Filters & Simple Analysis of Vector Data; Functions & Modules

Open Source RS/GIS Python
Week 3

Attribute filters

- The Layer object has a method **`SetAttributeFilter(<where_clause>)`**
- Resets reading so **`GetNextFeature()`** gets the first feature that matches the filter
- Pass **`None`** to clear the filter

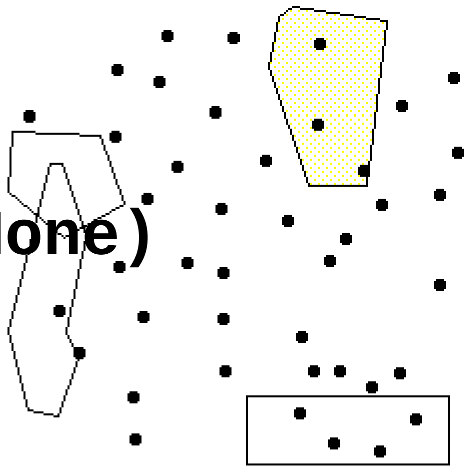
```
>>> layer.GetFeatureCount()
42
>>> layer.SetAttributeFilter("cover = 'shrubs'")
>>> layer.GetFeatureCount()
6
>>> layer.SetAttributeFilter(None)
>>> layer.GetFeatureCount()
42
```

Spatial filters

- There are two methods on the Layer object to set spatial filters
  - **`SetSpatialFilter(<geom>)`**
  - **`SetSpatialFilterRect(<minx>, <miny>, <maxx>, <maxy>)`**
- Use **`SetSpatialFilter(None)`** to clear the filter

layerAreas is polygon and layerSites is points

```
>>> featAreas = layerAreas.GetNextFeature()
>>> poly = featAreas.GetGeometryRef()
>>> layerSites.GetFeatureCount()
42
>>> layerSites.SetSpatialFilter(poly)
>>> layerSites.GetFeatureCount()
3
>>> layerSites.SetSpatialFilterRect(460000,
  4590000, 490000, 4600000)
>>> layerSites.GetFeatureCount()
4
>>> layerSites.SetSpatialFilter(None)
>>> layerSites.GetFeatureCount()
42
```



More complicated filters

- DataSource objects have a method **`ExecuteSQL(<SQL>)`**
- Returns a Layer object that can be looped through like other layers
- When done with the resulting layer, call **`ReleaseResultSet(<result_layer>)`** on the DataSource
- See http://www.gdal.org/ogr/ogr_sql.html for more info about valid SQL syntax

- To select all features where cover type is 'grass' and to return them in descending order:

```
result = dsSites.ExecuteSQL("select * from sites
  where cover = 'grass' order by id desc")
resultFeat = result.GetNextFeature()
while resultFeat :
  print resultFeat.GetField('id')
  resultFeat = result.GetNextFeature()
dsSites.ReleaseResultSet(result)

42
40
:
4
```

- To count the number of features where cover type is 'grass’:

```
>>> result = dsSites.ExecuteSQL("select count(*)
  from sites where cover = 'grass'")
>>> result.GetFeatureCount()
1
>>> result.GetFeature(0).GetField(0)
11
>>> dsSites.ReleaseResultSet(result)
```

- To get a list of unique cover types:

```
result = ds.ExecuteSQL("select distinct cover from
  sites")
resultFeat = result.GetNextFeature()
while resultFeat:
  print resultFeat.GetField(0)
  resultFeat = result.GetNextFeature()
ds.ReleaseResultSet(result)
```

```
shrubs
trees
rocks
grass
bare
Water
```

- To get a count of each cover type:

