Cassie Follett
Contact	shwang9@depaul.edu (773) 325-8668	beccaeweiss@googlemail.com	CFOLLETT@depaul.edu (773) 325-3267
Where	990 W Fullerton, 3133	990 W Fullerton, 3135 (GIS Lab)	990 W Fullerton, 3134
When	Tue/Thu 11:30a-12:30p or by appointment	Tue/Thu 3-4 pm	when technical issues arise in <a href="#">990 GIS Lab</a>

**3. Course Topics:** The course is divided into two parts. The first half covers [Python fundamentals](#) by writing short scripts. Those fundamentals include data type, operations applied to different data types, conditional statement, and loop structure. The second half covers [ArcPy](#), an ArcGIS library of pre-defined geoprocessing functions which can be called in a Python script.

Design and development of geospatial applications (computer programs) is identified as one of three core technical competencies (along with data acquisition and data analysis) according to US DOL's [Geospatial Technology Competency Model](#). This course will equip you with balanced GIS skills as programming skills have been lacking in undergraduate GIS curriculum.

**4. Learning Outcomes:** with the completion of this course you should be able to

- Write Python scripts for a given task using various data types and operations
- Write Python scripts for a given task using conditional statement
- Write Python scripts for a given task using loop structure
- Perform geoprocessing using ArcPy functions and classes
- Explore and manipulate geospatial data using ArcPy Cursors
- Read and write text files using Python

## 5. Readings

Required textbook: Paul A. Zandbergen (2013) *Python Scripting for ArcGIS*, ESRI Press (ISBN: 9781589482821) - available at college bookstore in LPC. In case you run into the alternate (2014, 2015) edition, the alternate edition is same as the 2013 edition content-wise (verified by publisher). Although the 2013 edition is written for ArcGIS 10.1, it works fine with ArcGIS 10.6 and Python 2.7 that are currently installed in selected labs at DePaul University.

Other readings are provided on D2L.

## 6. Outlines of Topics and Tentative Schedules

Wk	Dt.	Topic	Reading	In-class lab activities	HW (due)
1	4.02 4.04	Course overview 1. Script editor & ModelBuilder	Ch1, 2, 3	1. IDLE, Python script from ModelBuilder	
2	4.09 4.11	2. Data types and operations	Ch4:- p. 81	2A. Data types and operations in Python	
3	4.16 4.18		Ch12	2B. Python for custom-labeling in ArcGIS	
4	4.23 4.25	3. Conditional statement & loop	Ch4: p. 81 -	3A. Use If, while, and for	<b>HW1</b> 4.26
5	4.30 5.02			3B. Use If for field calculator in ArcGIS	
6	5.07 5.09	4. Introduction to ArcPy	Ch5	4A. Environment setting, Describe data	<b>HW2</b> 5.10
7	5.14 5.16	<b>Midterm</b>	Ch6	4B. Batch processing	
8	5.21 5.23	5. ArcPy Cursors	Ch7: - p. 149	5A. Read and write rows in feature class	<b>HW3</b> 5.24
9	5.28 5.30		Ch7: p. 149 -	5B. Read and write text files	
10	6.04 6.06				<b>HW4</b> 6.07
11	6.13	<b>Final exam 2:30-4:45 PM (Thurs)</b>			

## 7. Grading Components

Components	Points	Notes	Due dates
Participation	10	See below for rubric	Every week
9 labs	27	Each 3 pt. Group submission	Every week
4 homework	24	Each 6 pt. Individual submission	Friday on week 4,6,8,10
Exam	15 24	Midterm (module 1,2,3) Final (comprehensive)	Week 7 Tuesday Week 11 Thursday
Project	See below	If you're a graduate student	

**7.1 Participation:** score is assigned according to the criteria below.

- A (9-10) = Student is present in all or nearly class meetings, and prepared, at all times, to respond to questions. Student is an active participant in and out of class, and stays on task in class-time activities.
- B (8-9) = Student participates as above, 75% of the time.
- C (6.5-8) = Student does not volunteer comments; responses demonstrate vague familiarity with course readings. Student is a passive participant in and out of class, and/or does not stay on task during class-time activities.
- D (5-6.5) = Student never volunteers, cannot respond to direct questions, keeps silent during class discussions and is unable to summarize readings if asked.
- F (0-5) = Student misses many class sessions and/or sits silently in classes when present, or is disruptive and non-participatory in the classroom.

