Introduction to Python for ArcGIS Scripts Only

Description

Programming tools are now a standard feature within GIS software packages and allow GIS users to automate, speed up, and become more precise in their data management and analytic work. This workshop is designed for GIS users who have little to no experience with computer programming and will cover core programming concepts related to GIS using the Python programming language. The workshop will focus on guiding attendees through hands-on exercises designed to provide the essential skills to programmatically manipulate data as part of a GIS workflow. This workshop is designed to be preparation for the following workshop on **Advanced Python for ArcGIS, but may be taken independently**.

Specific Topics Include:

- Core Python programming concepts
- Introduction to ArcPy site package for ArcGIS
- Working with geospatial data using Python and ArcPy
- Simple data management and geoprocessing tasks

Computing and Software Needs

- Your may use your own laptop, however computers are available in the lab
- ArcGIS Desktop 10.x (Standard or Advanced preferred) or ArcGIS Pro 1.4+
- Python IDE
  - IDLE (https://docs.python.org/2/library/idle.html) is also shipped with ArcGIS for Desktop, so it can be used.
  - PyScripter (http://sourceforge.net/projects/pyscripter/files/) (v. 2.6.0 **32-bit** version) is good for ArcMap script development *NOTE:* The zip files contain portable versions of PyScripter. No installation is needed. Just unzip the archive and start using PyScripter.
  - Spyder IDE (https://github.com/spyder-ide) is better for ArcGIS Pro development, however this requires special installaiton instuctions to make it work with ArcGIS, so do not install this prior to the workshop; I can deal with this on a case-by-case basis

Instructor

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As the GIS Specialist in the Main Library at the University of Illinois at Urbana-Champaign, Mr. Whitacre's primary role is to provide GIS consultation and research assistance for faculty, staff, and students. Additionally, he teaches a myriad of GIS workshops for beginner to advanced users and helps manage the Library's GIS data and software assets. He is also a central resource for the GIS community on campus to promote the use of GIS in research. Mr. Whitacre holds a Master of Science in Geography and was previously the GIS Manager for the Carnegie Museum of Natural History.

II. Data and Software Setup

Download Exercise Data

GitHub: https://github.com/whitacrej/Python-For-ArcGIS-2017 (https://github.com/whitacrej/Python-For-ArcGIS-2017)

BOX: https://uofi.box.com/PythonForArcGIS (https://uofi.box.com/PythonForArcGIS)

- Extract the data to a folder on the Desktop or other well-known folder
- For folks who can't download the files, we have it on a flash drive

Type the code below into your IDE and run it....

- I will give an explanation of concepts, then have code examples that can be run in the IDE in the grey boxes.
- Please ***type*** the code as we go and try to ***avoid copy and pasting*** unless instructed otherwise. Typing the code will help you learn it better!
- When typing in the IDE, you will likely notice the auto complete functionality. Mastering this will help type code faster and with less mistakes. I will point out tips as we go.
- ***Congratulations***, this is your first code!!!

In [ ]:
```
print('hello world')
```

III. What is Python?

IV. Python Basics

In [ ]:
```
# This won't work in ArcGIS Pro (i.e. Python 3.x)
print 'Python is so cool!'
```

In [ ]:
```
print('Python is so cool!')
```

Variables

In [ ]:
```
food = 'cheese'

food_count = 6

print(food)
print(food_count)
```

In [ ]:
```
# cool tips...

food, food_count = 'bread', 100

print(food)
print(food_count)

food1 = food2 = food3 = 'banana'

print(food1)
print(food2)
print(food3)
```

Basic Data Types

Data Type	Examples
String	**“cheese”** or **'Food Time'**
Integer Number	**68** or **23456** or **0**
Float Number	**345.67** or **28.1** or **98.0**
Boolean	**True** or **False**
List	**[“apple”, “orange”]**
Tuple	**(“apple”, “orange”)**
Dictionary	**{“lat”:39.799, “lon”:-89.64}**

Strings

In [ ]:
```
print('cheese ' + 'whiz') # Note the space...
print('cheese' * 3) # Note no space...
print('cheese'[1:4])
print('cheese'[:2])
print('cheese'[:-2])
print('cheese'[2:])
print('cheese'[-2:])
```

