Introduction to Python

Python 3

Introduction to Python

- Python is a high-level programming language
- Open source and community driven
- “Batteries Included”
  - a standard distribution includes many modules
- Dynamic typed
- Source can be compiled or run just-in-time
- Python is a interpreted language
- Similar to perl, tcl, ruby, matlab etc

Why Python?

- Nowadays, Python is one of the most popular programming languages worldwide according to the TIOBE index and the number of programmers who use it is growing every day.
- The language has a huge community of developers around the world. If you have a problem, you can always ask other programmers for help or find a suitable answer on a site like stackoverflow.com
- Python has a wide range of possible applications, especially in:
  - web development
  - data science (including machine learning)
  - scripting (task automation, e.g. text processing or a simulation of typical user actions)
  - Desktop App (object methodology)

Short history of Python

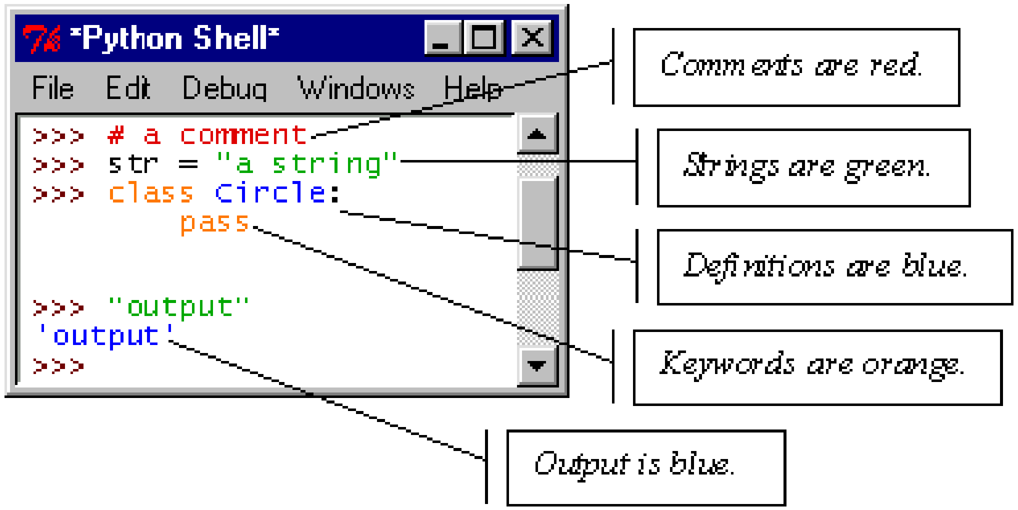
- Like other programming languages, Python has gone through a number of versions. Python 1.0 was released in 1994 and laid the basic principles of the language with emphasis on simplicity.
- Python 2.0 was released in 2000. This version has become very popular among programmers. Different 2.x subversions (2.6, 2.7) are still used in various projects and libraries. The symbol **x** in 2.x means any subversion of Python 2.
- Python 3.0 was the next major version released in 2008. It broke backward compatibility with its predecessors in order to rid the language of historic clutter and make Python more readable and consistent.
- So, today two similar but incompatible versions of Python are commonly in use. **Throughout this, we will learn Python 3.x**.

Python Interfaces

- IDLE – a cross-platform Python development environment
- PythonWin – a Windows only interface to Python
- Python Shell – running 'python' from the Command Line opens this interactive shell
- For the exercises, we'll use IDLE, but you can try them all and pick a favorite

