**Python Training: Batch Processing and Geoprocessing**

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*\*Note Python script spacing in these examples is for a demonstration of how the scripts should look in Python or the Python Ide (Idle). Copying and pasting scripts in Python may not work because the spacing will not be correct.*

**1. DOS and Python**

**1.1. To use Python in a DOS prompt either:**

1. Open a DOS command prompt
2. Type in the full path to your python.exe file (i.e. C:\Python25\python.exe)
3. Return



**Figure 1**: Python program in the DOS prompt window. Notice that your version of Python is printed under your command line (i.e. Python 2.5.1)

**1.2. Or, set environmental variable “Path” to the python.exe:**

1. Go to “Control Panel\All Control Panel Items\System” on your computer
2. Select Advanced system settings
3. Select Environmental Variables
4. Highlight “Path” under “System Variables”
5. Select “Edit”
6. In the “Variable value:” box type “;” (a semicolon) after the last item in the list of variables (e.g. E:\Perl\bin) and type in the folder location in that holds your python.exe file (e.g. E:\Perl\bin; C:\Python25) and click “OK”. Do not put a “;” (a semicolon) after the Python folder.

-If you set your Python path correctly, you should now be able to access Python using a DOS prompt.

-To test whether you can use Python in Dos:

1. Open a DOS command prompt
2. Type in: python
3. Return

-You should now be able to type in your python commands (see Figure 1).

**2. Python Versions**

-You can install multiple versions of Python on your computer; however, you will need to determine which version you are currently running as the default.

**2.1. Determine Current Version of Python**

# Print the current version of Python you are using

import sys

print sys.version

**2.2. Change Your Computer’s Default Version of Python**

-If you have different versions of Python installed, to change the version of Python that your machine is currently using as the default:

1. Open a DOS command prompt
2. Type in: ftype Python.File=”C:\Python25\python.exe” “%1” %\*

(In this example I typed the location of my Python 2.5 python.exe file, you can change the file location to whichever version of python you want to use.)

1. Return
2. Type in: Assoc .py = Python.File
3. Return

**3. Multiple File Loops**

**3.1 os.walk**

*import os*

*# Path to input file*

*InFile = "D:\\Temp\\"*

*# Walk through nested files in your directory structure.*

*for root, dirs, files in os.walk(InFile, topdown=False):*

 *for r\_in in files:*

 *if r\_in.endswith('.tif'):*

 *# Join the path and file together*

 *InRaster = os.path.join(root, r\_in)*

 *else:*

 *pass*

**3.2. Glob**

*# Examine folders for all files*

*import glob*

*# Change \* to \*.tif if looking for TIF files*

*InFile = "D:\\Temp\\\*"*

*#Examine each file in the list created by the glob command*

*for f in glob.glob(InFile):*

 *print f*

**4.0 Determine Whether File Exists**

*import os*

*InFile = "D:\\Temp\\"*

*# Determine if Path exists, if not, make a directory.*

*if not os.path.exists(InFile):*

 *# If file doesn’t exist, insert function here…*

 *os.mkdir(InFile)*

*else:*

 *pass*

**5. ArcGIS**

**5.1. ArcGIS Versioning**

-Determine which version of ArcGIS is installed on your computer:

*import \_winreg*

*# Use winreg to check your registry for the version of ArcGIS installed on your machine.*

*hkey = \_winreg.OpenKey(\_winreg.HKEY\_LOCAL\_MACHINE, "SOFTWARE\ESRI\ArcGIS", 0,*

*\_winreg.KEY\_READ)*

*val,typ = \_winreg.QueryValueEx(hkey, "RealVersion")*

*\_winreg.CloseKey(hkey)*

*version = val[0:3]*

*print version*

**5.2. ArcGIS 9.\***

-Version 9.\* uses Python 2.5

# Calling ArcGIS 9.\* from Python

*import arcgisscripting*

*gp = arcgisscripting.create()*

# gp is the geoprocessing object (i.e. gp.describe()) for calling the different processing functions # within ArcGIS.

-ArcGIS often requires that you set your workspace folder.