Numbers

In [ ]:
```
print(5 + 7 - 3)

three = 3

print(5 + 7 - three)
```

Booleans

In [ ]:
```
print(True)
print(False)

a = True
b = False

print(a)
print(b)
```

In [ ]:
```
y = 0 # Run it once to evaluate, then change to 1 and run again; change to []
 and run again

if y:
    print(True)
else:
    print(False)
```

Lists

In [ ]:
```
fruitlist = ['apples', 'oranges', 'bananas']

print(fruitlist)

print(fruitlist[1])

print(fruitlist[1:3])

print(len(fruitlist))
```

In [ ]:
```
# Iterate over the list...more on this later
for fruit in fruitlist:
    print(fruit)
```

In [ ]:
```
# Change the list...
fruitlist = ['apples', 'oranges', 'bananas']

fruitlist[1] = 'peaches'
fruitlist.append('cherries')
fruitlist.remove('apples')
del fruitlist[1]

print(fruitlist)
```

Tuples

In [ ]:
```
fruittuple = ('apples', 'oranges', 'bananas')

print(fruittuple)
print(fruittuple[1])
print(fruittuple[1:3])
```

In [ ]:
```
fruittuple = ('apples', 'oranges', 'bananas')

for fruit in fruittuple:
    print(fruit)
```

In [ ]:
```
fruittuple[1] = 'peaches' # Invalid syntax with tuple, this will produce an er
ror, but it will work for a list
```

Dictionaries

In [ ]:
```
dicttest = {'key':'value', 'lat':39.98, 'long': -89.65}

print(dicttest['key'])
print(dicttest['lat'])
print(dicttest['long'])

print(dicttest.keys())

print(dicttest.values())
```

Data Type Conversion

In [ ]:
```
# Run the following code...What happens?

x = 99

print("There are " + x + " files.")

# Change x to be str(x)
```

In [ ]:
```
x = 99
s = "99"
l = [s, x]
t = (s, x)

print(type(x))
print(type(s))
print(type(l))
print(tuple(l))
print(type(t))
print(list(t))
```

Simple Math with Python

Python Arithmetic Operators

Operator	Description	Example
+ Addition	Adds values on either side of the operator.	`a + b = 30`
- Subtraction	Subtracts right hand operand from left hand operand.	`a – b = -10`
* Multiplication	Multiplies values on either side of the operator	`a * b = 200`
/ Division	Divides left hand operand by right hand operand	`b / a = 2`
% Modulus	Divides left hand operand by right hand operand and returns remainder	`b % a = 0`
** Exponent	Performs exponential (power) calculation on operators	`a**b =10 to the power 20`
// Floor Division	The division of operands where the result is the quotient in which the digits after the decimal point are removed. But if one of the operands is negative, the result is floored, i.e., rounded away from zero (towards negative infinity):	`9//2 = 4 and 9.0//2.0 = 4.0, -11//3 = -4, -11.0//3 = -4.0`

In [ ]:
```
print(1.5 + 2.5)

print(3.3 - 2.2)

print(2.0 * 2.2)

print(4.0 / 1.25)

print(4.0 // 1.2)

print(8 % 3)

x = 5
print(-x)
print(+x)

print(2 ** 3)
```

Python Basic Syntax

- Variables cannot start with a number or have a space in it

```
1line = 5 # This will not work...

  a line = 5 # Neither will this...
```

- Here is a list of common ***reserved words***; do **NOT** use these as variable names:

```
and, del, from, not, while, as, elif, global, or, with, assert, else, if, pa
ss, yield, break, except, import,
  print, class, exec, in, raise, continue, finally, is, return, def, for, la
mbda, try

  # Basically, if it turns a color when you are done typing it, don't use it
 as your variable's name!
  # There are likely many more reserved words!
```

- Variable name capitalization matters!!

```
Cat != cat
```

- Indentation matters!! AND...
- Colons matter!!

```
if x
  print(x)

  # Will not work, but this will:
  if x:
  ....print(x)

  # typically 2 or 4 spaces (represented by '.')
  # 4 spaces are prefered (using Tab in the IDE should do this automaticall
y)
```

