

# Geospatial Python

October 6, 2017

```
In [2]: { "type": "Feature",
          "geometry": {
            "type": "Point",
            "coordinates": [125.6, 10.1]
          },
          "properties": {
            "name": "Some place"
          }
        }
```

```
Out[2]: {'geometry': {'coordinates': [125.6, 10.1], 'type': 'Point'},
         'properties': {'name': 'Some place'},
         'type': 'Feature'}
```

```
In [4]: import os
import fiona

input_file = os.path.join('/share/HandsOn/python/scipy15', 'examples', 'nybb_15b/nybb.shp')
if os.path.exists(input_file):
    print('Inputu file:', input_file)
else:
    print('Please download the tutorial data or fix the path!')
```

```
Inputu file: /share/HandsOn/python/scipy15/examples/nybb_15b/nybb.shp
```

```
In [5]: boroughs = fiona.open(input_file)
```

```
In [6]: # The output will indicate it is an object of type Collection
boroughs
```

```
Out[6]: <open Collection '/share/HandsOn/python/scipy15/examples/nybb_15b/nybb.shp':0>
```

```
In [7]: # This will pretty-print the dictionary returned by the
# metadata property of `boroughs`
print("The meta property returns an object of type: ",
      type(boroughs.meta))
boroughs.meta
```

The meta property returns an object of type: `<class 'dict'>`

```
Out[7]: {'crs': {'datum': 'NAD83',
                'lat_0': 40.166666666666666,
                'lat_1': 40.666666666666666,
                'lat_2': 41.033333333333333,
                'lon_0': -74,
                'no_defs': True,
                'proj': 'lcc',
                'units': 'us-ft',
                'x_0': 300000,
                'y_0': 0},
        'crs_wkt': 'PROJCS["NAD_1983_StatePlane_New_York_Long_Island_FIPS_3104_Feet",
        'driver': 'ESRI Shapefile',
        'schema': {'geometry': 'Polygon',
                    'properties': OrderedDict([('BoroCode', 'int:4'),
                                                ('BoroName', 'str:32'),
                                                ('Shape_Leng', 'float:19.11'),
                                                ('Shape_Area', 'float:19.11')])}}
```

```
In [9]: boroughs.meta['schema']
```

```
Out[9]: {'geometry': 'Polygon',
        'properties': OrderedDict([('BoroCode', 'int:4'),
                                    ('BoroName', 'str:32'),
                                    ('Shape_Leng', 'float:19.11'),
                                    ('Shape_Area', 'float:19.11')])}}
```

```
In [11]: # Dictionaries are indexed by keys. The line below will
        # show the contents of the 'crs' value of the dictionary.
        boroughs.meta['crs']
```

```
Out[11]: {'datum': 'NAD83',
          'lat_0': 40.166666666666666,
          'lat_1': 40.666666666666666,
          'lat_2': 41.033333333333333,
          'lon_0': -74,
          'no_defs': True,
          'proj': 'lcc',
          'units': 'us-ft',
          'x_0': 300000,
          'y_0': 0}
```

```
In [12]: # If the dictionary item returns another dictionary,
        # you can read its values in a single line
        boroughs.meta['crs']['units']
```

```
Out[12]: 'us-ft'
```

```
In [13]: boroughs.close()
```

```
In [15]: # Check if the file is closed
         boroughs.closed
```

```
Out[15]: True
```

```
In [17]: # pretty printing - makes some kinds of text output easier to read
         import pprint
```

```
         with fiona.open(input_file) as src:
             #Schema
             print("Schema of the shapefile fields: ")
             pprint.pprint(src.schema)
             print()
             #Get first record
             record = src.next()
             print("Values of the first record: ")
             pprint.pprint(record['properties'])
```

Schema of the shapefile fields:

```
{'geometry': 'Polygon',
  'properties': OrderedDict([('BoroCode', 'int:4'),
                             ('BoroName', 'str:32'),
                             ('Shape_Leng', 'float:19.11'),
                             ('Shape_Area', 'float:19.11')])}
```

