06_pandas

July 16, 2019

1 Statistical analysis using pandas

- Python Data science handbook
- 10 Minutes to Pandas

Table of Content:

Introduction

This is a short introduction to pandas, geared mainly for new users. You can see more complex recipes in the cookbook.

1.0.1 Import pandas

[1]:
```
%matplotlib inline
import pandas as pd
import numpy as np
import matplotlib.pyplot as plt
```

Pandas Series

[2]:
```
data = pd.Series([0.25, 0.5, 0.75, 1.0])
data
```

[2]:
```
0    0.25
1    0.50
2    0.75
3    1.00
dtype: float64
```

[3]:
```
data.values
```

[3]:
```
array([0.25, 0.5 , 0.75, 1.  ])
```

[4]:
```
data.index
```

[4]:
```
RangeIndex(start=0, stop=4, step=1)
```

[5]:
```
data[1]
```

[5]:
```
0.5
```

[6]:
```
data[1:3]
```

[6]:
```
1    0.50
2    0.75
dtype: float64
```

1.0.2 Dealing with nan

[7]:
```
data_np = np.array([1, 3, 5, np.nan, 6, 8])
data = pd.Series(data_np)
data
```

[7]:
```
0    1.0
1    3.0
2    5.0
3    NaN
4    6.0
5    8.0
dtype: float64
```

1.0.3 max, min, mean

[8]:
```
#no problem
data.max(), data.min(), data.mean()
```

[8]:
```
(8.0, 1.0, 4.6)
```

[9]:
```
# A bit complicated
data_np.max(), data_np.min(), data_np.mean()
```

[9]:
```
(nan, nan, nan)
```

[10]:
```
# But not impossible
np.nanmax(data_np), np.nanmin(data_np), np.nanmean(data_np)
```

[10]:
```
(8.0, 1.0, 4.6)
```

1.0.4 labelled series

[11]:
```
data = pd.Series([0.25, 0.5, 0.75, 1.0],
                 index=['a', 'b', 'c', 'd'])
data
```

[11]:
```
a    0.25
b    0.50
```

```
c    0.75
d    1.00
dtype: float64
```

[12]:
```
data['b']
```

[12]:
```
0.5
```

[13]:
```
data.iloc[1]
```

[13]:
```
0.5
```

[14]:
```
data.iloc[1:3]
```

[14]:
```
b    0.50
c    0.75
dtype: float64
```

1.0.5 Dictionary index

[15]:
```
population_dict = {'California': 38332521,
                   'Texas': 26448193,
                   'New York': 19651127,
                   'Florida': 19552860,
                   'Illinois': 12882135}
population = pd.Series(population_dict)
population
```

[15]:
```
California    38332521
Texas         26448193
New York      19651127
Florida       19552860
Illinois      12882135
dtype: int64
```

DataFrames

[16]:
```
import numpy as np
t = np.linspace(-6, 6, 20)
sin_t = np.sin(t)
cos_t = np.cos(t)
```

[17]:
```
df = pd.DataFrame({'sin': sin_t, 'cos': cos_t},index=t)
df.head()
```

[17]:
```
                sin       cos
-6.000000  0.279415  0.960170
-5.368421  0.792419  0.609977
-4.736842  0.999701  0.024451
-4.105263  0.821291 -0.570509
-3.473684  0.326021 -0.945363
```

[18]:
```
df.to_numpy()
```

[18]:
```
array([[ 0.2794155 ,  0.96017029],
       [ 0.79241881,  0.6099774 ],
       [ 0.99970104,  0.02445069],
       [ 0.82129115, -0.57050928],
       [ 0.32602102, -0.94536252],
       [-0.29503045, -0.95548785],
       [-0.80225698, -0.59697884],
       [-0.99996678, -0.00815095],
       [-0.81188195,  0.58382164],
       [-0.310567  ,  0.95055149],
       [ 0.310567  ,  0.95055149],
       [ 0.81188195,  0.58382164],
       [ 0.99996678, -0.00815095],
       [ 0.80225698, -0.59697884],
       [ 0.29503045, -0.95548785],
       [-0.32602102, -0.94536252],
       [-0.82129115, -0.57050928],
       [-0.99970104,  0.02445069],
       [-0.79241881,  0.6099774 ],
       [-0.2794155 ,  0.96017029]])
```

[19]:
```
df.dtypes
```

[19]:
```
sin    float64
cos    float64
dtype: object
```

[20]:
```
df2 = pd.DataFrame({'A': 1.,
                    'B': pd.Timestamp('20130102'),
                    'C': pd.Series(1, index=list(range(4)), dtype='float32'),
                    'D': np.array([3] * 4, dtype='int32'),
                    'E': pd.Categorical(["test", "train", "test", "train"]),
                    'F': 'foo'})

df2
```