ArcGIS 9.\*

# There are multiple ways to tell Arc which folder is your working directory

*gp.workspace = “D:/Temp/”*

*gp.workspace = “D:\\Temp\\”*

*gp.workspace = r’D:\Temp’*

**5.2. ArcGIS 10.\***

ArcGIS Version 10.0 uses Python 2.6 and Version 10.1 uses Python 2.7

# Calling ArcGIS 10.\* from Python

*import arcpy*

# arcpy is the object (i.e. arcpy.Describe()) for calling the different processing functions within

# ArcGIs.

ArcGIS often requires that you set your workspace folder.

ArcGIS 10.\*

# Arc 10 requires that you important the environmental module (env)

*from arcpy import env*

# There are multiple ways to tell Arc which folder is your working directory

*env.workspace =“D:/Temp/”*

*env.workspace = “D:\\Temp\\”*

*env.workspace = r’D:\Temp’*

**6. ERDAS Imagine**

**6.1. Image Command Tool**

-Need to create three files:

1. .bat-“Batch” file: Runs the file from DOS
2. .bcf-“Batch Command File”: Contains the ERDAS commands
3. .bls-empty file that ERDAS utilizes

-Pyramids and Statistics example

*import os*

*import shutil*

*# Change these paths according to your computer setup*

*InFolder = 'D:\\update\_2010\\Review\\'*

*# Path on your computer to modeler.exe*

*ERDAS = 'C:\\ERDAS\\Geospatial Imaging 9.3\\bin\\ntx86\\batchprocess.exe'*

*# BLS-Empty file required by ERDAS*

*bls\_filename = InFolder + 'pystats.bls'*

*bls = open(bls\_filename, 'w')*

*bls.close()*

*# BCF-Insert ERDAS command lines here.*

*bcf\_filename = InFolder + 'pystats.bcf'*

*bcf = open(bcf\_filename, 'w')*

*BcfOut = []*

*for root, dirs, files in os.walk(InFolder, topdown=False):*

 *for img in files:*

 *if img.endswith('.img'):*

 *ImgIn = (os.path.join(root, img)).replace('\\', '/')*

 *Rrd = img.replace('.img', '.rrd')*

*# Determine whether .rrd images exist*

 *if not os.path.exists(Rrd):*

 *# Insert the image command tool build pyramids here with your file information.*

 *BcfOut.append('imagecommand ' + ImgIn + ' -stats 0 0.0000000000000000e+000 1'\*

 *' 1 Default 256 -aoi none -pyramid 3X3 1 -meter imagecommand' +\*

 *'\n')*

 *else:*

 *pass*

 *else:*

 *pass*

*bcf.writelines(BcfOut)*

*bcf.close()*

*# BAT-Create Bat file to run required ERDAS files*

*bat\_filename = InFolder + 'pystats.bat'*

*bat = open(bat\_filename, 'w')*

*Lines = '"' + ERDAS + '" -bcffile ' + '"' + bcf\_filename.replace('/', '\\') + '" -blsfile "' +\ bls\_filename.replace('/', '\\') + '"' + '\n'*

*bat.writelines(Lines)*

*bat.close()*

*# Runs script using DOS. ERDAS Version 9 and below require ERDAS to be open*

*os.system(bat\_filename)*

**6.2. Modeler .mdls**

-Need to create:

