

# Geography 441/641 GIS Programming & Customization Fall, 2018

**Instructor:** Dr. Keith Rice

**Office Hours:** Wednesday 10:00 – 10:50am  
Tuesday & Thursday 11:00 – 11:50am  
or by appointment

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This course is an introduction to programming techniques and script customization within a GIS program. The class is divided into two parts, in the first half you will develop programming proficiencies in a common scripting computer language (Python). Basic concepts in structured programming will be introduced along with fundamental techniques (e.g. sequence, decision structures, loops). Python principles and concepts will be defined and illustrated along with a broad overview of Python script components and applicable syntax tools (e.g. PythonWIN, IDLE). The second half of the course will focus on how a scripting language can be used within the ArcGIS geoprocessing environment. The goal is to customize GIS software routines for extended functionality and utility of the import, query, and display of geospatial information. You will learn how to create a geoprocessing tool within ArcToolbox, and set up required parameters and environmental settings. A thorough discussion of geometric objects and their associated properties will laid the foundation for the development and implementation of Python scripts within ArcGIS. Examination of Python debugging, and ArcToolbox error checking, dialog windows and script documentation will also be explored.

**Lectures:** Lecture sessions will be on Tuesday and Thursday mornings and will concentrate on the conceptualization of small to medium-sized programming scripts and their associated syntax and applications to GIS problems. These topics will lay the foundation for both interactive assignments and programming exercises.

**Laboratory:** The lab session will meet every Wednesday afternoon. There will be eight different programming exercises and four required programs. The exercises are designed to introduce you to fundamental concepts and syntax of the Python language, and then the structure and utility of the geoprocessing functions of ArcGIS. Each will contain a specific series of tasks that may involve introduction of new syntax, programmatic problem solving, geoprocessing modular tasks, rudimentary steps in writing and running scripts, as well as debugging the program and error checking. These will be worth 5 points apiece (for a total of 40 points). Each exercise will provide pertinent background information for your independent programming work. You are also required to write four different Python programs or scripts; the first two will be stand-alone Python programs (developed through PythonWIN or IDLE), while the second pair will be integrated modular Python scripts that will be executed through ArcToolbox. Each program is worth 10 points (for a total of 40 points). These laboratory exercises tally 80 points (or 80% of your final course grade). In most circumstances you will have one-week to complete each programming exercise, and a due date of at least two weeks for each script completion or program. These projects should be completed and handed in by the due date indicated by the instructor. Similarly, reading assignments should be completed before the class sessions for which they are assigned.

**Examinations:** There will be one exam – a final comprehensive exam scheduled for **Monday, December 17<sup>th</sup> (8:00-10:00am)**. It will be mostly composed of multiple-choice and matching questions, but you will also have a series of short programming segments (this part will be a take-home exam component). The multiple-choice questions will focus not only on basic concepts, principles, and definitions of Python programming, but also on the applications of this knowledge to pertinent ArcToolbox script problems. It will count 20 percent of your final grade.

**Texts:** **A Python Primer for ArcGIS**, by Nathan Jennings, CreateSpace Independent Publishing Platform, Lexington, Kentucky, 2011 [*UWSP textbook rental*]

**Python – Scripting for ArcGIS** (for ArcGIS 10) by Paul A. Zandbergen, ESRI Press, Redlands, California, 2013 [*GIS Center Text Rental*]

(*optional*) **Learning Python**, 4<sup>th</sup> edition, by Mark Lutz, O'Reilly and Associated, Inc. Sebastopol, California, 2009 [*reference Python syntax book*]  
(there is a 5<sup>th</sup> available edition, but you just need the 4<sup>th</sup> edition since you will be using Python 2.7)

**Selected Readings** Geoprocessing in ArcGIS, (ESRI guide to ModelBuilder)

*from:* Geoprocessing Quick Reference Guide (to ArcToolbox tools with scripts)

Writing Geoprocessing Scripts (ESRI Python guide)

Python Programming Language (official website – [www.python.org](http://www.python.org))

**Attendance:** Although class attendance records will not be kept, it is strongly urged that class sessions not be missed. Remember that the success of class discussions is directly related to the amount of verbal participation, and with a small class one person can make a significant difference in aiding a classmate's understanding of a topic. But, in order to comply with federal financial aid Title IV legislation attendance will be taken several times during the course of the semester. UWSP Financial Aid Office is required by Federal law to retract financial aid for students that do not complete at least 60% of the semester for which they were awarded financial assistance. The mandated retraction formula uses the last date of attendance as a factor in determining the percentage of financial aid that must be returned to the U.S. Department of Education (DOE).

**Readings:** A separate handout will detail the reading assignments for the semester. Additional materials, however, such as articles, may also be given intermittently.

**Printing Costs:** During the course of the semester each student will be responsible to hand in several word documents and completed programming assignments. All student printers are now handed through UWSP-IT so you will be charged for 5 cents for each B&W page (single side) as well as 15 cents for each color copy (single side). You start out with \$10 in a UWSP printing account for the semester (for all of your classes) and then are charged a fee at the end of the semester for any printing exceeding that initial balance. You can always check your student printing account on your myPoint portal page on the Finances tab. Most of your assignments that you hand-in will likely just be B&W copies and programming assignments will be graded through documentation (and final program) that you will deposit in your assigned class server directories.