[20]:

	A	B	C	D	E	F
0	1.0	2013-01-02	1.0	3	test	foo
1	1.0	2013-01-02	1.0	3	train	foo
2	1.0	2013-01-02	1.0	3	test	foo
3	1.0	2013-01-02	1.0	3	train	foo

[21]:
```
df2.dtypes
```

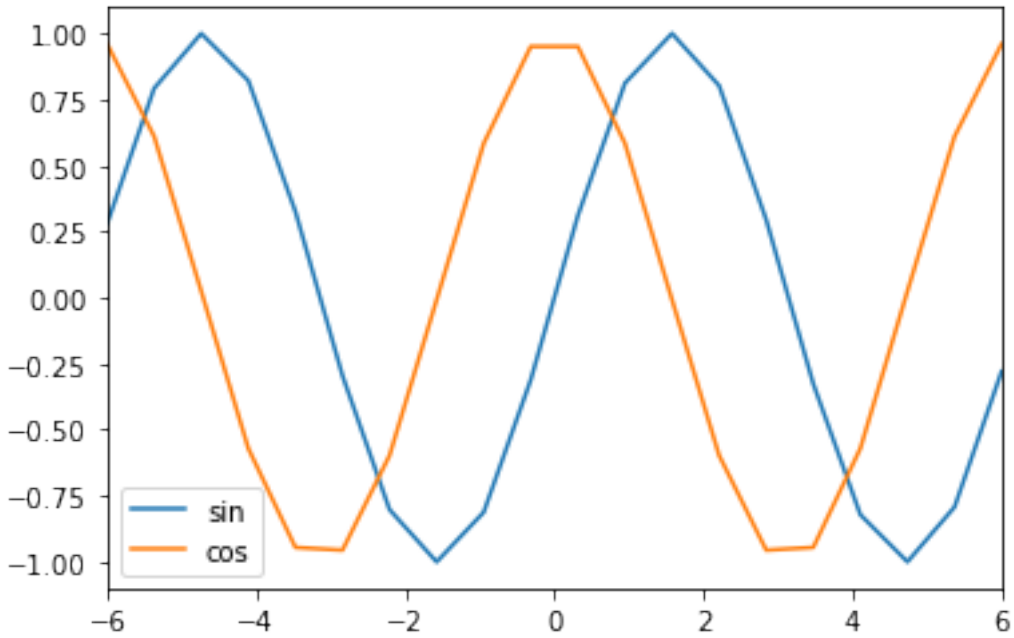
[21]:
```
A           float64
B    datetime64[ns]
C           float32
D             int32
E          category
F            object
```

```
dtype: object
```