**7.2 Labs:** complete labs after lectures in the class when instructors are present. If you can't complete the lab in time, make arrangement with a TA. You can complete labs individually, but should submit scripts as a group assigned during class hours each week.

**7.3 Homework:** write and submit Python scripts that perform assigned tasks.

- HW1: this covers module 1 (ModelBuilder) and module 2 (data type and operations) testing the following: (a) export a model to a Python script; (b) calculate distance between two points using functions and methods for numeric data; (c) custom-label features using string methods in the Label expression dialog box
- HW2: this covers module 3 (conditionals and loop) testing the following: (a) calculate descriptive statistics using list methods; (b) custom-label features & calculate fields using conditional statements; (c) calculate fields using conditional statements
- HW3: this covers module 4 (ArcPy) testing the following: (a) retrieve properties of geospatial data with ArcPy functions and classes; (b) perform batch processing with ArcPy
- HW4: this covers module 5 (cursor and text file handling) testing the following: (a) check data quality by looping through the geodatabase table with ArcPy Cursor and SQL; (b) generate a summary statistics by looping through multiple text files

**7.4 Exam:** Midterm covers module 1, 2, and 3. The midterm exam focuses on reading Python codes. The exam consists of multiple choice, and short answer which is designed to test how well you understand Python fundamentals. The final exam is comprehensive, and focuses on writing Python codes. For instance, you should write a script that performs a given task, such as printing the string "Hello World" 20 times.

You're allowed to refer to Python help, and ArcPy help during the final exam. You are also allowed to bring a cheat sheet (A4 size in both side) to the final exam. In the cheat sheet, you can write down syntax for Python operations and ArcPy geoprocessing functions.

**7.5 Project:** if you are a graduate student, you need to propose and complete a final project that uses Python to perform a geoprocessing task in the area of your interest. You should submit a tool written in Python as a final product along with the documentation of the tool you created. The proposed project should meet the following minimum requirements:

The minimum requirements of a proposed project	# required
# Python data types {strings, numbers, lists, tuples, dictionary, date & time}	3
# Python operations, such as operators, and built-in functions and methods <ul style="list-style-type: none"> <li>• Generic operators (eg. ==, !=, =, +=, and, or, not, in, not in)</li> <li>• Strings (eg. +, [], in, len(), upper(), find(), strip(), split(), replace())</li> <li>• Numbers (eg. +, -, /, *, **, int(), float(), abs())</li> <li>• Lists (eg. len(), max(), min(), append(), count(), insert(), remove())</li> </ul>	6
# Python conditional statement and loop structure (if, while, for)	2
# ArcPy geoprocessing tools, functions and classes <ul style="list-style-type: none"> <li>• Tools/functions (eg. Buffer, SelectLayerByAttribute, CalculateField, GetCount, SearchCursor, UpdateCursor, GeocodeAddresses)</li> <li>• Classes (eg. SpatialReference, Extent, Cursor, Field)</li> <li>• Functions (eg. Describe, Exists, ListFeatureClasses, ListFields)</li> </ul>	6
Others—for example, <ul style="list-style-type: none"> <li>• Text file reading &amp; writing</li> <li>• User keyboard input (eg. raw_input(), ArcPy GetParameter())</li> </ul>	1

- |   |  |
|---|--|
| <ul style="list-style-type: none"> <li>• ArcPy modules (eg. Data Access, Mapping, Spatial Analyst)</li> <li>• Python modules &amp; functions (eg. math, random, datetime, csv)</li> </ul> |  |
|---|--|

A tool defined by the project proposal will usually perform tasks that cannot be accomplished effectively through manual processes. A well-conceived tool will make a good use of Python fundamentals like conditionals, iterations, and taking a user input, and ArcPy geoprocessing tools.

