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# INTRODUCTION TO PYTHON

TOPIC 1

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## Course Overview

This is an introductory course in geospatial applications using Python. Python is a free open-source computer scripting language. Python can be used in several different geospatial-mapping programs, for this class Esri ArcMap Desktop will be the main software utilized but some discussions of Esri ArcGIS Pro and QGIS will also be included. Esri ArcMap is a 32-bit application and thus the 2.x Python family of code is used. For 64-bit applications the 3.x code would be used. These two versions of Python are not 100% compatible. The libraries of commands used in the Python scripts are software specific and less compatible. The libraries contain code related to specific geospatial operations.

The learner of this material should be experienced with Esri ArcMap Desktop and have geospatial knowledge as might be obtained from an Introduction to GIS course. Individuals who have worked with other geospatial software packages should have the expertise for this class, but will need to review the specific commands for Esri ArcMap Desktop used in this class. Terminology may be unique between different geospatial software applications.

This course is not designed to make the learner into a Python expert programmer, but will provide the knowledge to automate processes and write short scripts. This course assumes no previous programming knowledge but any type of programming knowledge would be very useful.

## Course Content (Modules)

- Introduction to Python for Geospatial Technology (this module)
- Python Basics
- Using Python in an external IDE with Arcpy
- Loops and decision making operations
- Using Python in Esri ArcMap
- Creating a toolbox for use in Esri ArcMap
- Using Python Window in Esri ArcMap
- Additional Python scripts using the IDE
- Using Python in QGIS and ArcGIS Pro (optional)

## Course Composition

In this course, a single concept is introduced and the purpose of the concept is explained. It is assumed that the learner will know how the command functions from a geospatial standpoint. If the learner requires a more in-depth knowledge of the geospatial functions it is suggested that the concepts be reviewed in Esri ArcMap or through the author's website at:

<http://introductiontogist.weebly.com>.

## Methodology

- The learner will be presented with the methods required to complete the task. The processes will be explained in a line-by-line fashion. Some lines that are repeated in numerous operations will be explained more briefly in the more advanced sessions. It is assumed that the learner will be able to access the help feature within ArcMap or through the web.
- The learner should create the scripts for all examples of code presented. Data is provided that the author used or the learner may use their own data that is applicable.

## Assessments

- Assessments will occur throughout the learning experience. Different assessments will have different depth levels and be worth different point values toward the final grade.
- The learner will be required to have software that can be used to capture all or portions of their computer screen. The author uses Jing and Windows Snipping Tool. All written scripts must be saved in a Python format with a py extension. A naming convention for the assessments and scripts should be used such as:

descriptive assignment name\_learners initials.py  
Assignment\_2.5\_VAD.py

- Assessments will take numerous formats.
  - Assignments and exercises are normally one or two concept ideas based on lessons previously discussed.
  - Quizzes will cover a specific amount of material, the answers maybe short answer, multiple choice or require short pieces of code.
  - Case Studies will combine multiple concepts into an authentic contextual project (real world), there must be a written description included beyond just screen captures and scripts within the case study.
  - Student Designed Projects

## Introduction

As previously noted this not a general Python class:

- This course is specifically designed for the geospatial field of study; the user must have an understanding of geospatial operations and software.
- The participants should have a functional understanding of the geospatial field such as might be obtained in an Introduction to GIS course.
- Since the Esri arcpy module will be used throughout the course and many of the examples use Esri ArcMap, the learner must have a copy of ArcMap installed on their computer. Note: Esri ArcMap functions only in a Windows environment, Python will run on an Apple operating system but the arcpy module will not be present since ArcMap does not run on this operating system. The described operations should work with any

version of ArcMap 10.1 or higher. The screenshots for these lessons have been created on a variety of versions of Esri ArcMap including: 10.2, 10.2.1, 10.2.2, 10.3 and 10.4.1. ArcGIS Pro uses a different version of Python and a different version of arcpy and thus the commands discussed in the first eight modules may not work in Esri ArcGIS Pro.