Values of the first record:

```
OrderedDict([('BoroCode', 5),
             ('BoroName', 'Staten Island'),
             ('Shape_Leng', 330466.075042),
             ('Shape_Area', 1623827185.9)])
```

```
In [19]: import pprint
```

```
         with fiona.open(input_file) as src:
             #Get all record
             for record in src:
                 print("Values of the record: ")
                 pprint.pprint(record['properties'])
```

Values of the record:

```
OrderedDict([('BoroCode', 5),
             ('BoroName', 'Staten Island'),
             ('Shape_Leng', 330466.075042),
             ('Shape_Area', 1623827185.9)])
```

Values of the record:

```
OrderedDict([('BoroCode', 3),
             ('BoroName', 'Brooklyn'),
```

```

        ('Shape_Leng', 741185.900596),
        ('Shape_Area', 1937596577.12)])

```

Values of the record:

```

OrderedDict([('BoroCode', 4),
             ('BoroName', 'Queens'),
             ('Shape_Leng', 897040.298576),
             ('Shape_Area', 3045167504.51)])

```

Values of the record:

```

OrderedDict([('BoroCode', 1),
             ('BoroName', 'Manhattan'),
             ('Shape_Leng', 358408.460709),
             ('Shape_Area', 636446736.17)])

```

Values of the record:

```

OrderedDict([('BoroCode', 2),
             ('BoroName', 'Bronx'),
             ('Shape_Leng', 464400.198868),
             ('Shape_Area', 1186972572.87)])

```

```

In [20]: # Speaking of making the output easier to read, it's
         # possible to construct tables with Markdown or HTML
         # Later, we'll use a different Python library that
         # happens to do the nice formatting automatically.
import IPython
with fiona.open(input_file) as src:
    # make header row out of field names
    values=""
    for field in src.schema['properties']:
        values += field
        values += "|"
        values += '\n|'
    # separates header row
    for i in range(len(src.schema['properties'])):
        values += "---|"
        values += "\n"

    # rows for each record
    for record in src:
        values += "|"
        for field in record['properties']:
            values += str(record['properties'][field])
            values += '|'
            values += '\n'
    print("Markdown text for displaying as table: \n",
          values, sep="\n") #\n is code for new line
    print("\nSame text presented as table: ")
    IPython.display.display_markdown(values, raw=True)

```

Markdown text for displaying as table:

```
|BoroCode|
|BoroName|
|Shape_Leng|
|Shape_Area|
|---|
---|
---|
---|
|5|
Staten Island|
330466.075042|
1623827185.9|
|3|
Brooklyn|
741185.900596|
1937596577.12|
|4|
Queens|
897040.298576|
3045167504.51|
|1|
Manhattan|
358408.460709|
636446736.17|
|2|
Bronx|
464400.198868|
1186972572.87|
```

Same text presented as table:

```
|BoroCode| |BoroName| |Shape_Leng| |Shape_Area| |—| —| —| —| |5| Staten
Island| 330466.075042| 1623827185.9| |3| Brooklyn| 741185.900596| 1937596577.12| |4|
Queens| 897040.298576| 3045167504.51| |1| Manhattan| 358408.460709| 636446736.17| |2|
Bronx| 464400.198868| 1186972572.87|
```

```
In [22]: total_area=0
         with fiona.open(input_file) as src:
             for record in src:
                 total_area+=record['properties']['Shape_Area']
             print("Total Area is ", total_area)
```