Plotting
plotting is super-easy

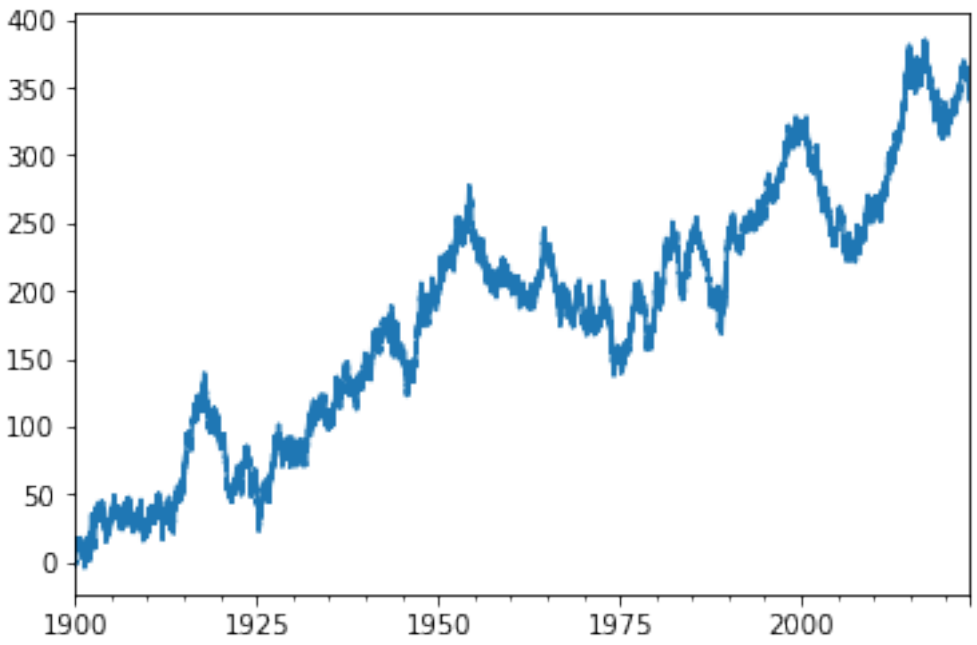
[22]:
```
df.plot()
```

[22]:
```
<matplotlib.axes._subplots.AxesSubplot at 0x7fdef2cfa780>
```



[23]:
```
ts = pd.Series(np.random.randn(45000),
               index=pd.date_range('1/1/1900', periods=45000))
ts = ts.cumsum()
ts.plot()
```

[23]:
```
<matplotlib.axes._subplots.AxesSubplot at 0x7fdef0b762e8>
```

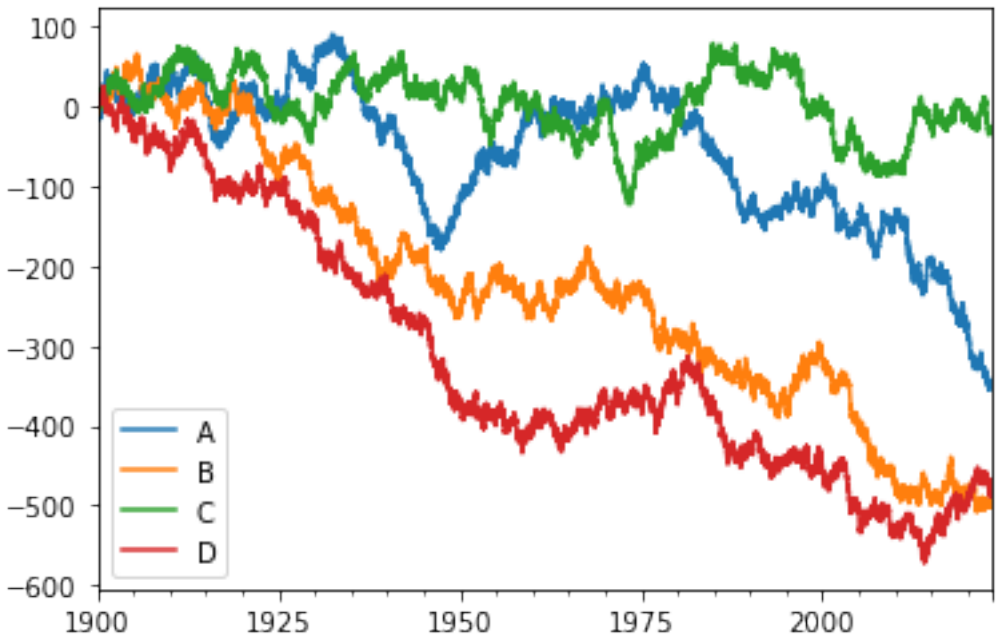


[24]:
```
df = pd.DataFrame(np.random.randn(45000, 4), index=ts.index,
                  columns=['A', 'B', 'C', 'D'])
df = df.cumsum()

plt.figure()
df.plot()
plt.legend(loc='best')
```

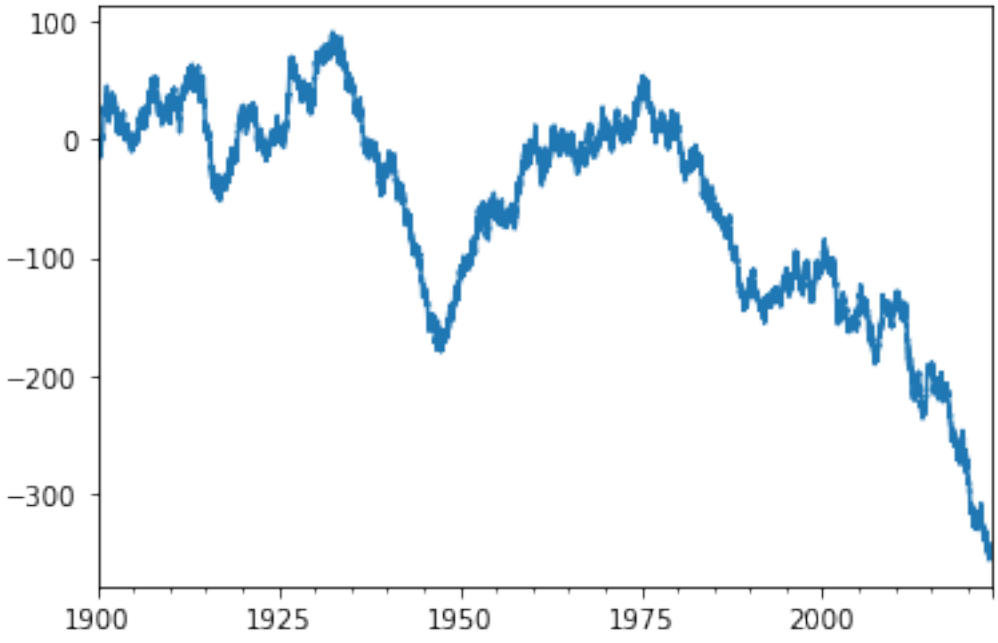
[24]:
```
<matplotlib.legend.Legend at 0x7fdef0679a20>
```

```
<Figure size 432x288 with 0 Axes>
```