Project is required to pass the course for a graduate student. Maximum 15 points are assigned to project. Total 115 points will be calculated as 100% of the total grade when a grade is submitted. A proposal is due on week 9 Sunday, and final product (that contains Python script, data and documentation) is due on week 11 Friday. Guidelines will be provided.

**Grading scale:** A = 93-100%; A- = 90-92.99%; B+ = 87-89.99%; B = 83-86.99%; B- = 80-82.99%; C+ = 77-79.99%; C = 73-76.99%; C- = 70-72.99%; D+ = 60-69.99%; D = 50-59.99%; F = 0-49.99%

**Late Work Policy:** Late work will NOT be accepted. Extensions can be requested if needed, but will be only granted if excused.

**Makeup Exam/Incomplete Grade Policy:** A makeup exam or an incomplete grade can be arranged or granted only when credible dire and documented medical or family situations arise and these circumstances are communicated in a timely fashion.

## 8. Access to ArcGIS

**Digital Student License:** If you're enrolled in a GIS class at DePaul University, you can download and install ArcGIS Desktop on your home computer for free. Reach out to a GIS coordinator for instructions. ArcGIS is only supported in a Windows computer.

**Labs with ArcGIS Desktop:** SAC GIS lab (SAC 224), SAC 268, 990 GIS lab (990 W Fullerton, Room# 3135), Richardson Library, Loop Library, Daley 1327

### GIS Lab Open Hours

- 990 GIS Lab (990 W Fullerton, Room# 3135): <https://las.depaul.edu/academics/geography/geographic-information-systems-certificate/Pages/gis-lab.aspx> or the lab door.
- SAC GIS lab (SAC 224): <http://qrc.depaul.edu/hours.htm> or the lab door.

**DePaul Virtual Lab:** you can access ArcGIS Desktop in both PC and Mac remotely at <http://vlab.depaul.edu>. There is no need for installing ArcGIS, but experiences may not be smooth as ArcGIS is computationally intensive. At least 8 Mbps is required for internet speed. Contact a GIS coordinator or TSC if you have any problem with using Virtual Lab.

## 9. Miscellaneous

**Attendance/Absentee Policy:** Consistent with university's policy, all students are expected to attend class meetings. Unless absence is explained on medical or compassionate grounds (documentation is required), absence from any classes is grounds for a grade adjustment.

**Academic Honesty and Plagiarism:** Academic honesty and integrity are expected at all times. Academic dishonesty, such as cheating or copying during exams, will be punished severely. Plagiarism – using someone else’s work without acknowledgment and, therefore, presenting their ideas or quotations as your own work – is strictly forbidden. DePaul University officials will be informed of any instance of academic dishonesty and notification will be placed in your file. Please read the DePaul Academic Integrity Resources page (<http://academicintegrity.depaul.edu/Resources/index.html>) for definitions and explanations of plagiarism and the University’s Academic Integrity expectations for students. Cutting and pasting text taken directly from a web-site without appropriate referencing and quotation marks is plagiarism and is forbidden. Submitting work that has any part cut and pasted directly from the internet is grounds for an automatic grade of zero.

**University Center for Writing-Based Learning:** Collaborates with writers from all disciplines, backgrounds, levels of expertise, and roles within the University community. Their goal is to help develop better writers along with better writing and reflection through continual revision. If you need assistance with writing assignments, they can be contacted at: 773.325.4272 (LPC) or [wcenter@depaul.edu](mailto:wcenter@depaul.edu)

**Universal Design for Learning:** GEO is committed to helping students achieve their full potential by removing barriers to learning and making reasonable accommodation when appropriate. Please help us by identifying barriers and suggesting ways we can diminish or remove them.