1. .bat file
2. .mdl file

-Mdl example

*import os*

*import sys*

*# sys.argv allows you to enter in extra data in the*

*# DOS command prompt (i.e. script.py 1739)*

*PR = sys.argv[1]*

*P = PR[0:2]*

*R = PR[2:4]*

*InFolder = 'E:\\BAE\\' +\*

 *'p0' +\*

 *P +\*

 *'r0' +\*

 *R +\*

 *'\\'*

*Bnb8Folder = InFolder + 'bnb8\\'*

*BnblcFolder = InFolder + 'bnblc\\'*

*NlcdFile = 'D:\\ROSES\\NLCD\_2006\\' + 'p' + P + 'r' + R + '\_nlcd\_2006.img'*

*# Path on your computer to modeler.exe'*

*ERDAS = 'C:\\ERDAS\\ERDAS Desktop 2011\\bin\\Win32Release\\modeler.exe'*

*if not os.path.exists(BnblcFolder):*

 *os.mkdir(BnblcFolder)*

*else:*

 *pass*

*for root, dirs, files in os.walk(Bnb8Folder, topdown=False):*

 *for raster in files:*

 *if raster.endswith('\_bnb8.tif'):*

 *InRaster = Bnb8Folder + raster*

 *OutRaster = BnblcFolder + raster.replace('\_bnb8.tif', '\_bnblc.tif')*

 *if not os.path.exists(OutRaster):*

 *print '\n\nCreating ' + raster.replace('\_bnb8.tif', '\_bnblc.tif') + '...'*

 *# BAT*

 *BatName = OutRaster.replace('.tif', '.bat')*

 *MdlName = OutRaster.replace('.tif', '.mdl')*

 *Bat = open(BatName, 'w')*

 *# Write your bat command here. This is the same command your would run in DOS*

 *Bat.writelines('"' + ERDAS + '" ' +\*

 *'"' + MdlName + '"')*

 *Bat.close()*

*# Mdl You can write out any command in ERDAS to a txt file. To find out your commands,*

*# examine a mdl file that can be saved after your complete your gmd file*

 *Mdl = open(MdlName, 'w')*

 *Mdl.write('SET CELLSIZE MIN;' + '\n' +\*

 *'SET WINDOW Intersection;' + '\n' +\*

 *'SET AOI NONE;' + '\n\n' +\*

 *'Integer RASTER n1\_nlcd FILE OLD PUBINPUT NEAREST NEIGHBOR '\*

 *'AOI NONE "' + NlcdFile.replace('\\', '/') + '";\n' +\*

 *'Integer RASTER n2\_in FILE OLD PUBINPUT NEAREST NEIGHBOR '\*

 *'AOI NONE "' + InRaster.replace('\\', '/') + '";\n' +\*

 *'Integer RASTER n3\_out FILE NEW PUBOUT USEALL THEMATIC BIN '\*

 *'DIRECT DEFAULT 1 BIT UNSIGNED INTEGER "' +\*

 *OutRaster.replace('\\', '/') + '";\n\n' +\*

 *'SET PROJECTION USING n1\_nlcd;' + '\n\n' +\*

 *'n3\_out = CONDITIONAL {' + '\n' +\*

 *'(($n1\_nlcd != 0 && $n1\_nlcd != 11 && $n1\_nlcd != 21 &&' + '\n' +\*

 *'$n1\_nlcd != 22 && $n1\_nlcd != 23 && $n1\_nlcd != 24 &&' + '\n' +\*

 *'$n1\_nlcd != 81 && $n1\_nlcd != 82) && ($n2\_in >= 95)) 1' + '\n' +\*

 *'};' + '\n' +\*

 *'QUIT;' + '\n'*

 *)*

 *Mdl.close()*

 *# Run Mdl*

 *print '\n\nRunning ' + BatName + '...'*

 *os.system(BatName)*

 *else:*

 *print '\n\n' + raster.replace('\_bnb8', '\_bnblc') + ' already exists...'*

**7. GDAL**

-Installation directions

*Python 2.5*

http://www.gis.usu.edu/~chrisg/python/2009/docs/gdal\_win.pdf

*Python 2.6+*

http://pythongisandstuff.wordpress.com/2011/07/07/installing-gdal-and-ogr-for-python-on-windows/

-Or download QGIS to get Python, Gdal, and other open source geospatial packages

https://www.qgis.org/en/site/forusers/download.html

**7.1. Reading in imagery**

*import os*

*from osgeo import gdal*

*dNBRFile = 'C:\\Temp\\dNBR\_test.tif'*

*# Open Raster image*

*DT = gdal.Open(dNBRFile)*

*# Initiate the GeoTransform method*

*geotransform = DT.GetGeoTransform()*

*# Number of rows*

*DTrows = DT.RasterYSize*

*# Number of columns*

*DTcols = DT.RasterXSize*

*# Number of bands*

*DTbands = DT.RasterCount*

*# Center of pixel: +15 to move right from the left hand corner of a 30m image*

*DTX = geotransform[0] + 15*

*# Center of pixel: -15 to move down 15 meters from the left hand corner of a 30m image*

*DTY = geotransform[3] -15*

*# Set the band you want to see*

*DTband1 = DT.GetRasterBand(1)*

*# Gdal allows you to read in data as an array.*

*# The Python module Numpy can allow you to perform more complicated array functions.*