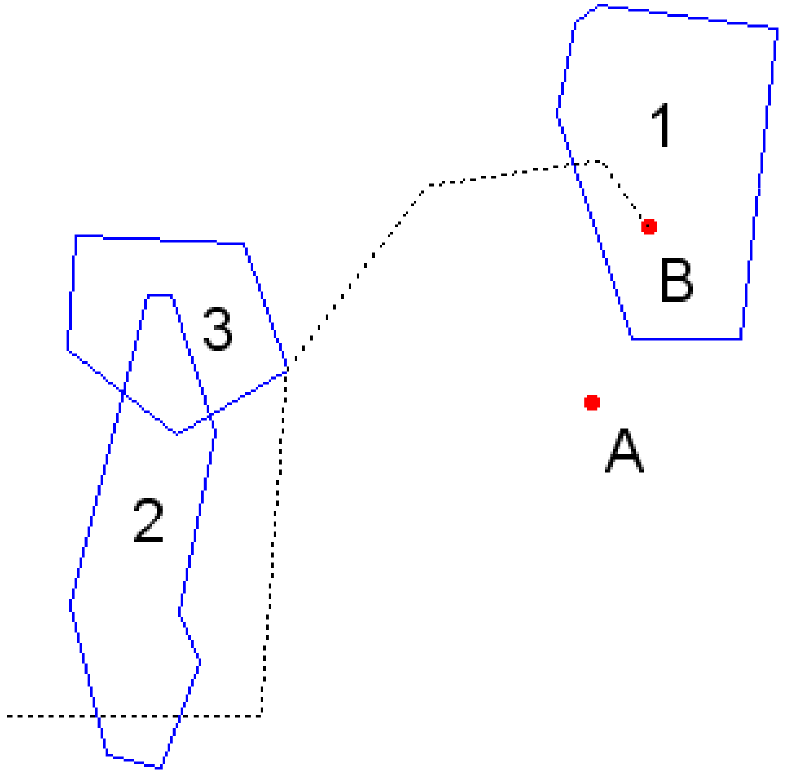
```
coverLayer = ds.ExecuteSQL('select distinct cover
  from sites')
coverFeat = coverLayer.GetNextFeature()
while coverFeat:
  cntLayer = ds.ExecuteSQL("select count(*) from
    sites where cover = '" + coverFeat.GetField(0) +
    "'")
  print coverFeat.GetField(0) + ' ' +
    cntLayer.GetFeature(0).GetFieldAsString(0)
  ds.ReleaseResultSet(cntLayer)
  coverFeat = coverLayer.GetNextFeature()
ds.ReleaseResultSet(coverLayer)
```

```
shrubs 6
trees 11
rocks 6
grass 11
bare 6
water 2
```

Intersect

- Do two geometries intersect?

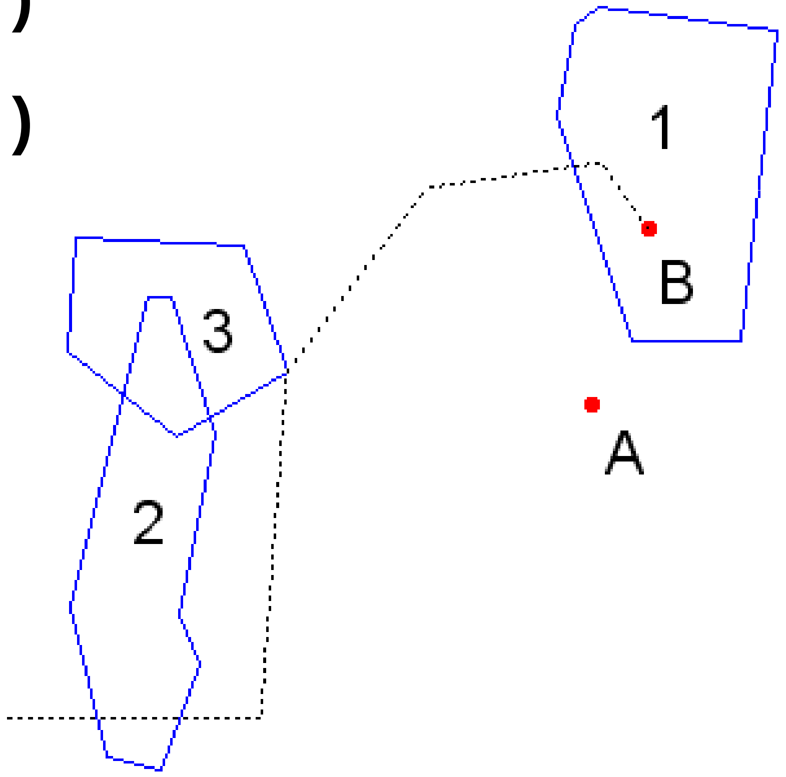
```
>>> poly2.Intersect(poly1)
0
>>> poly2.Intersect(poly3)
1
>>> poly2.Intersect(poly2)
1
>>> poly1.Intersect(ptA)
0
>>> poly1.Intersect(ptB)
1
>>> poly1.Intersect(line)
1
>>> poly3.Intersect(line)
1
>>> line.Intersect(ptB)
1
```



Disjoint

- Are two geometries disjoint?

