Introduction to Python

An Introduction to Numpy

Topics

1) Numpy
2) pandas
    1) Series
    2) Dataframe

Numpy

Python is currently one of most popular languages for data science and machine learning.

In the next set of lectures, we will focus on working with and analyzing data.

Python has many optimized libraries for working with data. We will cover two powerful libraries for scientific computing and data processing: Numpy and pandas.

Numpy

Numpy is a Python library that provides a high-performing multidimensional array object(matrices) and mathematical operations to work with these arrays.

```
import numpy as np
a = np.array([1,2,3,4])
b = np.array([[1,2,3,4], [5,6,7,8]])
print(a.shape)   # (4,)
print(b.shape)   # (2, 4)
print(b.dtype)  # int64
```

Numpy arrays can only store data of a single type and are super fast.

Python lists can hold objects of different types and are very slow.

Numpy

```
import numpy as np
a = np.array([[1,2,3,4],
              [5,6,7,8],
              [9,10,11,12]])
print(a[0, 0])   # 1
print(a[1, 3]   # 8
```

Note the use of commas, if it was a 2D Python list: print(a[0][0])

Numpy uses commas(tuples) for indexing.

```
print(a[:, 1:3])    # all rows, columns 1 and 2.
[[ 2, 3],
 [ 6, 7],
 [10, 11]]
```

Similar to Python lists, slicing works with Numpy arrays!

arange(integer ranges)

```
import numpy as np

In[5]: np.arange(5)
Out[5]: array([0, 1, 2, 3, 4])

In[5]: np.arange(5, 10)
Out[5]: array([5, 6, 7, 8, 9])

In[5]: np.arange(5)
Out[5]: array([0, 1, 2, 3, 4])

In[5]: np.arange(7, 1, -2)
Out[5]: array([7, 5, 3])
```

linspace(floating-point ranges) and reshape

```
import numpy as np


In[5]: np.linspace(0.0, 1.0, num=5)
Out[5]: array([0. , 0.25, 0.5 , 0.75, 1. ])

In[5]: np.arange(6).reshape(2, 3)
Out[6]:
array([[0, 1, 2],
       [3, 4, 5]])
```

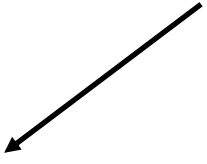
zeros and ones

```
import numpy as np

In[5]: np.zeros((3, 2))
Out[7]:
array([[0., 0.],
       [0., 0.],
       [0., 0.]])

In[5]: np.ones((3, 2), dtype=int64)
Out[7]:
array([[0, 0],
       [0, 0],
       [0, 0]])
```

Numpy Operators

```
import numpy as np
In[1]: numbers = np.arange(6).reshape(2, 3)
In[2]: numbers
Out[2]:
array([[0, 1, 2],
       [3, 4, 5]])

In[3]: numbers * 2
Out[3]:
array([[0, 2, 4],
       [6, 8, 10]])
```

Note that numbers is unchanged!



```
In[4]: numbers
Out[4]:
array([[0, 1, 2],
       [3, 4, 5]])
```

Numpy Operators

```
import numpy as np

In[5]: numbers ** 3
Out[5]:
array([[  0,   1,   8],
       [ 27,  64, 125]])

In[5]: numbers += 5
In[6]: numbers
Out[6]:
array([[  5,   6,   7],
       [  8,   9,  10]])
```

Note that numbers is changed!

Numpy Operators

```
import numpy as np
In[5]: a = np.array([[1,2,3,4],
                     [5,6,7,8]])

In[6]: b = np.array([[10,11,12,13],
                     [14,15,16,18]])

In[6]: a + b
Out[6]:
array([[11, 13, 15, 17],
       [19, 21, 23, 26]])
```

Comparing Arrays

```
import numpy as np
In[5]: a = np.array([[1,2,3,4],
                     [5,6,7,8]])

In[6]: a >= 4
Out[6]:
array([[False, False, False,  True],
       [ True,  True,  True,  True]])
```

Comparing Arrays

```
import numpy as np
In[5]: a = np.array([[1,2,3,4],
                     [5,6,7,8]])

In[6]: b = np.array([[0,0,0,0],
                     [14,15,16,18]])

In[6]: a < b
Out[6]:
array([[False, False, False, False],
       [ True,  True,  True,  True]])
```

Comparing Arrays

```
import numpy as np
In[5]: a = np.array([[1,2,3,4],
                     [5,6,7,8]])

In[6]: b = np.array([[0,0,0,0],
                     [5,6,7,8]])

In[6]: a == b
Out[6]:
array([[False, False, False, False],
       [ True,  True,  True,  True]])
```