- Quotations are a bit tricky, but very cool
  - Single (') , double (") and triple-single and triple-double (''' or """) quotes can be used to denote strings
  - Make sure to end the strip denotation with the same type of quote structure
  - Single quotes (') are the easiest to type (no Shift!!), so I default to them usually

```
# Examples

    word1 = 'Dog'
    word2 = "'Dog'"
    word3 = '"Dog"'
    print(word1, word2, word3)
    # The three words above will print: Dog, 'Dog', and "Dog"

    words1 = 'That's the dog's toy' # Is a syntax error
    words2 = "That's the dog's toy" # Prints: That's the dog's toy

    more_words = """She said, "Good dog!" And the dog's tail wagged."""
    # Prints: She said, "Good dog!" And the dog's tail wagged.
```

- Backslashes can be confusing...

```
# These are all the same thing...
  'C:\\data\\things' # I prefer this one when working in ArcGIS Pro...I will
 tell you why later
  'C:/data/things'
  r'C:\data\things' # I prefer this one when working in ArcMap...I will tell
 you why later
```

- Commenting is great!!
  - Use it to help document and explain your code...we will do this throughout the exercises!
  - Comments are not run in code; they are ignored
  - Blank lines are also ignored

```
    # This is a block comment
    ## So is this
    ### The blank line below this one will be ignored

    """ This is good for multi-line block comments
    Notice that this line is still a comment
    Use block commnets as mush as you need, but not too much
    Don't forget to close the multi-line comment"""

    s = 'something' # This is an in-line comment...use these sparingly i
    n your code
```

See the Style Guide for Python Code (https://www.python.org/dev/peps/pep-0008/) for more information

Conditional Statements and Decision Making

`if` Statements

Comparison Operators

Operator	Description	Example
==	If the values of two operands are equal, then the condition becomes true.	(1 == 2) is NOT true
!=	If values of two operands are not equal, then condition becomes true.	(1 != 2) is true
<>	If values of two operands are not equal, then condition becomes true. *This is the same as != operator, but is deprecated and not valid in Python 3.*	(1 <> 2) is true
>	If the value of left operand is greater than the value of right operand, then condition becomes true.	(1 > 2) is not true.
<	If the value of left operand is less than the value of right operand, then condition becomes true.	(1 < 2) is true.
>=	If the value of left operand is greater than or equal to the value of right operand, then condition becomes true.	(1 >= 2) is not true.
<=	If the value of left operand is less than or equal to the value of right operand, then condition becomes true.	(1 <= 2) is true.
and	Called Logical AND operator. If both the operands are true then then condition becomes true.	(a and b) is true
or	Called Logical OR Operator. If any of the two operands are non zero then then condition becomes true.	(a or b) is true
not	Called Logical NOT Operator. Use to reverses the logical state of its operand. If a condition is true then Logical NOT operator will make false.	not(a && b) is false
in	Evaluates to true if it finds a variable in the specified sequence and false otherwise.	x in y, here in results in a 1 if x is a member of sequence y
not in	Evaluates to true if it does not find a variable in the specified sequence and false otherwise.	x not in y, here not in results in a 1 if x is not a member of sequence y

Adapted from: https://www.tutorialspoint.com/python/python_basic_operators.htm (https://www.tutorialspoint.com/python/python_basic_operators.htm)

In [ ]:
```
a = 21
b = 10
c = 0

if a == b:
    print("Line 1 - a is equal to b")
else:
    print("Line 1 - a is not equal to b")

if a != b:
    print("Line 2 - a is not equal to b")
else:
    print("Line 2 - a is equal to b")

# This is novalid in Python 3:
# if a <> b:
#    print("Line 3 - a is not equal to b")
# else:
#    print("Line 3 - a is equal to b")

if a < b:
    print("Line 4 - a is less than b")
else:
    print("Line 4 - a is not less than b")

if a > b:
    print("Line 5 - a is greater than b")
else:
    print("Line 5 - a is not greater than b")
```

In [ ]:
```
a = 5;
b = 20;
if a <= b:
    print("Line 6 - a is either less than or equal to  b")
else:
    print("Line 6 - a is neither less than nor equal to  b")

if b >= a:
    print("Line 7 - b is either greater than  or equal to b")
else:
    print("Line 7 - b is neither greater than  nor equal to b")
```

