

Federal GIS Conference

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Python: Beyond the Basics

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Agenda

- **Intro**
- **Intermediate skill set**
 - **Script tools**
 - **Cursors**
 - **List comprehensions**
 - **Geometry objects**
 - **Server, co-presenter**
 - **Mapping**
- **Wrap up**

Script Tools



- Well-developed and complete Python script → Script Tool
- Help → <http://desktop.arcgis.com/en/desktop/latest/analyze/creating-tools/a-quick-tour-of-creating-script-tools.htm>
- Formal geoprocessing tool, integrated with the geoprocessing framework
- Advantages:
 - More accessible than a stand-alone script, Easy to use
 - More flexible, with arguments
 - Can be put into a model
 - Can be run in the Python window, need to import its custom toolbox
 - Easy to share
 - Geoprocessing Package
 - Service

Dynamic Scripts

- **To replace hard-coded variables, allow for user declared input**
- **Add argument/parameter**
- **arcpy.GetParameterAsText function allows user input values to be passed at runtime**
- **Requires an index value corresponding to the order of inputs**
 - **arcpy.GetParameterAsText(0) is for input item 1, arcpy.GetParameterAsText(1) is for input item 2, and so on**
- **Use the Add Script wizard to take a script from a stand-alone script to a script tool**

Demo

- **Script tools**
- **Help** → <http://desktop.arcgis.com/en/desktop/latest/analyze/creating-tools/a-quick-tour-of-creating-script-tools.htm>

Data Cursors

- Key for many data management and analysis workflows
- Help → <http://desktop.arcgis.com/en/desktop/latest/analyze/python/data-access-using-cursors.htm>
- Provides access to data (attributes and geometry) in tables and feature classes
- Allows for reading, editing and inserting data

CURSOR TYPE	PURPOSE	SYNTAX
Search	Read-only access	<code>arcpy.da.SearchCursor(in_table, field_names, {where_clause}, {spatial_reference}, {explode_to_points}, {sql_clause})</code>
Insert	Write access, add rows	<code>arcpy.da.InsertCursor(in_table, field names)</code>
Update	Read-Edit access, update or delete rows	<code>arcpy.da.UpdateCursor(in_table, field_names, {where_clause}, {spatial_reference}, {explode_to_points}, {sql_clause})</code>

Cursor Performance

- Use only those fields you need
- Use tokens
 - Get only what you need
 - *Full geometry is expensive*

- **SHAPE@XY** —A tuple of the feature's centroid x,y coordinates.
- SHAPE@**SHAPE@XY** —A tuple of the feature's true centroid x,y coordinates.
- SHAPE@X —A double of the feature's x-coordinate.
- SHAPE@Y —A double of the feature's y-coordinate.
- SHAPE@Z —A double of the feature's z-coordinate.
- SHAPE@M —A double of the feature's m-value.
- SHAPE@JSON — The esri JSON string representing the geometry.
- SHAPE@WKB —The well-known binary (WKB) representation for OGC geometry. It provides a portable representation of a geometry value as a contiguous stream of bytes.
- SHAPE@WKT —The well-known text (WKT) representation for OGC geometry. It provides a portable representation of a geometry value as a text string.
- SHAPE@ —A [geometry](#) object for the feature.
- SHAPE@AREA —A double of the feature's area.
- SHAPE@LENGTH —A double of the feature's length.
- OID@ —The value of the [ObjectID](#) field.

Data Cursors

- Two types
 - *****Data Access cursors use lists and tuples**

- `arcpy.da.<>`
- Values are accessed by index
- Very good performance
- Use this type!

```
>>> import arcpy
>>> fc = r'C:\GIS_Data\Landmarks.gdb\hospitals'
>>> fields = ["NAME", "ADDRESS", "TELEPHONE", "TYPE"]
>>> EXP = "'STATE' = 'DC'"
>>> with arcpy.da.SearchCursor(fc, fields, where_clause=EXP) as cur:
...     for row in cur:
...         print("{} , {} , {} , {}".format(row[0], row[1], row[2], row[3]))
...
RIVERSIDE HOSPITAL, 4460 MACARTHUR BOULEVARD NORTHWEST, 202-333-9355, LEVEL 1 TRAUMA
SIBLEY MEMORIAL HOSPITAL, 5255 LOUGHBORO ROAD NORTHWEST, 202-537-4000, ACUTE
```