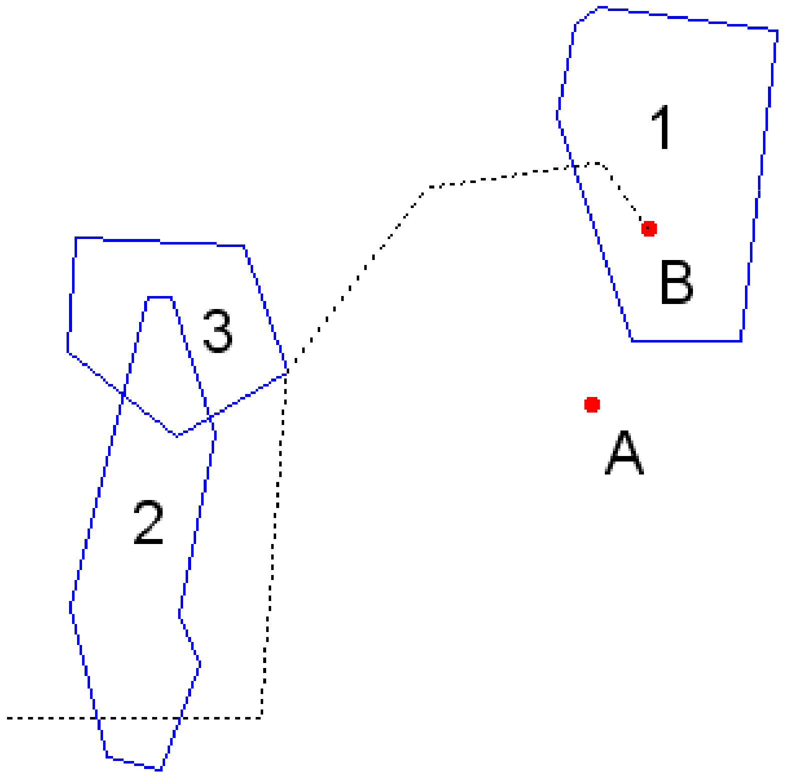
```
>>> poly2.Disjoint(poly1)
1
>>> poly2.Disjoint(poly3)
0
>>> poly1.Disjoint(ptA)
1
>>> poly1.Disjoint(ptB)
0
>>> poly1.Disjoint(line)
0
>>> poly3.Disjoint(line)
0
>>> line.Disjoint(ptB)
```



Touches

- Do two geometries touch (on the edge)?

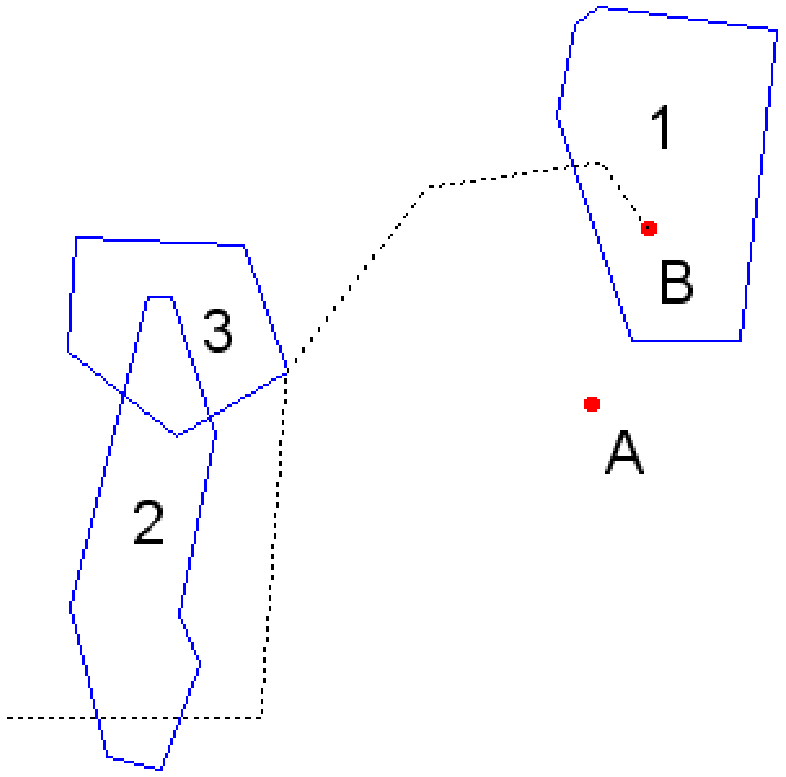
```
>>> poly2.Touches(poly1)
0
>>> poly2.Touches(poly3)
0
>>> poly1.Touches(line)
0
>>> poly1.Touches(ptB)
0
>>> poly3.Touches(line)
1
```



Crosses

- Do two geometries cross each other?