Functions

```
# Basic Funtion syntax

    def functionname( parameters ):
        """function_docstring""" # This is optional, note triple-quotes
        function_suite
        return [expression]
```

Source: https://www.tutorialspoint.com/python/python_functions.htm (https://www.tutorialspoint.com/python/python_functions.htm)

Script Source: https://www.codecademy.com/learn/python (https://www.codecademy.com/learn/python)

In [ ]:
```
def tax(bill):
    """Calculates 8% tax of restaurant bill."""
    tax = bill * 0.08
    print('Tax: ${:0.2f}'.format(tax))
    return tax

def tip(bill):
    """Calculates 15% tip of restaurant bill."""
    tip = bill * 0.15
    print('Tip: ${:0.2f}'.format(tip))
    return tip

def totalbill(bill, tax, tip):
    """Calculates the total restaurant bill."""
    total = bill + tax + tip
    print('Total: ${:0.2f}'.format(total))
    return total

# Change the meal_cost value a few times to see how the results change
meal_cost = 100
print('Bill: ${:0.2f}'.format(meal_cost))

meal_tax = tax(meal_cost)
meal_tip = tip(meal_cost)
meal_total = totalbill(meal_cost, meal_tax, meal_tip)
```

Loops

for Loops

```
for item in list_of_items:
        # Do some code...
```

In [ ]:
```
a_list = ['a', 'b', 'c', 'd']

for item in a_list:
    print(item)
```

`while` Loops

```
i = 0 # This is called a sentry variable
    while i <= 10:
        print(i)
        i += 1 # Increment the sentry variable to ensure the exit condition
```

In [ ]:
```
i = 0

while i <= 10:
    print(i)
    i += 1
```

V. Calculate Fields Using Python

Using Python in the Field Calculator Window

1. Open the *Illinois.mxd* ArcMap document *or* Illinois.aprx ArcGIS Project File

2. Open the Attribute Table for the 'Illinois Counties' Layer

We see that there is a field named 'AREA', but we don't know the units.
Note the other fields

3. Add a field with the following parameters:

Name: AreaTest
Type: Double

4. Right-click on the new field header and select Field Calculator

5. Double click any field to add it to the expression box

Make sure the VB Script radio button is selected

6. Select the Python radio button and add the same field

What is different?
Clear the expression box when done

7. Click on the 'About calculating fields' link at the bottom left

Notice the different examples
Find the 'Code samples-geometry' section
These expressions can be used in lieu of the 'Calculate Geometry' window accessed t
hrough the attribute table
These expressions can also be used in the Calculate Field tool

8. Enter the following code in the expression box

Note: In ArcGIS Pro, Python becomes the default coding language for calculating fields and the above steps do not apply

In [ ]:
```
""" Note: The following code is intended to be used to calculate an attribute
 table field in
ArcGIS using the Field Calculator window or Calculate Field tool. """

# First try square meters

!Shape.area@SQUAREMETERS!

# How close are the vales compared to the AREA field?


# Second, try square miles

!Shape.area@SQUAREMILES!

# Are these vales closer to the AREA field? Do you think we can get better?


# Now try

!Shape.geodesicArea@SQUAREMILES!

# Which method is more acurate? Why do you think that is?


# One last trick, type:

None

# This will make all the values NULL in the field...it is good to know about!
```

Field Calculator (continued)

Now we know the units, but we want to calculate the population density. We also want to know the difference between the median and average household income.

1. Delete the 'AreaTest' field

Click 'Yes' on the warning

2. Add two fields with the following parameters:

Name: DensitySqmi
Type: Double
Alias: Density Per SqMi

Name: DiffIncome
Type: Double
Alias: Avergae vs. Median Income

3. Calculate the field using Python

Clear the expression box before each calculation
Make sure the Python radio button is selected
Enter the code below

In [ ]:
```
""" Note: The following code is intended to be used to calculate an attribute
 table field in
ArcGIS using the Field Calculator window or Calculate Field tool. """

# DensityPerSqmi calculation

!ACSTOTPOP! / !AREA!

############################################################

# DiffIncome calculation

!ACSAVGHINC! - !ACSMEDHINC!
```

Field Calculator Window (continued)

Now we would like to have three more fields for a short name, a long name, and a name with the area.