*DTData = DTband1.ReadAsArray(0,0,DTcols,DTrows)*

*# (start, stop, step)*

*for x in range(0, DTrows):*

 *for y in range(0, DTcols):*

 *# Get the X Locations*

 *DTXout = DTX - (30 \* x)*

 *# GET the Y Locations*

 *DTYout = DTY + (30 \* y)*

 *DTData[x,y]#Extract pixel value*

**8.0 R**

**8.1. Installation**

 **8.1.1. Install R**

-Check to see which version of R is currently compatible with your version of Python (see http://rpy.sourceforge.net/rpy2/doc-2.4/html/overview.html#installation for details).

-You can download different versions of R from http://cran.r-project.org/bin/windows/base/old/

-Double click the R install-package .exe file to install R on your system.

-Accept all of the R install-package predetermined variables.

 **8.1.2. Install R Pages**

-Open the R program.

- The easiest way to install R packages is to type the command line in R. Download the “rgdal” and “sp” R packages. Both of these packages will help with performing geospatial calculations and getting shapefiles and raster files into R. After you type in the package install command for “rgdal” and “sp” (see below) “hit” the Return button. You will then be prompted to select a Cran Mirror site for the download. Select a Cran Mirror site.

>install.packages("rgdal", dep=TRUE)

**8.1.3. Set System Variables**

-Go to: Advance and System Settings; Environmental variables

-Select: Path; Edit; Add “;” and the path to your R.exe file (e.g. ;C:\Program Files\R\R-3.1.1\bin) after the last item in the list; Ok

-Add R\_HOME as a System variable: New; Variable Name: R\_HOME, Variable Value: Path to R folder (e.g. C:\Program Files\R\R-3.1.1); Ok; Ok

**8.1.4. Fix potential robject.py error**

-Navigate to your Python \Lib\site-packages\rpy2\robjects folder (e.g. C:\Python27\ArcGIS10.2\Lib\site-packages\rpy2\robjects).

-Open robject.py in IDLE

-On line 41: Hit return after “tmpf.close()”

-Now, on line 42: type self.\_\_close(tmp)

-Save and close robject.py

-See https://bitbucket.org/lgautier/rpy2/issue/191/unable-to-unlink-file for more details.

**8.1.5. Install Python Modules**

-Install the “pywin32-219.win32-py2.7.exe” python module. The Rpy2 program is dependent on some information contained within this module. This module must be installed after R.

-Install the “rpy2‑2.4.3.win32‑py2.7.exe” Rpy2 python module (see http://rpy.sourceforge.net/rpy2/doc-2.4/html/overview.html#download for more details). Accept all of the program’s suggestions. The RPY2 module will allow Python to communicate with R. This module must be installed after pywin32 and R.

**8.2 Running scripts**

-Open Python

*import rpy2.robjects as robjects*

*# Call robjects (Rpy2) to send R commands through R*

*r = robjects.r*

*# Calculate the sum of x1 (10) and x2 (40) in Python using R*

*r('x1=10')*

*r('x2=40')*

*VAR1=r('x1+x2')*

*print VAR1[0]*

**9.0 DOS**

-Use DOS to run .exe’s from command line

 **9.1. 7zip example**

-Assumes path to 7zip (7z) is in your Environments/Paths

*import os*

*# Change the working folder*

*os.chdir('C:\Users\jpicotte\Desktop\Temp')*

*# Extract files command*

*cmd = "7z e L5045028\_02820110909\_nbr.img.gz"*

*# Run the command in DOS*

*os.system(cmd)*

**9.2. Gdal command line example**

-Assumes path to gdal\bin is in your Environments/Paths

*import os*

*# Shape to Kml command*

*cmd = 'ogr2ogr -f "ESRI Shapefile" E:\ROSES\HMS\_annual\HmsKml\2004\1028\test.shp'\ 'E:\ROSES\HMS\_annual\HmsKml\2004\1028\LE70100282004140EDC02\_hms.kml'*

*# Run the command*

*os.system(cmd)*

**10.0. Databases**

**10.1. Sql alchemy**

-Use to connect to a database including Mysql, Postgresql, ect.