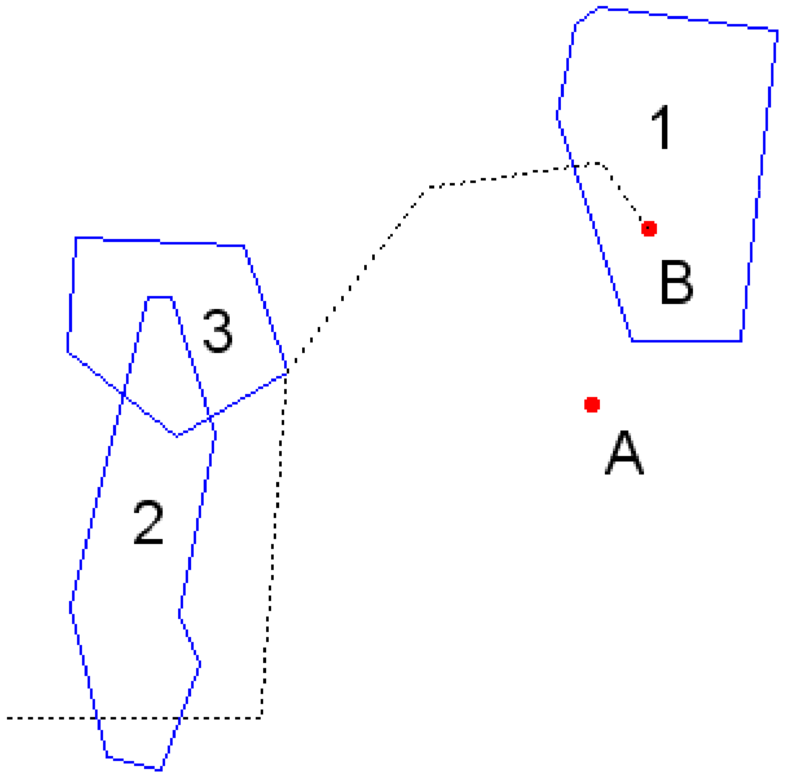
```
>>> poly2.Crosses(poly1)
0
>>> poly2.Crosses(poly3)
0
>>> poly2.Crosses(line)
1
>>> poly3.Crosses(line)
0
>>> poly1.Crosses(line)
1
>>> line.Crosses(ptB)
0
```



Within

- Is one geometry within another one?

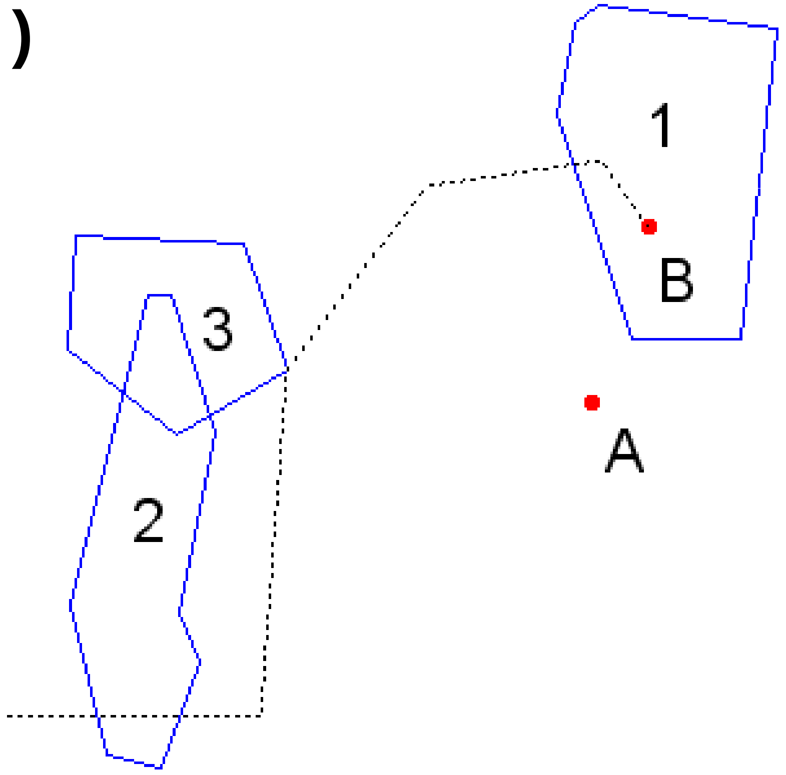
```
>>> poly3.Within(poly2)
0
>>> line.Within(poly2)
0
>>> ptA.Within(poly1)
0
>>> ptB.Within(poly1)
1
>>> poly1.Within(ptB)
0
```



