Pandas and Friends

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- Source: http://github.com/desertpy/presentations

What does it do?

Pandas is a Python data analysis tool built on top of NumPy that provides a suite of data structures and data manipulation functions to work on those data structures. It is particularly well suited for working with time series data.

Getting Started - Installation

Installing with pip or apt-get:

```
pip install pandas
# or
sudo apt-get install python-pandas
```

- Mac - Homebrew or MacPorts to get the dependencies, then pip
- Windows - Python(x,y)?, Commercial Pythons

Panda's Friends!

- IPython
- Numpy
- Matplotlib

Pandas and Friends

Getting Started - Dependencies

Dependencies, required, recommended and optional

```
# Required
numpy, python-dateutil, pytx
# Recommended
numexpr, bottleneck
# Optional
cython, scipy, pytables, matplotlib, statsmodels, openpyxl
```

Background - IPython

IPython is a fancy python console. Try running `ipython` or `ipython --pylab` on your command line. Some IPython tips

```
# Special commands, 'magic functions', begin with %
%quickref, %who, %run, %reset
# Shell Commands
ls, cd, pwd, mkdir
# Need Help?
help(), help(obj), obj?, function?
# Tab completion of variables, attributes and methods
```

Background - IPython Notebook

There is a web interface to IPython, known as the IPython notebook, start it like this

```
ipython notebook
# or to get all of the pylab components
ipython notebook --pylab
```

IPython - Follow Along

Follow along by connecting to one of these servers.

- http://ipynb1.desertpy.com
- http://ipynb2.desertpy.com

NOTE: Only active on presentation day.

Background - NumPy

- NumPy is the foundation for Pandas
- Numerical data structures (mostly Arrays)
- Operations on those.
- Less structure than Pandas provides.

Background - NumPy - Arrays

```
import numpy as np
# np.zeros, np.ones
data0 = np.zeros((2, 4))
#array([[ 0.,  0.,  0.,  0.],
#       [ 0.,  0.,  0.,  0.]])
data1 = np.arange(100)
#array([  0, 1, 2, .. 99])
```

Background - NumPy - Arrays

```
data = np.arange(20).reshape(4, 5)
#array([[ 0,  1,  2,  3,  4],
#       [ 5,  6,  7,  8,  9],
#       [10, 11, 12, 13, 14],
#       [15, 16, 17, 18, 19]])
data.dtype    #dtype('int64')
result = data * 20.5
#array([[ 0. , 20.5, 41. , 61.5, 82. ], ...
#dtype('float64')
```

Now, on to Pandas

Pandas and Friends

Pandas

- Tabular, Timeseries, Matrix Data - labeled or not
- Sensible handling of missing data and data alignment
- Data selection, slicing and reshaping features
- Robust data import utilities.
- Advanced time series capabilities

Data Structures

- Series - 1D labeled array
- DataFrame - 2D labeled array
- Panel - 3D labeled array (More D)

Assumed Imports

In my code samples, assume I import the following

```
import pandas as pd
import numpy as np
```

See `code/series_ex1.py` for python source from which the next slides were derived.

Series

- one-dimensional labeled array
- holds any data type
- axis labels known asi index
- `dict`-like

Create a Simple Series

```
s1 = pd.Series([1, 2, 3, 4, 5])
# 0    1
# 1    2
# 2    3
# 3    4
# 4    5
# dtype: int64
```

Series Operations

```
print s1 * 5
# 0     5
# 1    10
# 2    15
# 3    20
# 4    25
# dtype: int64
```

Series Operations - Cont.

```
print s1 * 5.0
# 0     5
# 1    10
# 2    15
# 3    20
# 4    25
# dtype: float64
```

Series Index

```
s2 = pd.Series([1, 2, 3, 4, 5],
               index=['a', 'b', 'c', 'd', 'e'])
# a    1
# b    2
# c    3
# d    4
# e    5
# dtype: int64
```

Date Convenience Functions

A quick aside ...

```
dates = pd.date_range('20130626', periods=5)
# <class 'pandas.tseries.index.DatetimeIndex'>
# [2013-06-26 00:00:00, ..., 2013-06-30 00:00:00]
# Length: 5, Freq: D, Timezone: None

dates[0]
# <Timestamp: 2013-06-26 00:00:00>
```

Datestamps as Index

```
s3 = pd.Series([1, 2, 3, 4, 5], index=dates)
# 2013-06-26    1
# 2013-06-27    2
# 2013-06-28    3
# 2013-06-29    4
# 2013-06-30    5
# Freq: D, dtype: int64
```

Selecting By Index

Note that the integer index is retained along with the new date index.

```
s3[0]
# 1
s3[1:3]
# 2013-06-27    2
# 2013-06-28    3
# Freq: D, dtype: int64
```

Selecting by value

```
s3[s3 < 3]
# 2013-06-26    1
# 2013-06-27    2
# Freq: D, dtype: int64
```

Selecting by Label (Date)

```
s3['20130626':'20130628']
# 2013-06-26    1
# 2013-06-27    2
# 2013-06-28    3
# Freq: D, dtype: int64
```

Series Wrapup

Things not covered but you should look into:

- Other instantiation options: `dict`
- Operator Handling of missing data `NaN`
- Reforming Data and Indexes
- Boolean Indexing
- Other Series Attributes:
  - `index` - `index.name`
  - `name` - Series name

DataFrame

- 2-dimensional labeled data structure
- Like a SQL Table, Spreadsheet or `dict` of `Series` objects.
- Columns of potentially different types
- Operations, slicing and other behavior just like `Series`

See `code/dataframe_ex1.py` for python source from which the next slides were derived.