IDLE – Development Environment

- IDLE helps you program in Python by:
  - color-coding your program code
  - debugging
  - auto-indent
  - interactive shell



```
>>> # a comment
>>> str = "a string"
>>> class Circle:
        pass

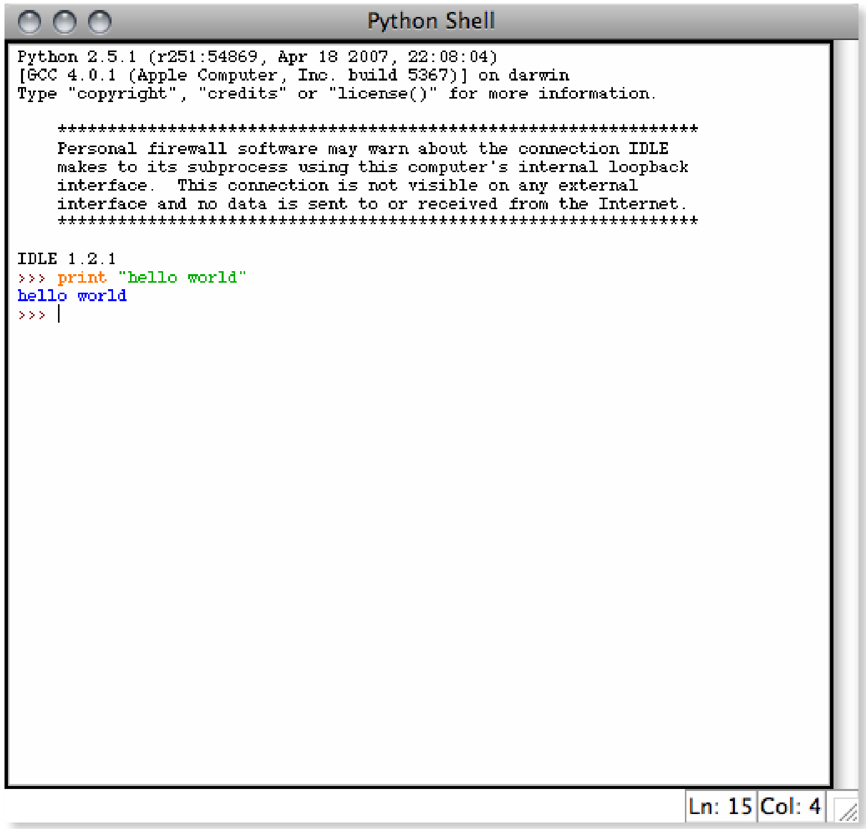

>>> "output"
'output'
>>>
```

Example Python

- Hello World

  `print("hello world")`

- Prints hello world to standard out
- Open IDLE and try it out yourself
- Follow along using IDLE



```
Python 2.5.1 (r251:54869, Apr 18 2007, 22:08:04)
[GCC 4.0.1 (Apple Computer, Inc. build 5367)] on darwin
Type "copyright", "credits" or "license()" for more information.

    ****************************************************************
    Personal firewall software may warn about the connection IDLE
    makes to its subprocess using this computer's internal loopback
    interface.  This connection is not visible on any external
    interface and no data is sent to or received from the Internet.
    ****************************************************************

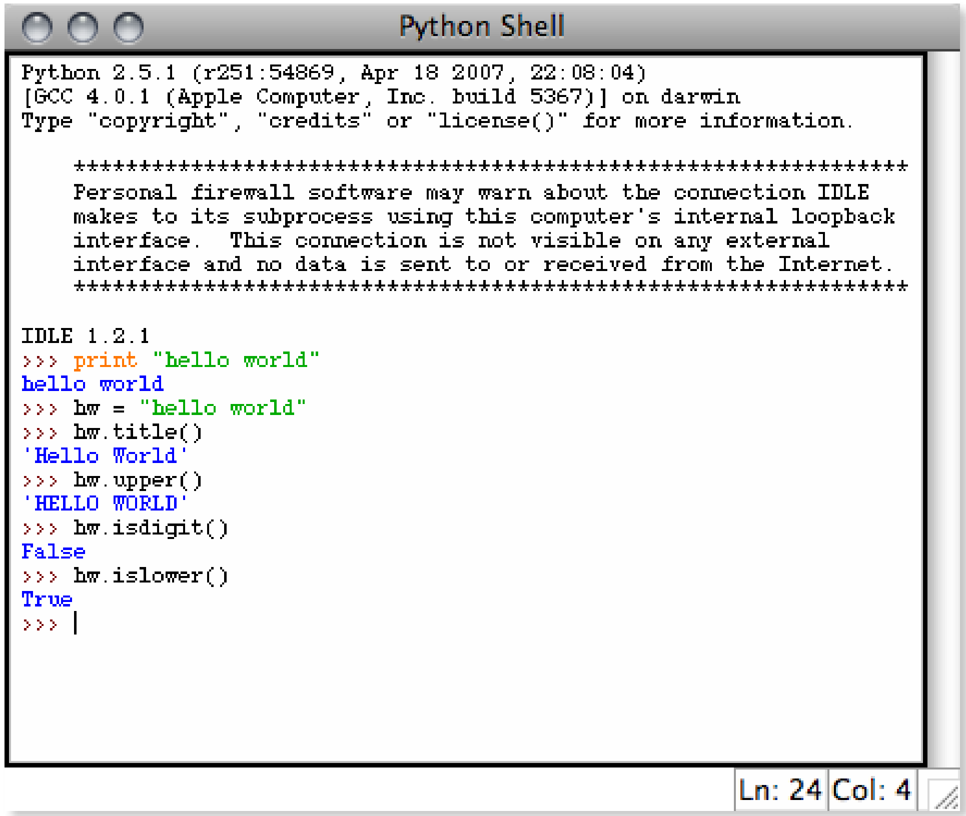
IDLE 1.2.1
>>> print "hello world"
hello world
>>> |
```