Contains

- Does one geometry contain another one?

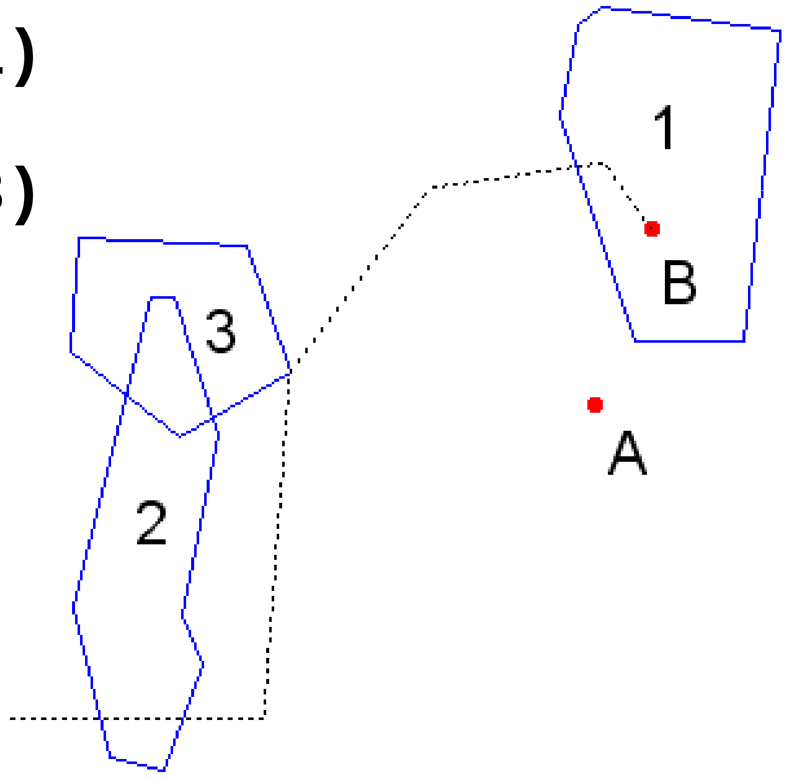
```
>>> poly3.Contains(poly2)
0
>>> line.Contains(poly2)
0
>>> poly2.Contains(line)
0
>>> poly1.Contains(ptA)
0
>>> poly1.Contains(ptB)
1
>>> ptB.Contains(poly1)
0
```



Overlaps

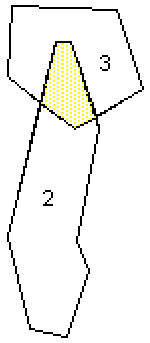
- Do two geometries overlap?

```
>>> poly2.Overlaps(poly1)
0
>>> poly2.Overlaps(poly3)
1
>>> poly2.Overlaps(line)
0
>>> poly3.Overlaps(line)
0
>>> poly1.Overlaps(ptB)
0
```