1. Add two fields with the following parameters:

```
Field 1:
    Name: NameLong
    Type: Text
    Alias: Long Name
    Length: 100

Field 2:
    Name: NameShort
    Type: Text
    Alias: Short Name
    Length: 50

Field 1:
    Name: NameArea
    Type: Text
    Alias: Name (with Area)
    Length: 100
```

2. Calculate the fields using Python

```
Clear the expression box before each calculation
Make sure the Python radio button is selected
Enter the code below
```

In [ ]:

```
""" Note: The following code is intended to be used to calculate an attribute
 table field in
ArcGIS using the Field Calculator window or Calculate Field tool. """

# NameLong calculation

!NAME! + ', ' + !STATE_NAME!

############################################################

# NameShort calculation

!NAME!.replace(' County', '')

# Note the first parameter...what do you notice?

############################################################

# NameArea calculation

!NAME! + ' (Area: ' + !AREA! + ' SqMi)'

# Did it work? Why or why not? Hint: Check the ArcMap Results window if you ca
n't figure it out
# Change the expression to be correct...


# NameArea can also be calculated this way

' '.join([!NAME!, '(Area:', str(!AREA!), 'SqMi)'])

# What do you notice that is different with the elements being joined? I'm loo
king for 2 specific things...
# Hint: Don't space out on me...and...0, 1, 2, 3
```

Field Calculator Window (continued)

Now we would like to classify the median income levels.

1. Add a field with the following parameters:

Name: IncomeLevel
Type: Text
Alias: Income Level
Length: 50

2. Calculate the fields using Python

Clear the expression box
Make sure the Python radio button is selected
Check the 'Show Codeblock' box
Enter the code below

3. When you have completed the calculation in the Field Calculator window, open the result from the Results window

How does this look different?

In [ ]:
```
""" Note: The following code is intended to be used to calculate an attribute
 table field in
ArcGIS using the Field Calculator window or Calculate Field tool. """

# When calulating a field, a function usually is used in the
# Pre-Logic Script Code:

def income_level(median_income, low_income, mid_income):
    """Classifies median income levels given low income and middle income valu
es"""
    if median_income < low_income:
        return 'Low Income'
    elif low_income <= median_income < mid_income:
        return 'Middle Income'
    else:
        return 'High Income'


# Expression:

income_level(!ACSMEDHINC!, 35000, 60000)
```

Field Calculator Window (continued)

Now we would like to know how many vertices are in each feature...just for fun!

We will use an example from the ArcGIS Desktop help for Calculate Field examples (http://desktop.arcgis.com/en/arcmap/latest/tools/data-management-toolbox/calculate-field-examples.htm#ESRI_SECTION1_C9E46547D3B246C1B89A36B0C84F7BA8). This page is a great resource.

1. Add a field with the following parameters:

```
Name: VertexCount
Type: Long Integer
Alias: Number of Vertices
```

2. Calculate the fields using Python

```
Clear the expression box
Make sure the Python radio button is selected
Make sure to check the 'Show Codeblock' box
```

Copy and Paste the code below (it is for demonstrating that while loops can be used in the Field Calculator)

In [ ]:
```
""" Note: The following code is intended to be used to calculate an attribute
 table field in
ArcGIS using the Field Calculator window or Calculate Field tool."""

# Pre-Logic Script Code:
def VertexCount(feat):
    partnum = 0

    # Count the number of points in the current multipart feature
    partcount = feat.partCount
    pntcount = 0

    # Enter while loop for each part in the feature (if a singlepart
    # feature this will occur only once)
    #
    while partnum < partcount:
        part = feat.getPart(partnum)
        pnt = part.next()

        # Enter while loop for each vertex
        #
        while pnt:
            pntcount += 1
            pnt = part.next()

            # If pnt is null, either the part is finished or there
            # is an interior ring
            #
            if not pnt:
                pnt = part.next()
        partnum += 1
    return pntcount


# Expression:

VertexCount(!Shape!)
```

Future Challenge: Try using Python with map labels in ArcGIS

Break

VI. Introduction to ArcPy

What is ArcPy?