-Some Databases may require additional python modules to connect properly (i.e. Postgresql needs psycopg).

*from sqlalchemy import \**

*# Create database engine*

*Engine=create\_engine('mysql://root:password@localhost/database? '\ 'charset=utf8&use\_unicode=0', pool\_recycle=3600)*

*# Need metadata to create new tables and connect to database*

*metadata = MetaData(bind=engine)*

*# Can use this to connect to database*

*connection = engine.connect()*

*# Select Query..Prints out all results*

*# Insert SQL query here…*

*result = engine.execute("SELECT Id From Param")*

*# Loop through each row in your results*

*for row in result:*

 *# Call the row you want to evaluate by its database name*

 *print "Id:", row['Id']*

*# Make sure to close your query before next query starts*

*result.close()*

**10.1 Clustering using Scikit (sklearn.cluster)**

-Scikit (is a module package that contains many functions for data mining and analysis.

-Clustering based upon X, Y, and Z data can be achieved using sklearn.cluster in the Scikit module.

-Clustering methods include K-means, Affinity Propagation, Mean-shift, Spectral clustering, Ward hierarchical clustering, Agglomerative clustering, DBSCAN, and Gaussian mixtures (for descriptions of each function see http://scikit-learn.org/stable/modules/clustering.html).

-This example focuses on Mean-shift, because you can have many clusters of even size (for a full explanation see http://scikit-learn.org/stable/modules/clustering.html#mean-shift).

-This example uses Hazard Mapping System fire detection data that is an amalgamation of GOES, MODIS, and AVHRR fire hot spot detections that can be acquired bi-hourly (see http://satepsanone.nesdis.noaa.gov/FIRE/fire.html).

-The python Scipy, numpy, and scikit modules need to be installed along with your version of python.

*import csv*

*import os*

*import collections*

*import numpy as np*

*import pylab as pl*

*from scipy.spatial import distance*

*from sklearn.cluster import MeanShift, estimate\_bandwidth*

*InFolder = 'D:\\Workspace\\'*

*InCsv = InFolder + 'LE70180392012074EDC00\_hms.csv'*

*Hms = ((InCsv.split('\\'))[-1]).replace('.csv', '')*

*NewCsv = InCsv.replace('.csv', '\_group\_meanshift\_XyOnly.csv')*

*CluCsv = InCsv.replace('.csv', '\_center\_meanshift\_XyOnly.csv')*

*NewFig = NewCsv.replace('.csv', '.png')*

*Onew = open(NewCsv, 'w')*

*Cnew = open(CluCsv, 'w')*

*# Pull in data as dictionary using DictReader*

*Inlabels = ['X', 'Y', 'Date', 'UTC', 'Sensor']*

*Onew.write('Group,' + ','.join(Inlabels) + '\n')*

*Cnew.write('Group,TotalPoints,X,Y\n')*

*# Set X axis*

*# Separate out the coordinates, which is the only data we care about for now*

*data = csv.DictReader(open(InCsv, 'r').readlines()[1:], Inlabels)*

*Xcoords = [(float(d['X'])) for d in data if len(d['X']) > 0]*

*# Set X start, midpoint, and end coordinates for graph outputs*

*Xsort = np.sort(Xcoords)*

*XStart = int(Xsort[0] - 5000)*

*XMid = int(np.mean(Xcoords))*

*XEnd = int(Xsort[-1]) + 5000*

*XStartToMid = int((XStart + XMid) / 2)*

*XMidToEnd = int((XEnd + XMid) / 2)*

*# Determine the total number of Coordinates*

*TotalNum = len(Xsort)*

*del data*

*# Set Y axis*

*# Separate out the coordinates, which is the only data we care about for now*

*data = csv.DictReader(open(InCsv, 'r').readlines()[1:], Inlabels)*

*Ycoords = [(float(d['Y'])) for d in data if len(d['Y']) > 0]*

*Ysort = np.sort(Ycoords)*

*YStart = int(Ysort[0] - 5000)*

*YMid = int(np.mean(Ycoords))*

*YEnd = int(Ysort[-1]) + 5000*

*YStartToMid = int((YStart + YMid) / 2)*

*YMidToEnd = int((YEnd + YMid) / 2)*

*del data*

*# Load data*

*# Load everything into a Numpy array.*

*# Make sure to only use the columns (usecols=), in this*

*# case X and Y that you require. Adding more columns will affect the results*

*X = np.loadtxt(open(InCsv, "rb"), delimiter=",", skiprows=1, usecols=(0, 1))*

*# That this function takes time at least quadratic in n\_samples. For large datasets,*