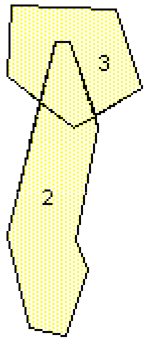


Simple geoprocessing

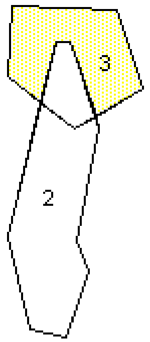
```
poly3.Intersection(poly2)
```



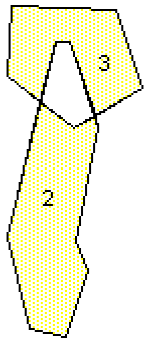
```
poly3.Union(poly2)
```



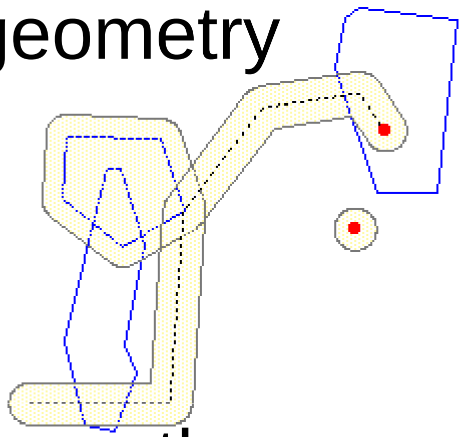
```
poly3.Difference(poly2)
```



```
poly3.SymmetricDifference(poly2)
```



- <geom>.Buffer(<distance>)
  - Buffer a geometry, returns a new geometry
- <geom1>.Equal(<geom2>)
  - Are the geometries equal?
- <geom1>.Distance(<geom2>)
  - Returns the shortest distance between the two geometries
- <geom>.GetEnvelope()
  - Returns the geometry's extent as a list (minx, maxx, miny, maxy)



Assignment 3a

- Use filters and buffers
  - Use an attribute filter to restrict cache_towns.shp to Nibley (“name” field)
  - Buffer the Nibley geometry by 1500
  - Use the new geometry with a spatial filter on sites.shp to find all sites within 1500 meters of Nibley
  - Print out the "id" value for those sites
  - Turn in your code and a screenshot of what got printed

Defining functions

- Writing functions allows easy reuse of code
- The keyword **def** means you're about to define a function
- Provide the function name and parameters
- Use **return** to return a value

```
def add(n1, n2): #function 'add' takes 2 args
  return n1 + n2
```

- For example, a function to reproject a shapefile (using EPSG codes) might look something like this:

```
def ProjectShapefile(inFN, outFN, inEPSG, outEPSG):
   # open inFN and create empty outFN
   # create CoordinateTransform using EPSG codes
   # loop through features in inFN
      # get feature geometry
      # reproject geometry
      # write geometry to outFN
      # destroy features
   # close files
```

Keywords & default parameters

- User can pass parameters by passing them in order (the usual way) or by using the variable name as a keyword

```
add(n2=5, n1=3)
```

- Can provide a default value by setting it in the function declaration line

```
def printNumbers(start=0, stop=10, step=1):
```

```
def printNumbers(start=0, stop=10, step=1):
  for i in range(start, stop, step):
     print i,

>>> printNumbers()
0 1 2 3 4 5 6 7 8 9
>>> printNumbers(5)
5 6 7 8 9
>>> printNumbers(5,15)
5 6 7 8 9 10 11 12 13 14
>>> printNumbers(5,15,2)
5 7 9 11 13
>>> printNumbers(step=2, stop=15, start=5)
5 7 9 11 13
>>> printNumbers(step=2)
0 2 4 6 8
>>> printNumbers(5, step=2)
5 7 9
```

Exceptions

- “Catch” exceptions to implement custom error handling, like flushing a buffer to disk before dying
- Can have as many **`except`** statements as you need per **`try`** statement

```
try:
   #code here
except <exception_name>:
   #code to handle error here

try:
  #code here
finally:
  #code that always runs
```

- Have to put the **`try…except`** statement inside of a **`try…finally`** statement if you want both behaviors

```
try:
  try:
     #code here
  except <exception_name>:
     #code to handle error here
  except <exception_name>:
     #code to handle error here
finally:
  #code that always runs
```

```
import sys, traceback

def getValue(array, index):
  try: # wrap everything so some code always executes
    try: # wrap code that might cause an error
      return array[index]
    except IndexError: # catch exc if index out of range
      print 'Looks like a bad index'
    except: # catch something we didn't anticipate
      print 'Exception type:', sys.exc_info()[0]
      print 'Exception value:', sys.exc_info()[1]
      traceback.print_exc()
  finally: # good place to close files, db connections…
    print 'This code always runs!'
```

```
>>> test = ['a','b','c']

>>> print getValue(test, 0) # good index
This code always runs!
a

>>> print getValue(test, 4) # bad index
Looks like a bad index
This code always runs!
None

>>> print getValue(test, 'a') # unknown error
Exception type: exceptions.TypeError
Exception value: list indices must be integers
Traceback (most recent call last):
  File "exceptions.py", line 6, in getValue
    return array[index]
TypeError: list indices must be integers
This code always runs!
None
```