`import` Statements

```
import arcpy
    import os
    import sys

    # Best practice is to stack each import statement as above, but this is not wro
ng:
    import arcpy, os, sys

    import arcpy as a # This can sometimes make things simpler; you can use a.whate
ver instead of arcpy.whatever
    from arcpy import da # Do this if you only want a specific part of the site pac
kage/module
    from arcpy.sa import * # This also works, but should be used sparingly
```

Importing ArcPy

In [ ]:
```
# Always import the ArcPy site package and other modules first in your script
# This may take a while if you are working outside of ArcGIS

import arcpy
```

Utilizing the ArcPy ArcGIS Desktop Help Documentation

VII. Using ArcPy in the ArcGIS Python Window

1. Download exercise data

GitHub: https://github.com/whitacrej/Python-For-ArcGIS-2017 (https://github.com/whitacrej/Python-For-ArcGIS-2017)

BOX: https://uofi.box.com/PythonForArcGIS (https://uofi.box.com/PythonForArcGIS)

- You should have already done this...but just is case you didn't

2. Open the 'Illinois.mxd' ArcMap Document *or* Illinois.aprx ArcGIS Project File

3. Open the Python Window in ArcGIS

- Click the Python widow button and dock it
- Allows for running geoprocessing tools while also taking advantage of other Python modules and librarires
- Can be used for single-line code (e.g. Used instead of ArcToolbox to access tools)
- Can be used for testing syntax and longer, more complex scripts that might be used for automating workflows
- Replaces the Command Line from earlier releases of ArcGIS (pre-10.x)

The Python Window (ArcMap)

- Left side is the interactive Python interpreter panel
  - This is where code is entered
  - Note the three greater-than symbols (>>>)
- Right side is the help and syntax panel
- Code is generally executed one line at a time and displayed immediately. Exceptions include:
  - Multi-line constucts (such as `if` statements)
  - Pressing SHIFT or CTRL + ENTER at the end of a line of code (you may need to hit ENTER a few times when you are ready to run the code)
- Other Advanatages of the Python window
  - Autocompletion
  - Conditional and Iteration executuion
  - Scripts can be saved and reused or opened with another Python IDE

See http://desktop.arcgis.com/en/arcmap/latest/analyze/executing-tools/what-is-the-python-window-.htm (http://desktop.arcgis.com/en/arcmap/latest/analyze/executing-tools/what-is-the-python-window-.htm) for more info

Describing Data with ArcPy

System Paths vs. Catalog paths

- System paths are recognized by the Windows operating system
  - Files in folders
  - Ex. Shapefiles and rasters
- Catalog paths are only recognized by ArcGIS
  - Used for feature classes and other data in geodatabases
  - Geodatabases could be file (.gdb), personal (.mdb) or enterprise (.sde)
  - Contain 2 parts:
    - Workspace - could be the geodatabase root or a feture dataset
    - Base name - the feature class, raster, or other file types that can be saved in geodatabases
  - Requires the programmer to be aware of the context inwhich the path is being used

Type, do not copy, the following code into the Python window

Note: The following code is intended to only be run in the Python window of ArcGIS

In [ ]:
```
# Step 1:
import arcpy

file_name = r'C:\Data\CSV\JeopardyContestants_LatLon.csv'
print(arcpy.Exists(file_name))

# What kind of path is this? System or Catalog?
# What is the result?


# Try again, this time, but type the up arrow to reload the last code
# Replace the '...' with the location where you placed your downloaded data
# I also have a cool trick...drag, drop, and roll!

file_name = r'C:\...\Data\CSV\JeopardyContestants_LatLon.csv'
print(arcpy.Exists(file_name))

# Does it exist? Keep trying until you get the path correct and the result ret
urns True


print(arcpy.Describe(file_name).dataType)

# What type of data is this?
```

In [ ]:
```
# Step 2:

# Replace the '...' with the location where you placed your downloaded data

feature_class = r'C:\...\Data\Illinois.gdb\Illinois_Counties'
# What kind of path is this?

print(arcpy.Exists(feature_class))

print(arcpy.Describe(feature_class).dataType)
# What type of data is this?
```

In [ ]:
```
# Step 3:

layer_name = 'Illinois Counties'

# What kind of path is this? System or Catalog?

print(arcpy.Exists(layer_name))

lyr_desc = arcpy.Describe(layer_name)
# Note how this Describe function and variable look different than before...
# We can have describe objects become variables to be used later

print(lyr_desc.dataType)
# What type of data is this?

# For layers, there is a Describe property called 'dataElement' that accesses
# the 'dataType' of what the layer is referencing

print(lyr_desc.dataElement.dataType)
# What type of data is this?
```

What is the difference between the last two print statements?