More than just printing

- Python is an object oriented language
- Practically everything can be treated as an object
- “hello world” is a string
- Strings, as objects, have methods that return the result of a function on the string

String Methods

- Assign a string to a variable
- In this case "`hw`"
- `hw.title()`
- `hw.upper()`
- `hw.isdigit()`
- `hw.islower()`



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IDLE 1.2.1
>>> print "hello world"
hello world
>>> hw = "hello world"
>>> hw.title()
'Hello World'
>>> hw.upper()
'HELLO WORLD'
>>> hw.isdigit()
False
>>> hw.islower()
True
>>> |
```

String Methods

- The string held in your variable remains the same
- The method returns an altered string
- Changing the variable requires reassignment
  - `hw = hw.upper()`
  - `hw` now equals “HELLO WORLD”

Other Python Objects

- Lists (mutable sets of strings)
  - `var = [] # create list`
  - `var = [‘one’, 2, ‘three’, ‘banana’]`
- Tuples (immutable sets)
  - `var = (‘one’, 2, ‘three’, ‘banana’)`
- Dictionaries (associative arrays or ‘hashes’)
  - `var = {} # create dictionary`
  - `var = {‘lat’: 40.20547, ‘lon’: -74.76322}`
  - `var[‘lat’] = 40.2054`
- Each has its own set of methods

Lists

- Think of a list as a stack of cards, on which your information is written
- The information stays in the order you place it in until you modify that order
- Methods return a string or subset of the list or modify the list to add or remove components
- Written as var[*index*], index refers to order within set (think card number, starting at 0)
- You can step through lists as part of a loop

List Methods

- Adding to the List
  - var[*n*] = *object*
    - replaces *n* with *object*
  - var.append(*object*)
    - adds *object* to the end of the list
- Removing from the List
  - var[*n*] = []
    - empties contents of card, but preserves order
  - var.remove(*n*)
    - removes card at *n*
  - var.pop(*n*)
    - removes *n* and returns its value

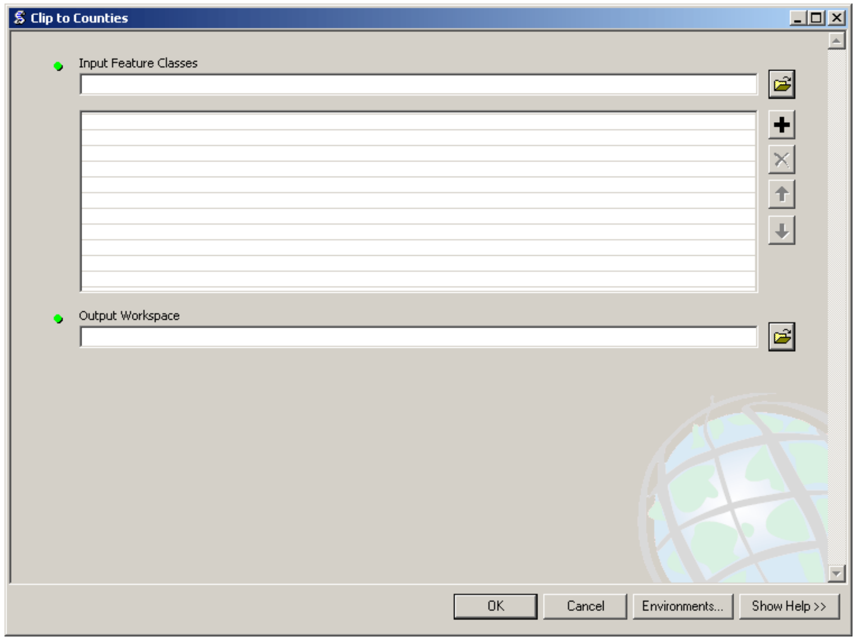
Lists in ArcToolbox

You will create lists:

- Layers as inputs
- Attributes to match
- Arrays of objects

You will work with lists:

- List of field names
- List of selected features



Tuples

- Like a list, tuples are iterable arrays of objects
- Tuples are immutable –
  once created, unchangeable
- To add or remove items, you must redeclare
- Example uses of tuples
  - County Names
  - Land Use Codes
  - Ordered set of functions

Dictionaries

- Dictionaries are sets of key & value pairs
- Allows you to identify values by a descriptive name instead of order in a list
- Keys are unordered unless explicitly sorted
- Keys are unique:
  - var[‘item’] = “apple”
  - var[‘item’] = “banana”
  - print var[‘item’] prints just banana

Indentation and Blocks

- Python uses whitespace and indents to denote blocks of code
- Lines of code that begin a block end in a colon:
- Lines within the code block are indented at the same level
- To end a code block, remove the indentation
- You'll want blocks of code that run only when certain conditions are met

Conditional Branching

- if and else