Creating modules

- Modules are handy places to keep functions
- Just put the function in a file called <name>.py
- A file named mymod.py could be imported using

```
import mymod
```

- And a function inside it called myFunction could be called like

```
mymod.myFunction()
```

- Import other needed modules at the top of your module

Example module

```
import math

def add(n1, n2):
  return n1 + n2

def printNumbers(start=0, stop=10, step=1):
  for i in range(start, stop, step):
    print i,

def maxNumFromBits(bits):
  return int(math.pow(2, bits) – 1)
```

- **Assuming that the module in the previous slide is saved as mymod.py, it can be used like this:**

```
>>> import mymod
>>> mymod.add(3,2)
5
>>> mymod.printNumbers(5,8)
5 6 7
>>> mymod.maxNumFromBits(8)
255
```

Finding modules

- Python will look for a module in the directory that the running script is in
- Then the PYTHONPATH environment variable
- Possibly the current working directory (depends on platform & version)
- Then standard library directories (i.e. site-packages)

- Modify **`sys.path`** to change the search path (but only for the current python session)
- If you delete things from **`sys.path`** you may not be able to import other modules, so you should probably just append

```
>>> import testmod # can't find it
Traceback (most recent call last):
  File "<stdin>", line 1, in ?
ImportError: No module named testmod
>>> import sys
>>> sys.path.append('d:/temp')
>>> import testmod # now it worked
>>> testmod.add(2,3)
5
```

Glob

- Lists files in a directory that match a pattern
  - * matches multiple characters
  - ? matches 1 character
  - [] matches character ranges, like [0-9], [a-z], or [a,e,i,o,u]

```
>>> import glob
>>> glob.glob('./[0-9].*')
['./1.gif', './2.txt']
>>> glob.glob('*.gif')
['1.gif', 'card.gif']
>>> glob.glob('?.gif')
['1.gif']
```

- For example, to loop through all .shp files in a directory:

```
>>> import glob
>>> for fn in glob.glob('d:/data/*.shp'):
...   print fn
...
d:/data/classes/python/data\areas.shp
d:/data/classes/python/data\lines.shp
d:/data/classes/python/data\points.shp
d:/data/classes/python/data\sites.shp
d:/data/classes/python/data\ut_counties.shp
```

Manipulating filenames

```
import os
fn = 'c:/data/test.shp'
```

- To get the basename of a filename:

```
>>> os.path.basename(fn)
'test.shp‘
```

- To get the basename with no extension:

```
>>> os.path.splitext(os.path.basename(fn))[0]
'test‘
>>> os.path.basename(fn)[:-4]
'test'
```

- An easy way to add a suffix to a filename:

```
>>> newfn = fn.replace('.shp', '_proj.shp')
>>> newfn
'c:/data/test_proj.shp‘
```

- An easy way to change the extension on a filename:

```
>>> newfn = fn.replace('.shp', '.prj')
>>> newfn
'c:/data/test.prj'
```

Homework

- Write a function to reproject a shapefile using EPSG codes
  - User should pass in the input & output filenames and input & output EPSG codes
  - Put the function in a module
- Write a script that imports the new module and uses the function to reproject all of the shapefiles in this week's data
  - Go from EPSG 26912 (UTM 12N NAD83) to EPSG 4269 (unprojected NAD83)

```
# function to copy fields (not the data) from one
# layer to another
# parameters:
#   fromLayer: layer object that contains the fields
#     to copy
#   toLayer: layer object to copy the fields into
def copyFields(fromLayer, toLayer):
  featureDefn = fromLayer.GetLayerDefn()
  for i in range(featureDefn.GetFieldCount()):
    toLayer.CreateField(featureDefn.GetFieldDefn(i))
```

```
# function to copy attributes from one feature to another
# this assumes the features have the same attribute fields!)
# parameters:
#   fromFeature: feature object that contains the data to copy
#   toFeature: feature object that the data is to be copied into
def copyAttributes(fromFeature, toFeature):
  for i in range(fromFeature.GetFieldCount()):
    fieldName = fromFeature.GetFieldDefnRef(i).GetName()
    toFeature.SetField(fieldName, fromFeature.GetField(fieldName))
```