Lets look at the help:

- http://desktop.arcgis.com/en/desktop/latest/analyze/arcpy-functions/describe-object-properties.htm (http://desktop.arcgis.com/en/desktop/latest/analyze/arcpy-functions/describe-object-properties.htm)
- http://desktop.arcgis.com/en/desktop/latest/analyze/arcpy-functions/layer-properties.htm (http://desktop.arcgis.com/en/desktop/latest/analyze/arcpy-functions/layer-properties.htm)

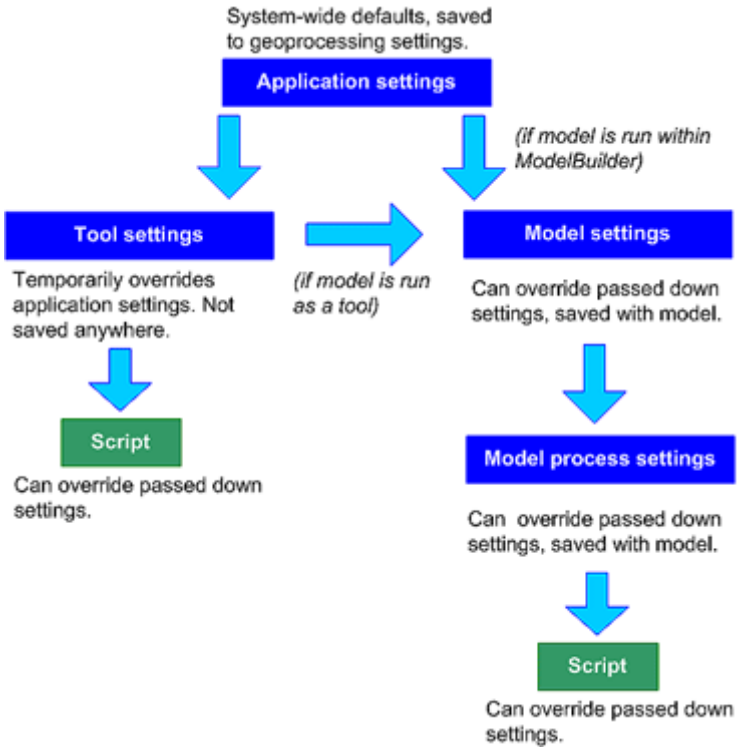
In [ ]:
```
# Step 4:

lyr_datatype = lyr_desc.dataElement.dataType

lyr_path = lyr_desc.path

lyr_basename = lyr_desc.baseName

lyr_spatialref = lyr_desc.spatialReference.name

lyr_count = arcpy.GetCount_management(layer_name)

# Here is a new way to format strings with inline variable substitution

print('{} is a {} stored at {} with a file name of {} with the {} coordinate s
ystem and contains {} features.'\
    .format(layer_name, lyr_datatype, lyr_path, lyr_basename, lyr_spatialref,
lyr_count))

    # The slash does not need to be typed, it is there for formatting purposes
```

Formatting Strings

Listing Data with ArcPy

Environmental Settings

http://desktop.arcgis.com/en/desktop/latest/tools/environments/what-is-a-geoprocessing-environment.htm (http://desktop.arcgis.com/en/desktop/latest/tools/environments/what-is-a-geoprocessing-environment.htm)



See http://desktop.arcgis.com/en/desktop/latest/tools/environments/environment-levels-and-hierarchy.htm (http://desktop.arcgis.com/en/desktop/latest/tools/environments/environment-levels-and-hierarchy.htm)

Type, do not copy, the following code into the Python window

Clear the Python window

Note: The following code is intended to only be run in the Python window of ArcGIS