```
if variable == condition:
        #do something based on v == c
else:
        #do something based on v != c
```

- elif allows for additional branching

if *condition*:

elif *another condition*:

…

else: #none of the above

Looping with For

- For allows you to loop over a block of code a set number of times
- For is great for manipulating lists:

```
a = ['cat', 'window', 'defenestrate']
for x in a:
    print x, len(x)
```

Results:

```
cat 3
window 6
defenestrate 12
```

Looping with For

- We could use a for loop to perform geoprocessing tasks on each layer in a list
- We could get a list of features in a feature class and loop over each, checking attributes
- Anything in a sequence or list can be used in a For loop
- Just be sure not to modify the list while looping

Modules

- Modules are additional pieces of code that further extend Python’s functionality
- A module typically has a specific function
  - additional math functions, databases, network…
- Python comes with many useful modules
- *arcgisscripting* is the module we will use to load ArcGIS toolbox functions into Python

Modules

- Modules are accessed using import
  - import sys, os # imports two modules
- Modules can have subsets of functions
  - os.path is a subset within os
- Modules are then addressed by modulename.function()
  - sys.argv # list of arguments
  - filename = os.path.splitext("points.txt")
  - filename[1] # equals ".txt"

Files

- Files are manipulated by creating a file object
  - f = open("points.txt", "r")
- The file object then has new methods
  - print f.readline() *# prints line from file*
- Files can be accessed to read or write
  - f = open("output.txt", "w")
  - f.write("Important Output!")
- Files are iterable objects, like lists

Error Capture

- Check for type assignment errors, items not in a list, etc.
- Try & Except

```
try:
    a block of code that might have an error
except:
    code to execute if an error occurs in "try"
```

- Allows for graceful failure
  – important in ArcGIS

Additional Python Resources

- Python Homepage
  http://www.python.org/
- Dive Into Python
  http://www.diveintopython.org/
- Learning Python, 3rd Edition
  http://www.oreilly.com/catalog/9780596513986/
- Getting Started Writing Geoprocessing Scripts
  Available on ESRI's support page