Total Area is 8430010576.570001

```
In [23]: # We have a `record` variable from earlier. What exactly is that?
         type(record)
```

```
Out[23]: dict
```

```
In [24]: record.keys()
```

```
Out[24]: dict_keys(['properties', 'id', 'geometry', 'type'])
```

```
In [25]: # We saw what was in 'properties' in our schema check earlier.  
# Which borough is this record?  
record['properties']['BoroName']
```

```
Out[25]: 'Bronx'
```

```
In [27]: # When we checked the schema earlier,  
# we saw that the geometry type was Polygon.  
# What can we do with the geometry?  
print("The type of object for the record's geometry property is: ",  
      type(record['geometry']))  
print()  
print("They keys of the dictionary are: ", record['geometry'].keys())
```

```
The type of object for the record's geometry property is: <class 'dict'>
```

```
They keys of the dictionary are: dict_keys(['coordinates', 'type'])
```

```
In [28]: # What are in those coordinates?  
record['geometry']['coordinates']
```

```
Out[28]: [[[(1012821.8057861328, 229228.26458740234),  
            (1012785.9133911133, 229165.3482055664),  
            (1012703.557800293, 229195.9155883789),  
            (1012500.8121948242, 229168.28118896484),  
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            (1012347.3937988281, 229638.58880615234),  
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            (1012828.1080322266, 229417.98901367188),  
            (1012821.8057861328, 229228.26458740234)]]],  
 [[(1015023.7134399414, 230286.7592163086),  
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...]]]
```

```
In [29]: record['geometry']['type']
```

```
Out[29]: 'MultiPolygon'
```

```
In [30]: # That's a lot of values. It looks like there
# are three levels of nested lists.
# If the first level of the list are individual
# polygons that make up the Bronx feature, how many are there?
dim1 = len(record['geometry']['coordinates'])
print("The", record['properties']['BoroName'],
      "feature has", dim1, "polygons.")
```

The Bronx feature has 24 polygons.

```
In [32]: # What's in the next level?
dim2 = []
for i in range(dim1):
    dim2 += [len(record['geometry']['coordinates'][i])]
print("The number of lists for each polygon is:\n", dim2)
```

The number of lists for each polygon is:

```
[1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1]
```

```
In [33]: # Well, that makes it easier to check the third level.
# Write a for loop that checks how many points
# belong to each feature.
# Remember, you know that for the second level of the
# list, there is only one item (another list)
dim3 = []
```

```

for i in range(dim1):
    dim3 += [len(record['geometry']['coordinates'][i][0])]
print("The number of points for each polygon is:\n", dim3)

```

The number of points for each polygon is:

```
[12, 506, 12, 5, 8, 6, 6, 1401, 97, 191, 5, 129, 107, 137, 5, 5, 6, 8, 6, 16, 6, 5]
```

```

In [34]: from matplotlib import pyplot as plt
        # This "magic" function tells Jupyter to display
        #matplotlib's graphics in the output of the cell
        %matplotlib inline

```

```

/opt/conda/lib/python3.5/site-packages/matplotlib/font_manager.py:273: UserWarning:
  warnings.warn('Matplotlib is building the font cache using fc-list. This may take
/opt/conda/lib/python3.5/site-packages/matplotlib/font_manager.py:273: UserWarning:
  warnings.warn('Matplotlib is building the font cache using fc-list. This may take

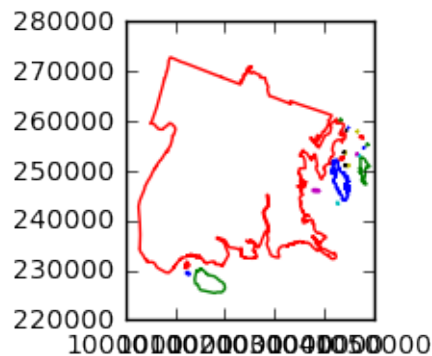
```

```

In [35]: plt.figure(figsize=(2, 2))
        for coords in record['geometry']['coordinates']:
            # We are one level deep in the list
            # here '*' is an unpack operator
            x, y = zip(*coords[0])
            # The [0] opens the second level of the list
            # (this level having only one member each)
            # The unpack operator gets the contents of the
            # list out of the list, and sends to the zip function

            plt.plot(x, y)
        plt.gca().set_aspect('equal')

```



```

In [38]: import rasterio
        # Rasterio's rasterio.open() takes a path and returns a dataset object.