[25]:
```
df['A'].plot()
```

[25]:
```
<matplotlib.axes._subplots.AxesSubplot at 0x7fdeef7fc898>
```



[26]:
```
df.describe()
```

[26]:

	A	B	C	D
count	45000.000000	45000.000000	45000.000000	45000.000000
mean	-58.612850	-226.988164	3.214128	-313.361073
std	91.822689	155.822916	40.212850	162.296298
min	-355.928156	-509.128080	-122.654053	-572.380638
25%	-128.998996	-336.737556	-20.737855	-437.785377
50%	-26.659032	-231.407431	6.508351	-372.697840
75%	10.543447	-111.334958	33.871246	-177.654215
max	90.370865	66.346537	79.357691	24.809176

2 File I/O

- reading `csv`
- reading `excel`
- reading `hdf5`

2.0.1 csv (fast, simple)

[27]:
```
df.index.name = 'time'
df.to_csv('foo.csv')
```

[28]:
```
!head foo.csv
```

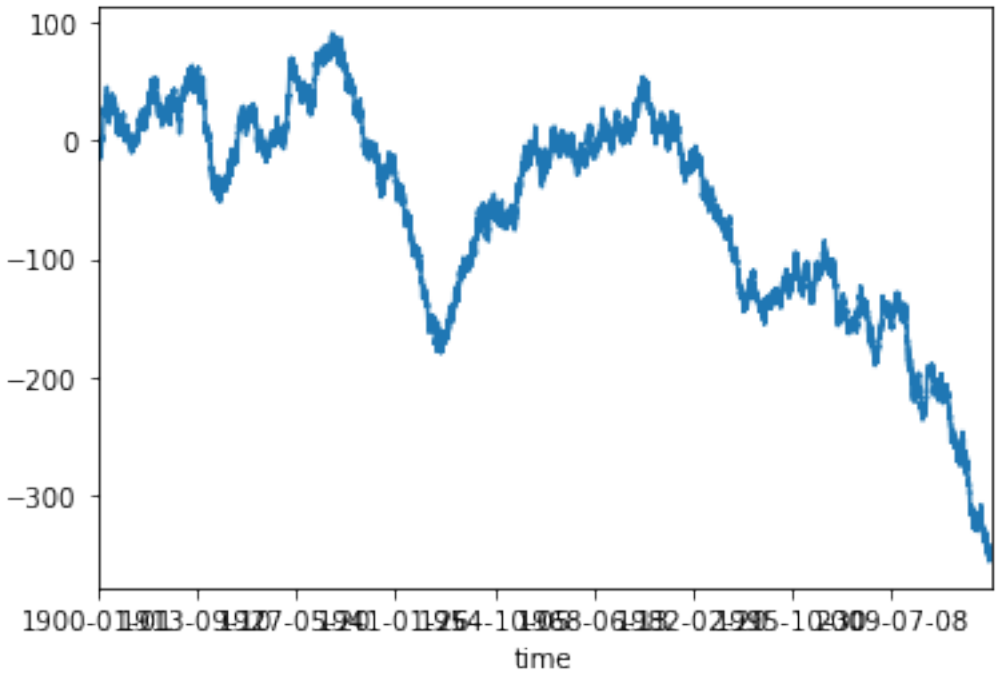
```
time,A,B,C,D
1900-01-01,-1.1190652434145012,-0.8170260608211657,0.6896412881609868,0.00739655
8262463458
1900-01-02,-1.6654255310812793,-2.5564780908235623,0.8426492151506279,0.58464683
74183935
1900-01-03,-1.711251251813269,-3.0108175817376357,1.8700588286988142,0.703069778
502929
1900-01-04,-3.509780829152314,-3.160235785270834,2.967196507245297,1.92614384126
35823
1900-01-05,-4.501883066644041,-3.571093314048569,4.061838027508743,2.07157782686
45084
1900-01-06,-3.728904735033837,-4.2595186308557125,4.678906407421984,3.5528452980
71466
1900-01-07,-2.5172141650767736,-4.920684125219758,4.043916014062499,1.9593641121
60967
1900-01-08,-2.2145059329950443,-2.9993851482961125,3.675626611019119,2.510610684
1781974
1900-01-09,-0.16421252367596972,-2.2517598726023165,5.412327160720512,3.40519537
2202757
```