- **Classic cursors use row objects**
 - `arcpy.<>`
 - Values are accessed by `setValue/getValue`

```
import arcpy

# Create insert cursor for table
rows = arcpy.InsertCursor("c:/base/data.gdb/roads_lut")

# Create 25 new rows. Set the initial row ID and distance values
for x in xrange(1, 26):
    row = rows.newRow()
    row.setValue("rowid", x)
    row.setValue("distance", 100)
    rows.insertRow(row)

# Delete cursor and row objects to remove locks on the data
del row
del rows
```


List Comprehensions

- Concise, efficient code writing
- Returns a result list
- Help → <https://docs.python.org/2/tutorial/datastructures.html#list-comprehensions>

```
• >>> distances = [10, 50, 200]
• >>> new_distances = ['{} feet'.format(d) for d in distances]
• >>> print(new_distances)
['10 feet', '50 feet', '200 feet']

• >>> field_names = [f.name for f in arcpy.ListFields(table)]
• >>> print(field_names)
[u'OBJECTID', u'NAME', u'ADDRESS']

• >>> field_names = [f.name for f in arcpy.ListFields(table) if not f.required]
• >>> print(field_names)
[u'NAME', u'ADDRESS']
```

Geometry Objects

- **Help automate tasks, perform analysis, automate data updates**
- **Help** → <http://desktop.arcgis.com/en/desktop/latest/analyze/arcpy-classes/geometry.htm>
- **Frequently used with cursors**
- **Exists in memory, aids in performance**
 - no need to create temporary feature classes on disk
 - Deleted from memory upon app completion
- **Ability to build point, multipoint, line, polygon**
- **Can return such things as JSON/WKT/WKB, area, centroid, pointCount, etc**
- **Methods for such tasks as buffer, clip, intersect, projectAs, etc**



2015 Esri Federal GIS Conference

Python: Beyond the Basics

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<https://github.com/aschumpert/arccgispython>



Introduction

- **About Me...** I work for KEYW, where I provide **Data Integration & System Administration** to multiple enterprise **ArcGIS Server** sites
- **Python** allows me to automate repetitive and complex workflows
- **Some of what I'm using Python for:**
 - Automate the editing of **ArcGIS Server** services
 - Using **arcpy** and **SQL** to directly query an **Oracle Geodatabase**

automate the editing of ArcGIS Server 10.2.2 services

Python Script #1

- Andrew Schumpert | KEYW Corp | Python for ArcGIS Server Administration

Problem to Solve

- **Hundreds of published ArcGIS services that need to be configured in a consistent and timely fashion**
- **A staff of 10 or so people working on different teams results in variances in how the services are published**
- **Some of the service properties have to be set via the ArcGIS Server admin site which can lead to greater chance for mistakes**
- **Using Python to script and automate these service edits resulted in:**
 - **Services with consistent and correct properties**
 - **Time and labor savings from not having to perform some of the configuration when publishing and from not having to regularly review 100s of services**
 - **The ArcGIS Server site and services run with fewer issues to troubleshoot**
 - **Andrew Schumpert | KEYW Corp | Python for ArcGIS Server Administration**

Pseudo Code

1. **Generate an authentication token to ArcGIS Sever**
2. **Get list of services**
3. **For each service:**
 1. **Get properties of service**
 2. **Examine property values and edit if needed**
 3. **If properties are edited, post updates back to the service**

- **Review the Code**
- **Live demo using ArcGIS Server**

Using arcpy and SQL to directly query an Oracle Geodatabase

Python Script #2

- Andrew Schumpert | KEYW Corp | Python for ArcGIS Server Administration

Problem to Solve

- **We needed a way to list the features in a geodatabase for use in reports or as input to various data management scripts**
- **arcpy.List..., arcpy.Describe, and arcpy.DA.walk performed too slow when querying very large geodatabases with thousands of feature datasets**
- **We knew that accessing our Oracle database with SQL had really good performance, and so arcpy.ArcSDESQLExecute() turned out to be the solution**

Pseudo Code

1. **Connect to the Oracle geodatabase**
2. **Loop through some SQL queries to get feature datasets, feature classes within datasets, feature classes (not within a dataset), tables, raster datasets, and raster catalogs**
3. **Return the list of features**

- **Review the Code**

Comparative Metrics

Average time to query a GDB schema owner for its features in a very large geodatabase.