```

```

# The path may point to a file of any supported raster format.
# Rasterio will open it using the proper GDAL format driver.
# Dataset objects have some of the same attributes as Python file objects.
manhattan_ras = rasterio.open("/share/HandsOn/python/scipy15/data/manhattan.tif")

In [39]: manhattan_ras.name

Out[39]: '/share/HandsOn/python/scipy15/data/manhattan.tif'

In [40]: manhattan_ras.mode

Out[40]: 'r'

In [41]: manhattan_ras.closed

Out[41]: False

In [43]: # Properties of the raster data stored in "manhattan.tif"
# can be accessed through attributes of the dataset object.
# Dataset objects have bands and this example has a band count of 4.
manhattan_ras.count

Out[43]: 4

In [44]: # A dataset band is an array of values representing
# the partial distribution
# of a single variable in 2-dimensional (2D) space.
# Width and height of the array are shown below
manhattan_ras.height

Out[44]: 5205

In [45]: manhattan_ras.width

Out[45]: 5757

In [47]: # The datatype of the four bands unsigned 8 bit integer
{i: dtype for i, dtype in zip(manhattan_ras.indexes, manhattan_ras.dtypes)}

Out[47]: {1: 'uint8', 2: 'uint8', 3: 'uint8', 4: 'uint8'}

In [48]: #Georeferencing the dataset
manhattan_ras.bounds

Out[48]: BoundingBox(left=583057.357, bottom=4511050.6293795705, right=588814.05905, top=4511050.6293795705)

In [49]: #Find the projection
manhattan_ras.crs

Out[49]: CRS({'init': 'epsg:26918'})

```

```
In [50]: manhattan_ras.indexes
```

```
Out[50]: (1, 2, 3, 4)
```

```
In [51]: band1=manhattan_ras.read(1)
band2=manhattan_ras.read(2)
band3=manhattan_ras.read(3)
band4=manhattan_ras.read(4)
```

```
In [53]: band1
```

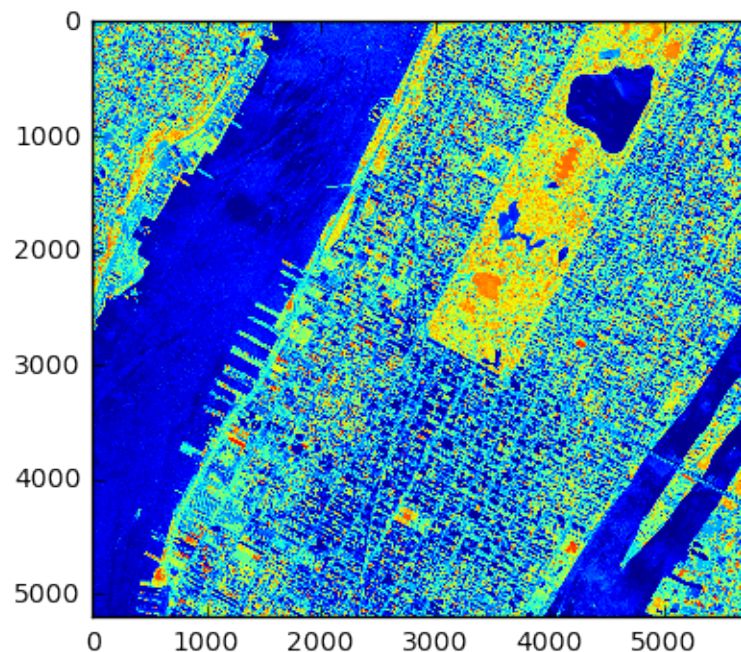
```
Out[53]: array([[183, 169, 159, ..., 211, 218, 206],
               [177, 189, 186, ..., 215, 209, 198],
               [129, 160, 184, ..., 215, 202, 197],
               ...,
               [ 69,  70,  69, ...,  90,  92,  90],
               [ 67,  68,  67, ...,  87,  87,  87],
               [ 67,  67,  67, ...,  88,  86,  85]], dtype=uint8)
```

```
In [54]: band4
```

```
Out[54]: array([[132, 130, 124, ..., 145, 149, 139],
               [125, 137, 135, ..., 147, 142, 132],
               [ 96, 117, 127, ..., 146, 137, 129],
               ...,
               [ 25,  25,  23, ...,  52,  48,  49],
               [ 25,  25,  23, ...,  48,  46,  45],
               [ 23,  23,  24, ...,  46,  43,  44]], dtype=uint8)
```