- Python is used in other GIS programs, such as QGIS and ArcGIS Pro. When working with QGIS this can be accomplished using an Apple computer operating system.
- Module 9 is optional.
- Python is an open source scripting language initially designed in 1991. <http://python.org>
- Scripting languages are different from traditional programming languages as they do not require compiling.
- Arcpy and other libraries will be used.
- A Python editor is required, you may use any editor, the author will use PythonWin and screen images will be created from this editor, except when using the ArcGIS Python Window and tool windows inside of ArcMap.
- A useful Python website: <http://pythongist.weebly.com> is maintained by the author.

## Editors

Most Integrated Development Environment (IDE) editors, have a graphic interface and are smart editors (when you begin typing a command line it recognizes the command and provides suggestions). Most editors have two modes of operation, an immediate mode and a scripting mode. The immediate mode will execute each line upon pressing the return key, while in scripting mode multiple commands execute when run is selected. When using the PythonWin editor two windows are opened one for composition and the other for running of the script. PythonWin requires saving the script prior to executing the code.

- Different Python Editors:
  - IDLE (Python Shell) - installed with Python. Python will be installed when ArcMap is installed.
  - PythonWin – must be downloaded and installed, the web address is in resources.
  - ArcGIS Python Window – located within ArcMap, will be used in addition to PythonWin. It is not suggested that you use this editor as your only editor since it is an immediate mode editor, thus lines are executed with each return, except for looping functions.
  - QGIS editor has both a programming and immediate mode.

Python code can use any text editor such as Wordpad or Notepad to write a script. These are not smart editors, which assist the learner with script composition and scripts cannot be executed in these text editors. A Python script is a text document, but saved with a py extension.

PythonWin should be installed after the installation of Esri ArcMap. If PythonWin is installed first it may have issues with locating the proper pathways for the arcpy module. If an updated version of ArcMap is installed, it may require updating the PythonWin installation.

## Logic and Formatting

Basic computer programming logic and Python specific formatting is used throughout the course. Since no prior programming knowledge is a requirement for the course formatting and the logic is discussed that is required.

- Variables:
  - are words or letters that should provide a descriptive understanding of the contained information. A variable can be in either numerical or text format.
  - can contain a single piece of data such as a person's last name or multiple data items (a list or an array) such as the names of every student enrolled at a college.
  - a solid naming convention for the variables should be used in scripts and from one script to another. By the use of a solid naming scheme, it will be possible to identify the purpose of the variables.
  - predefined names that cannot be used as a variable name (reserved words that are defined for specific operations).
  - should also avoid the use of spaces.
- Additional modules/libraries can be loaded into Python, this keeps the script smaller, thus loading only what is required makes the code very flexible and easy to move from one computer to another as long as the new computer contains the library or has a path to the library. It also provides a uniformity in how the script is composed.
- In general, the first letter of all program lines should be lower case, some editors want to capitalize the first letter.
- Anything contained within double quotation marks ("" ) or single quotation marks ( ' ' ) is text (string).
- A pound sign (#) is used for comments, it is required for the course that you use comments throughout the program to explain what is being created. In addition, when trying to locate errors use a # sign in front of an operational line, will change the line to a non-operational line without the need for deleting the code, this is an effective way to troubleshoot a script. Comments can be placed at the end of an operational line, to comment about the specific line. In general, that comments be placed on their own line. Comments can also be used to separate parts of a script. At the beginning of every script, comments should be used to identify the author, organization and contact information as well as the purpose of the script.

## Getting Started

Using an IDE in immediate mode three greater than signs are displayed, >>>, to print the text Your Name. In Figure 1 the PythonWin immediate mode window, notice the format. In Figure 2, the command is