*# it’s wise to set that parameter to a small value.*

*# quantile : float, default 0.3*

*# should be between [0, 1] 0.5 means that the median of all pairwise*

*# distances is used.*

*bandwidth = estimate\_bandwidth(X, quantile=0.01, n\_samples=len(X))*

*# bandwidth : float, optional*

*# Bandwidth used in the RBF kernel.*

*# If not given, the bandwidth is estimated using sklearn.cluster.estimate\_bandwidth;*

*# see the documentation for that function for hints on scalability.*

*ms = MeanShift(bandwidth=bandwidth, bin\_seeding=True)*

*ms.fit(X)*

*labels = ms.labels\_*

*cluster\_centers = ms.cluster\_centers\_*

*labels\_unique = np.unique(labels)*

*n\_clusters\_ = len(labels\_unique)*

*pl.figure(1)*

*pl.clf()*

*# Determine the number of points in each cluster*

*counter = collections.Counter(labels)*

*# Use Pylabs unique set of color combinations (in this case Set1) to*

*# create unique colors for each Mean Shift cluster*

*colors = pl.cm.Set1(np.linspace(0, 1, len(labels\_unique)))*

*DataOut = []*

*for k, col in zip(range(n\_clusters\_), colors):*

 *my\_members = labels == k*

 *cluster\_center = cluster\_centers[k]*

 *# Write out cluster center points*

 *ClusX = cluster\_center[0]*

 *ClusY = cluster\_center[1]*

 *# Keeps track of how many points make up each cluster*

 *Count = counter[k]*

 *ClusOut = (str(k) + ',' +*

 *str(Count) + ',' +*

 *str(ClusX) + ',' +*

 *str(ClusY) + '\n')*

 *Cnew.write(ClusOut)*

 *# markersize is scaled by twice the number of the count*

 *pl.plot(cluster\_center[0], cluster\_center[1], 'o', markerfacecolor=col,*

 *markeredgecolor='k', markersize=int(Count \* 2))*

 *pl.plot(X[my\_members, 0], X[my\_members, 1], 'o', markerfacecolor=col,*

 *markeredgecolor='k', markersize=3)*

 *pl.xticks([XStart, XStartToMid, XMid, XMidToEnd, XEnd])*

 *pl.yticks([YStart, YStartToMid, YMid, YMidToEnd, YEnd])*

 *for i in X[my\_members]:*

 *# join lines together*

 *InLine = str(k) + ',' + ','.join(str(x)*

 *for x in i) + ','*

 *# Need to convert float Date/time to strings*

 *LineOut = InLine.replace(*

 *'.0,',*

 *',')*

 *Lo = LineOut.split(',')*

 *x = Lo[1]*

 *y = Lo[2]*

 *data = csv.DictReader(open(InCsv, 'r').readlines()[1:], Inlabels)*

 *for d in data:*

 *if y == d['Y'] and x == d['X']:*

 *Date = d['Date']*

 *Utc = d['UTC']*

 *Sensor = d['Sensor']*

 *Out = LineOut +\*

 *Date + ',' +\*

 *Utc + ',' +\*

 *Sensor + '\n'*

 *DataOut.append(Out)*

 *else:*

 *pass*

*pl.title(*

 *Hms +*

 *'\nTotal Number of Detections: %d' %*

 *TotalNum +*

 *'\nTotal Number of Clusters: %d' %*

 *n\_clusters\_,*

 *fontweight="bold",*

 *fontsize=10)*

*# Saves the figure*

*pl.savefig(NewFig)*

*Onew.writelines(set(DataOut))*

*Onew.close()*

*Cnew.close()*

**

***Figure 2:*** *Example output from clustering algorithm. Notice that grouped points are on top of the cluster centers, and that the clusters and centers have the same color. Plot centers have also been scaled in size to have an area that is equal to twice the number of points.*