Students with special learning needs, or who are in circumstances which necessitate special consideration, must contact the instructor at the beginning of the course or earlier. Students with a documented disability who wish to discuss academic accommodations should contact the instructor as soon as possible and immediately contact the DePaul University’s Office of Students with Disability at <http://studentaffairs.depaul.edu/studentswithdisabilities/>.

Please note: All university employees must report to the Title IX Coordinator all relevant details about any incidents of sex discrimination, including sexual harassment and sexual or relationship violence, of which they become aware. DePaul employees are also mandated reporters under the Illinois Abused and Neglected Child Reporting Act [325 ILCS 5/4]. If you need to speak directly with a [Title IX Coordinator](#), email [titleixcoordinator@depaul.edu](mailto:titleixcoordinator@depaul.edu).

## **10. Department of Geography Learning Goals—GEO 345/445 addresses 1), 5), 6), and 7).**

Courses in the Department of Geography teach students:

- 1) Understand spatial patterns and processes of modification of the Earth’s physical and cultural landscapes
  - a. As social constructions.
  - b. As systems that link the Earth with human society in interdependent, dialectical relationships, and
  - c. Through mapping and visualization.
- 2) Understand the concept of scale as a spatial phenomenon that ties the local, the regional, the national, the transnational, and the global in a system of interaction.
- 3) Understand the phenomenology of the discipline of Geography—most importantly, “space”, “place”, “landscape,” “region,” and “location”.
- 4) Distinguish that spaces, places, and so on, may have both objective and subjective/symbolic dimensions.
- 5) Develop research and writing competences that would allow you to:

- a. Formulate a cogent research question about the spatial character of a physical, socio-cultural, or environment-societal phenomenon,
  - b. Write about it in ways that reflect analytical and critical thinking, and
  - c. Ethical concern over social and environmental justice, consistent with the University's social mission.
- 6) Engage competently in qualitative and quantitative spatial analysis, and with exercises that are concerned with explaining spatial regularities (for example, the spatial calculus behind the location of retail commerce in Chicago, or transnational flows of capital).
- 7) Learn the basic utility and use competently one or more of the information technologies that are now redefining the logistical limits of spatial analysis: geographic information systems (GIS) and remote sensing.
- 8) Achieve greater general knowledge of the world, its regions, its physical systems, its cultures, and political-territorial divisions.

## 11. Learning Objectives by Modules

Module 1. Script Editors and Model Builders – read chapter 1, 2, 3

- Get familiar with a script editor IDLE
- Build a model using ArcGIS ModelBuilder
- Create scripts from ModelBuilder

Module 2A. Python fundamentals I: data types and operations – read chapter 4 (- p. 81)

- Get familiar with Python's standard (or built-in) data types: numbers, strings, and lists
- Describe how an index positioning system works in strings and lists
- Distinguish functions, methods, and modules

Module 2B. Python parser for labeling in ArcGIS – read chapter 12 and [building label expressions](#)

- Use methods for manipulating strings
- Define your own function
- Custom-label features using a Python parser in ArcGIS

Module 3A. Python fundamentals II: workflow control – read chapter 4 (p. 81 -)

- Write conditional statements
- Use while loop structure
- Use for loop structure

Module 3B. Conditional statements for field calculator in ArcGIS – read [Python-based field calculation](#)

- Get familiar with list methods
- Use conditional statements for labeling in ArcGIS
- Use conditional statements for field calculator in ArcGIS

Module 4A. Introduction to ArcPy – read chapter 5

- Understand how ArcPy is organized
- Differentiate ArcPy functions, classes, and modules
- Specify environment settings using ArcPy env class

Module 4B: Batch processing with ArcPy – read chapter 6

- Describe data using ArcPy Describe function

- Perform batch geoprocessing using List Object function

Module 5A. Manipulate geospatial data using Cursors – read chapter 7 (-p. 149)

- Use SearchCursor to read rows in the feature class
- Use UpdateCursor to write rows in the feature class

Module 5B: work with text files – read chapter 7 (p. 149-)

- Read a text file
- Write a text file