DataFrame - Simple

```
data1 = pd.DataFrame(np.random.rand(4, 4))
#           0         1         2         3
# 0  0.748663  0.119829  0.382114  0.375031
# 1  0.549362  0.409125  0.336181  0.870665
# 2  0.102960  0.539968  0.356454  0.661136
# 3  0.233307  0.338176  0.577226  0.966152
```

DataFrame - Index/Column Names

```
dates = pd.date_range('20130626', periods=4)
data2 = pd.DataFrame(np.random.rand(4, 4),
                     index=dates, columns=list('ABCD'))
#                   A         B         C         D
# 2013-06-26  0.538854  0.061999  0.099601  0.010284
# 2013-06-27  0.800049  0.978754  0.035285  0.383580
# 2013-06-28  0.761694  0.764043  0.136828  0.066216
# 2013-06-29  0.129422  0.756846  0.931354  0.380510
```

DataFrame - Manipulating

See? You never need Excel again!

```
data2['E'] = data2['B'] + 5 * data2['C']
#                    A         B         C         D         E
# 2013-06-26  0.014781  0.929893  0.402966  0.014548  2.944723
# 2013-06-27  0.968832  0.015926  0.976208  0.507152  4.896967
# 2013-06-28  0.381733  0.916911  0.828290  0.678275  5.058361
# 2013-06-29  0.447551  0.066915  0.308007  0.426910  1.606950
```

DataFrame - Column Access

```
# Deleting a Column
del data2['E']

# Column Access as a dict
data2['B']
# or attribute
data2.B
```

DataFrame - Row Access

```
# by row label
data2.loc['20130627']
# by integer location
data2.iloc[1]
```

DataFrame - Taking a Peek

```
data3 = pd.DataFrame(np.random.rand(400, 4))
data2.head()
#           0         1         2         3
# 0  0.245475  0.488223  0.624225  0.563708
# 1  0.237461  0.441690  0.162622  0.173519

data2.tail()
#           0         1         2         3
# 398  0.474941  0.847748  0.682227  0.871416
# 399  0.414240  0.819523  0.234805  0.333394
```

Panel

Like DataFrame but 3 or more dimensions.

IO Tools

Robust IO tools to read in data from a variety of sources

- CSV
- Clipboard
- SQL
- Excel
- HDF

Plotting

- Matplotlib - The standard Python plotting tool
- Trellis - An 'R' inspired Matplotlib based plotting tool

Bringing it Together - Data

The csv file (`code/phx-temps.csv`) containing Phoenix weather data from GSOD:

```
1973-01-01 00:00:00,53.1,37.9
1973-01-02 00:00:00,57.9,37.0
...
2012-12-30 00:00:00,64.9,39.0
2012-12-31 00:00:00,55.9,41.0
```

Bringing it Together - Code

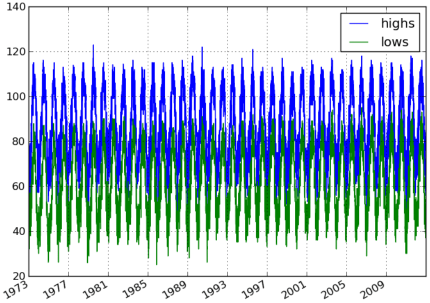
```python
# simple readcsv
phxtemps1 = pd.read_csv('phx-temps.csv')
# define index, parse dates, name columns
phxtemps2 = pd.read_csv('phx-temps.csv', index_col=0,
                        names=['highs', 'lows'],
                        parse_dates=True)
```

Bringing it Together - Code

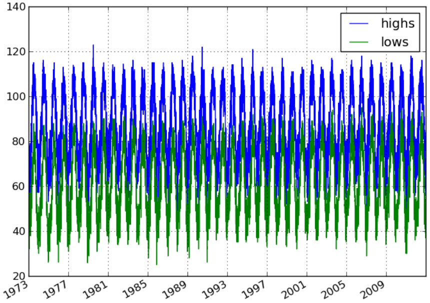
```
import matplotlib.pyplot as plt

phxtemps2 = pd.read_csv('phx-temps.csv', index_col=0,
                        names=['highs', 'lows'],
                        parse_dates=True)
phxtemps2.plot()  # pandas convenience method
plt.savefig('phxtemps2.png')
```

Bringing it Together - Plot



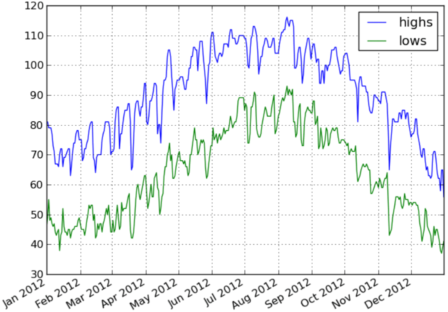
Bringing it Together - Plot



Boo, Pandas and Friends would cry if they saw such a plot.

Bringing it Together - Plot

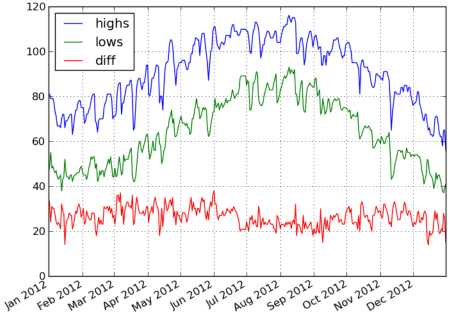
```
phxtemps2['20120101':'20121231'].plot()
```



Bringing it Together - Plot

```
phxtemps2['diff'] = phxtemps2.highs - phxtemps2.lows
phxtemps2['20120101':'20121231'].plot()
```

Bringing it Together - Plot



Alternatives

- AstroPy seems to have similar data structures.
- I suspect there are others.

References

- Pandas Documentation
- Python for Data Analysis
- Presentation Source - https://github.com/desertpy/presentations