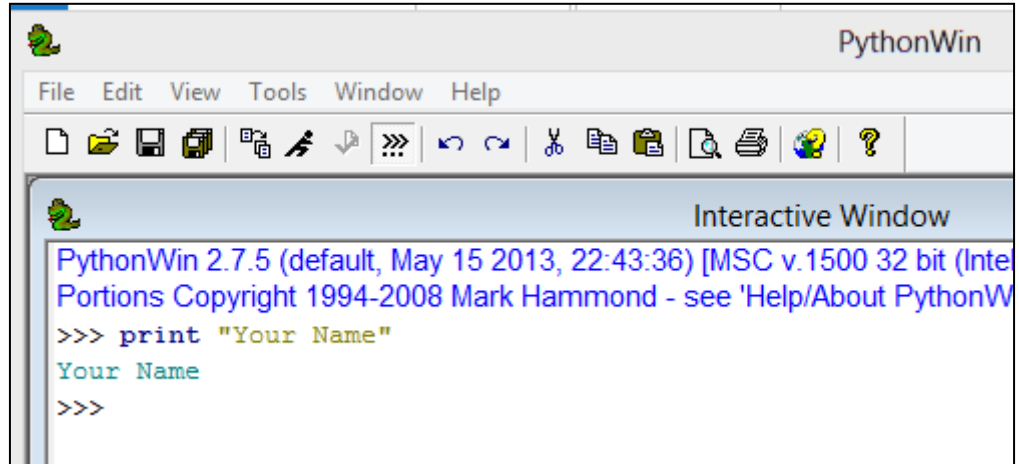


Figure 1: PythonWin immediate mode

shown in Esri ArcMap Python Window (the Python window has a button on the toolbar). In ArcMap there is a help window on the right side with command assistance.

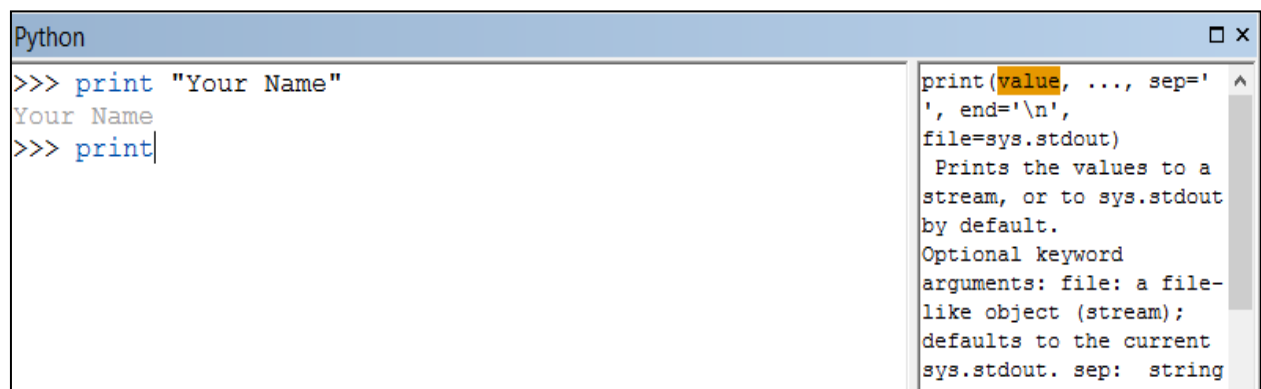


Figure 2: Esri ArcMap Python Window

## Assignment 1.1

The Camera Icon means that a screen image is required. Throughout the course, this icon will be used for any assignment that requires a screen capture. There will be other icons used and when they are first introduced, they will be explained. No script is required for this assignment.



- Work in immediate mode
- Show comments that should be placed at the top of any script to identify the creator of the script, the company, contact information and the purpose of the script.
- The script should print your actual name. This can be done using a variable or just the simple print command.

## Resources

- Python functions:  
<https://docs.python.org/2/library/functions.html>
- ArcPy commands:  
<http://resources.arcgis.com/en/help/main/10.2/index.html#//018v00000005p000000>
- This is a general website about Python and good starting point.
  - <https://www.python.org/>
  -
- Esri landing page:
  - <http://resources.arcgis.com/en/communities/python/>
  -
- Downloading PythonWin:  
<http://sourceforge.net/projects/pywin32/files/pywin32/Build%20219/pywin32-219.win32-py2.7.exe/download>
- Glossary:
  - <http://pythongist.weebly.com/glossary.html>
  -
- Author's Python Website:
  - <http://pythongist.weebly.com>
  -
- Books:
  - GIS Tutorial for Python Scripting, David W. Allen, 2014, Esri Press
  - Python Scripting for ArcGIS, Paul A. Zandbergen, 2013, Esri Press



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