Descriptive Statistics

```
import numpy as np
In[1]: grades = np.array([[87, 96, 70], [100, 87, 90],
                          [94, 77, 90], [100, 81, 82]])
In[2]: grades
Out[2]:
array([[ 87,  96,  70],
       [100,  87,  90],
       [ 94,  77,  90],
       [100,  81,  82]])
In[3]: grades.sum()
Out[3]:
1054
```

Basic Statistics

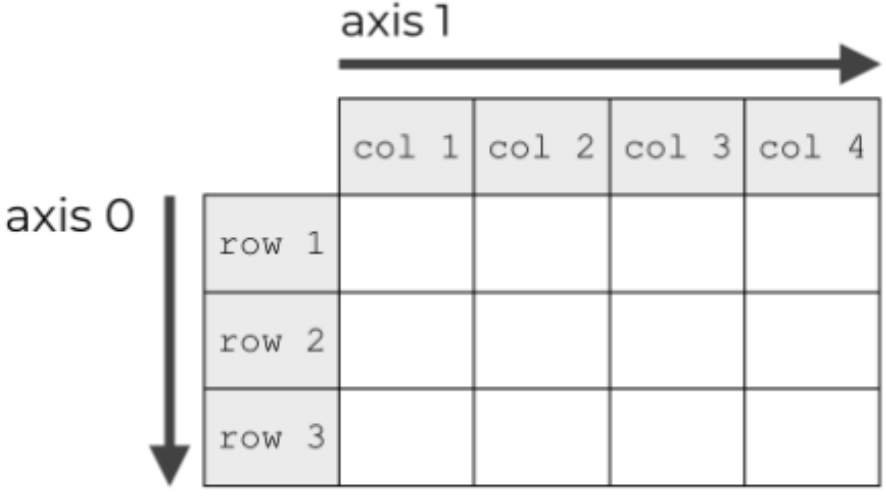
```
import numpy as np
In[4]: grades.min()
Out[4]:
70
In[5]: grades.max()
Out[5]:
100
In[6]: grades.mean()
Out[6]:
87.83333333333333
In[7]: grades.std()
Out[7]:
8.792357792739987
```

Calculations by Rows/Columns

Numpy arrays have axes.

In a 2-dimensional NumPy array, the axes are the *directions* along the rows and columns.

In a NumPy array, axis 0 is the "first" axis. Axis 0 is the axis that runs downward down the rows. Axis 1 is the "second" axis that runs horizontally across the columns.

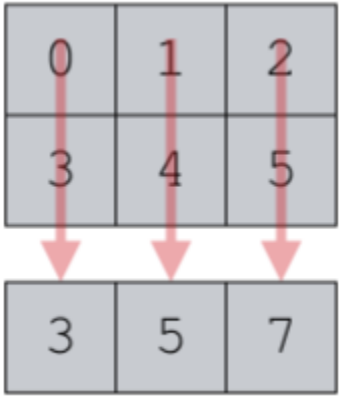


Calculations by Rows/Columns

Remember, functions like sum(), mean(), min(), and other statistical functions **aggregate** your data.

The axis parameter controls which axis will be *collapsed*.

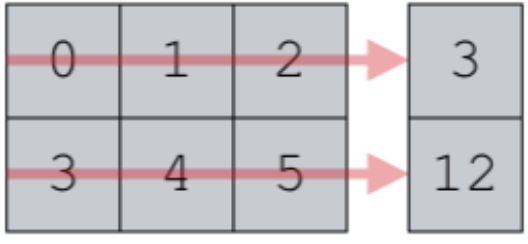
```
import numpy as np
In[1]: a = np.array([[0, 1, 2],
                     [3, 4, 5]])

In[2]: a.sum(axis=0)
Out[21]: array([3, 5, 7])
```



When we set axis = 0, we're aggregating the data such that we *collapse* the rows … we collapse axis 0.

Calculations by Rows/Columns

```
import numpy as np
In[1]: a = np.array([[0, 1, 2],
                     [3, 4, 5]])

In[2]: a.sum(axis=1)
Out[2]: array([3, 12])
```



When we set axis = 1, we're aggregating the data such that we *collapse* the columns … we collapse axis 1.

An Application

```
import numpy as np
In[1]: grades = np.array([[87, 96, 70],
                          [100, 87, 90],
                          [94, 77, 90],
                          [100, 81, 82]])
```

Test 1 Test 2 Test 3

Suppose we have four students, each took three tests. Their scores are stored in the grades array.

```
In[3]: grades.mean(axis=0)
Out[2]:
array([95.25, 85.25, 83.  ])
```

What does this compute?

The average of each test.

```
In[3]: grades.mean(axis=1)
Out[2]:
array([84.33333333, 92.33333333, 87., 87.66666667])
```

What does this compute? The average of each student across all three tests.