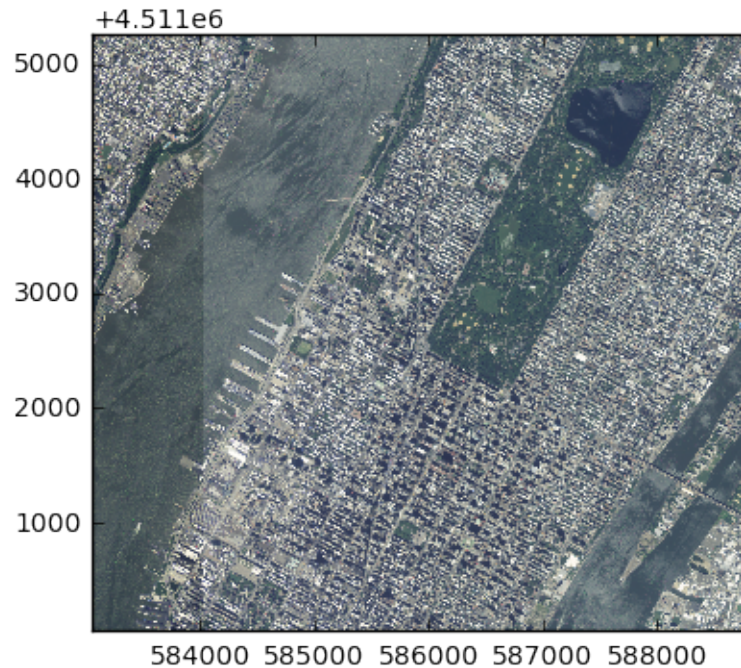
```
In [55]: plt.imshow(manhattan_ras.read(4))
```

```
Out[55]: <matplotlib.image.AxesImage at 0x7f9ba80f4cf8>
```



```
In [56]: from rasterio.plot import show
```

```
In [57]: show(manhattan_ras)
```



```
Out[57]: <matplotlib.axes._subplots.AxesSubplot at 0x7f9ba96439e8>
```

```
In [58]: manhattan_ras.meta
```

```
Out[58]: {'count': 4,
          'crs': CRS({'init': 'epsg:26918'}),
          'driver': 'GTiff',
          'dtype': 'uint8',
          'height': 5205,
          'nodata': None,
          'transform': Affine(0.999948245999997, 0.0, 583057.357,
                              0.0, -0.999948245999997, 4516255.36),
          'width': 5757}
```

```
In [59]: # What is that EPSG code? The osgeo library
```

```
from osgeo import gdal, osr
```

```
spatialRef = osr.SpatialReference()
```

```
spatialRef.ImportFromEPSG(26918)
```

```
print("Projected coordinate system is: ", spatialRef.GetAttrValue('projcs'
```

```
print("Geographic coordinate system is: ", spatialRef.GetAttrValue('geogcs'
```

```
Projected coordinate system is: NAD83 / UTM zone 18N  
Geographic coordinate system is: NAD83
```

```
In [ ]:
```