**Student Rights and Responsibilities:** Please make note of the following web-based pdf documents, that explains your responsibilities and rights within the UWSP campus community, including required behavior by students and faculty within the classroom environment: <http://www.uwsp.edu/stuaffairs/Documents/RightsRespons/rightsCommBillRights.pdf>, and <http://www.uwsp.edu/stuaffairs/Documents/RightsRespons/SRR-2010/rightsChap14.pdf>

**Additional Requirements for Geography 641 Students:**

Students taking Geog. 641 are required to conduct a separate GIS project that involves a topic of their choosing. It is usually to the advantage of the graduate student to select a topic related to their thesis or graduate school interest. The final project will consist of the creation of a Python programming script that provides a routine and/or tool that helps in solving a specific GIS related problem that was solved using ArcGIS 10.5.1 and the customized script. Graduate students should discuss with the instructor their chosen topic before beginning the project. Final grades will be termed using the following formula:

Geog. 441 requirements	80% of final grade
GIS final project	20% of final grade

**\*\* Schedule of Lecture Topics, and Lab Exercises/Assignments \*\*****Fall, 2018**

	<u>Lecture Topic</u>	<u>Exercises/Assignments</u>
<u>September</u>		
4	Course Overview & Introductory Comments	
6	Programming Basics: Problem Statement, Algorithms, Pseudocode, Code Specifications Elements of Programming: Problem Solving	-----
11 & 13	Elements of Programming: Languages Variable Concept, Structured Programming The Python Language, Common Uses, Its Strengths and Origin, Python Tools	Exercise 1 (5) (Python Programming Basics)
18 & 20	Python Interpreter – IDLE, Object Types Numbers & Strings, Lists, Dictionaries Tuples, Files, Expressions, Operators String Manipulation, Indentation	Exercise 2 (5) (Conditionals, Loops, Files)
25 & 27	File Structures- Open (Read, Write, Append) String Sequences, Decision & Loop Structures <i>If, If-Else, If-Elif-Else</i> statements, While Loops Format Variations, counters, IDLE Indentation Debugging & Deconstructing Error Messages	Assignment 1 (10) (Python Script: Classification)
<u>October</u>		
2 & 4	PythonWin, Additional Syntax Guidelines, Conditional Truth Tests, While statement, Nested loop structures, Extending the Loop Format Continue option, Breaks, <i>for</i> -Loops Logical Operators with Compound Conditions Initial Function Operations – Sort, Random	Exercise 3 (5) (Python Compound Conditionals)
9 & 11	Dictionaries and Keys Selected Dictionary Methods, Testing for a Key Using Dictionary Key Codes Defining and Implementing Functions Writing Functions and Script Controls	Exercise 4 (5) (Dictionary Keys and Functions)
16 & 18	Holding Variables and Recursive Loops Nearest Neighbor Analysis Receiving and Returning Values Documentation and Script Validation Splitting Data Sets and Sorting	Assignment 2 (10) (Python Script: Nearest Neighbor)

## October

23 & 25	ArcToolbox Structure and Utilities Advantages of Scripting in ArcToolbox Creating Script Parameters ESRI Programming Nomenclature Writing Python Scripts for ArcGIS The Script Toolbox Dissecting Model Builder Scripts	Exercise 5 (5) (Python Scripting for ArcGIS)
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## November

(Oct. 30) & 1	Interacting with ArcObjects Accessing the Geoprocessor ArcObject Creating your own Script Toolbox Setting up argument variables The <b>arcpy</b> variable and prefix controls	Exercise 6 (5) (Cursor Methods & Geometries)
6 & 8	Composing Python Scripts with the Geoprocessor Geoprocessing Tools and Environment Settings Enumeration Methods and Objects Cursor Methods and Objects (insert, search, update) Working with and creating geometries	Assignment 3 (10) (Polyline Creation Scripting)
13 & 15	Geoprocessor Model Diagrams – Symbolization and Functionality Geoprocessor Programming Model (10.3) Data Descriptions and Feature Classes	Exercise 7 (5) (ArcGIS Functions in a Python Script)
20	Feature Types, Fields and Attribute Manipulation Row Manipulation (read, edit, assign variables) Create and Edit Geometries – Modifying the Cursor	[no lab]
<b><i>[Thanksgiving Vacation November 22 – 25]</i></b>		
27 & 29	ArcGIS versions variations with the Geoprocessor Syntax Guidelines for the Geoprocessor with Python Toolbox Aliases and Examples	Assignment 4 (10) (Scripting for Raster Files)

## December

4 & 6	Code Execution Environments Interactions between ArcGIS Functions and Python Availability and Functionality of ESRI Python Scripts	Exercise 8 (5) (Script GUI & ArcTools)
11 & 13	Building Model Documentation Creating User Messages Final Exam Review Session	

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**Final Exam: Monday, December 17<sup>th</sup>; 8:00 – 10:00am**

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*Comments: (1) The worth of each exercise and programming assignment (in points) is denoted within the parentheses next to its title.*

*(2) This schedule is tentative and is subject to changes during the course of the semester.*