Process	Time	Peak Memory
arcpy.ArcSDESQLExecute	2 seconds	325 MB
arcpy.List...	5 minutes	4.16 GB
arcpy.Describe	7 minutes	414 MB
arcpy.Da.Walk	1 hour 35 minutes	384 MB

- Andrew Schumpert | KEYW Corp | Python for ArcGIS Server Administration

General Tips & Suggestions

- **Organize common or core code into Python modules to keep from reproducing the same functionality over and over, and to abstract away mundane details from the primary scripts**
- **Provide metadata within the script and perhaps as a ReadMe file so others can understand its purpose and how its being used**
- **Build upon the examples found in Esri documentation or others, and then change for your needs**

Questions ?

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<https://github.com/aschumpert/arcgispython>



Mapping Module

- **Part of the ArcPy Site Package, arcpy.mapping**
- **Help** → <http://desktop.arcgis.com/en/desktop/latest/analyze/arcpy-mapping/introduction-to-arcpy-mapping.htm>
- **Designed to automate the updating of map components**
 - Inventory contents of map docs, such as layers, data frames, layouts... access properties
 - Update layer symbology, definition queries, layout elements, map doc metadata
 - Automate the save, export and printing of maps
- **Functionality of the script can be published as a service**
- **Data Drive Pages for producing Map Books**

Demo

- **Mapping Module**
- **Simple script, made into script tool, used in ArcMap to update the definition query of all layers in the map, show only features in each layer where state equals user's choice**

```
import arcpy
userState = arcpy.GetParameterAsText(0)
mxd = arcpy.mapping.MapDocument('CURRENT')
layers = arcpy.mapping.ListLayers(mxd)
defQuery = "STATE = " + userState + ""
for lyr in layers:
    lyr.definitionQuery = defQuery
arcpy.RefreshActiveView()
arcpy.RefreshTOC()
```

What's New?

- **At 10.3... not much really, fairly stable and complete ☺ , but certainly still growing and improving**
 - http://desktop.arcgis.com/en/desktop/latest/main/get-started/whats-new-in-arcgis.htm#ESRI_SECTION1_67453F1014684120AE49B7BACE346558
- **Python and ArcGIS Pro**
 - **ArcGIS Pro**
 - **New Application Jan 2015!**
 - **The essential application for creating and working with spatial data on your desktop. It provides tools to visualize, analyze, compile, and share your data, in both 2D and 3D environments.**
 - **Works side by side with desktop, not a replacement**
 - **Python**
 - **Runs with v3.4.1, desktop is v2.4**
 - <http://pro.arcgis.com/en/pro-app/arcpy/get-started/python-migration-for-arcgis-pro.htm>

Help Resources, Beginners through Advanced

- **ArcGIS Resources** -- <http://resources.arcgis.com/en/home/>
 - Help Documentation
 - Forums
 - Videos
 - Blogs
- **Python for ArcGIS** -- <http://resources.arcgis.com/en/communities/python/>
- **ArcPy Café** -- <https://arcpy.wordpress.com/>
- **Esri's Geography Channel, Tech Workshops** -- <http://geochannel.esri.com/index.cfm?event=video.home>
- **Python Documentation** -- <https://docs.python.org> (2.7 or 3.4)
- **Esri's GeoNet** -- <https://geonet.esri.com/welcome>
- **Google Python group** -- <https://groups.google.com/forum/?fromgroups#!forum/comp.lang.python>
- **GitHub** -- <https://github.com>, <https://github.com/Esri>

Training Resources, Intermediate+ level

- Previous slide
- Esri training...
 - Instructor led, 3-day course, \$, Beginner to intermediate
 - Several 1-3 hour web courses, Live Training Seminars (recorded)
 - Creating Desktop Add-ins Using Python
 - Creating Python Toolboxes
 - Python Scripting for Map Automation
- Several hardcopy books available, varying levels of experience... explore at will!
- Conference proceedings at <http://video.esri.com/> or <http://geochannel.esri.com>
- 3rd party Python training
 - O'Reilly School of Technology -- [Getting more out of Python](#) and [The Python Environment](#)
 - Udemy -- <https://www.udemy.com/python-the-next-level/>

Upcoming Workshops at FedGIS...

- It's over 😊 😞
- **Several Tech Sessions at Wednesday's Developer's Summit DC – Join Us!!**

Slides for this presentation....

- Will be available online in 2-3 weeks
- View and download at <http://proceedings.esri.com/library/userconf/index.html>
- Or just search 'esri conference proceedings', first returned link will take you to a list of recent proceedings
- Click on the event of interest – PDF or PPTX or video possibly available

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Understanding our world.