In [ ]:
```
# Step 1:

# First, we must set the environmental settings
# Replace the '...' with the location where you placed your downloaded data
# Don't forget...drag, drop, and roll!
arcpy.env.workspace = r'C:\...\Data\CSV'

print(arcpy.ListFiles())

# How many files are listed?


arcpy.env.workspace = r'C:\...\Data\Illinois.gdb'

print(arcpy.ListFiles())

print(arcpy.ListFeatureClasses())

# What is the difference between the two list functions?
```

In [ ]:
```
# Step 2:

print(arcpy.ListFields('Illinois Counties'))

# What is the result? Can you understand it?
# What is actually being output in this case? (Hint: What type of object?)

fields = arcpy.ListFields('Illinois Counties')
print(type(fields[0]))

# We can print each field name...
for field in fields:
    print(field.name)

# Or the field aliases...
for field in fields:
    print(field.aliasName)
```

In [ ]:
```
# Step 3:
# We can also create a list of the field names; this is called a 'list compreh
ension' and they are very powerful

field_list = [field.name for field in arcpy.ListFields('Illinois Counties')]

print(field_list)

# How does this result look differently than above?

test_field = 'OBJECTID'

if test_field in field_list:
    print('{} exists'.format(test_field))
else:
    print('{} does not exist'.format(test_field))

# Repeat the above code using a test field that you know doesn't exist to test
 the 'else:' statement code
# Does it work?
```

List Comprehensions

Geoprocessing Tools with ArcPy

Type, do not copy, the following code into the Python window

Clear the Python window

Note: The following code is intended to only be run in the Python window of ArcGIS

In [ ]:
```
# Step 1:
import arcpy

layer_name = 'Illinois Counties'

expression = 'ACSMEDHINC <= 40000'

arcpy.SelectLayerByAttribute_management(layer_name, 'NEW_SELECTION', expressio
n)

# Now clear the selection
arcpy.SelectLayerByAttribute_management(layer_name, 'CLEAR_SELECTION')
```

In [ ]:
```
# Step 2:

# Ensure that a default geodatabase is set
arcpy.env.workspace = r'C:\...\Data\Illinois.gdb'

# Create a variable for dissolve fields
dissolve_fields = ['STATE_NAME', 'ST_ABBREV']

# New drag, drop, and roll trick...using tools from the toolbox!

arcpy.Dissolve_management(layer_name, 'Illinois', dissolve_fields, '', 'SINGLE
_PART', 'DISSOLVE_LINES')

arcpy.PolygonToLine_management('Illinois', 'Illinois_Boundary')

# You may want to rearrage your layers in the TOC
```

In [ ]:
```
# Step 3:

# Replace the '...' with the location where you placed your downloaded data

csv_file = r'C:\...\Data\CSV\JeopardyContestants_LatLon.csv'

arcpy.CopyRows_management(csv_file, 'JeopardyContestants_Table')

arcpy.MakeXYEventLayer_management('JeopardyContestants_Table', 'lon', 'lat',
'Jeopardy Contestants')

arcpy.Select_analysis('Jeopardy Contestants', 'JeopardyContestants', '"lat" IS
 NOT NULL OR "lon" IS NOT NULL')
# Note the quotes!!

arcpy.Buffer_analysis('JeopardyContestants', 'JeopardyContestants_Buffer', '5
 Miles', 'FULL', 'ROUND', 'ALL', '', 'GEODESIC')
```

Your turn:

1: Write code to clip the buffer to the Illinois state layer

```
Be careful with which tool you choose...there are few tools named 'Clip_...'
```

2: Write code to intersect the new buffer to the Illinois Counties layer

```
You might need to check the tool's help documentation...
```

3: Save your work as a text file (.txt) in the 'Scripts' folder (ArcMap only)

```
Open the text file and view it in a text editor (like Notepad)
```

4: Save your work as a Python file (.py) in the 'Scripts' folder

```
After saving, open the .py file in PyScipter or other IDE
You may need to clean up the script for any mistakes or extraneous code (look back
 at your errors...and delete!)
```

5. Load the Python file back into the Python window

```
Clear the Python window in ArcGIS
Try running the whole script at once
This is one way you can create, save, and reuse a script for use again!
```

Complete!

VIII. Conclusion

In [ ]:
```
print('Have a great evening. Ta ta for now!')
```