[29]:
```
df2 = pd.read_csv('foo.csv', index_col=0)
df2.head()
```

[29]:
```
                   A         B         C         D
time
1900-01-01 -1.119065 -0.817026  0.689641  0.007397
1900-01-02 -1.665426 -2.556478  0.842649  0.584647
1900-01-03 -1.711251 -3.010818  1.870059  0.703070
1900-01-04 -3.509781 -3.160236  2.967197  1.926144
1900-01-05 -4.501883 -3.571093  4.061838  2.071578
```

[30]:
```
df2['A'].plot()
```

[30]:
```
<matplotlib.axes._subplots.AxesSubplot at 0x7fdeef443780>
```



2.0.2 excel (slow)

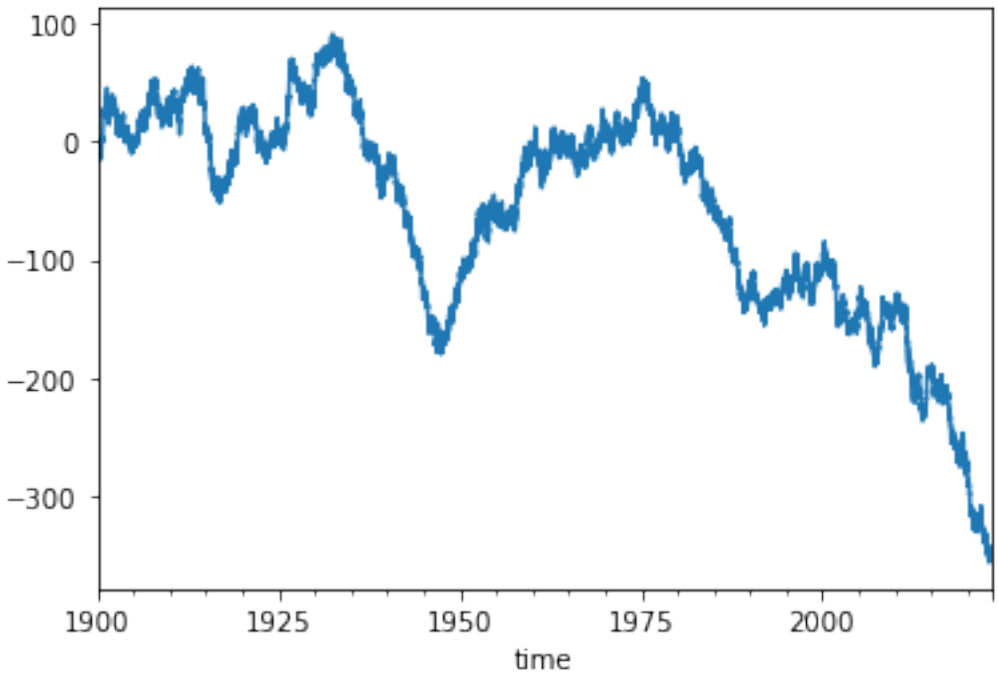
[31]:
```
df.to_excel('foo.xlsx', sheet_name='Sheet1')
```

[32]:
```
df2 = pd.read_excel('foo.xlsx', 'Sheet1', index_col=0, na_values=['NA'])
df2.head()
```

[32]:
```
                   A         B         C         D
time
1900-01-01 -1.119065 -0.817026  0.689641  0.007397
1900-01-02 -1.665426 -2.556478  0.842649  0.584647
1900-01-03 -1.711251 -3.010818  1.870059  0.703070
1900-01-04 -3.509781 -3.160236  2.967197  1.926144
1900-01-05 -4.501883 -3.571093  4.061838  2.071578
```

[33]:
```
df2['A'].plot()
```

[33]:
```
<matplotlib.axes._subplots.AxesSubplot at 0x7fdee1ffe400>
```



2.0.3 hdf5 (efficient, compressed)

[34]:
```
df.to_hdf('foo.h5', 'df')
```

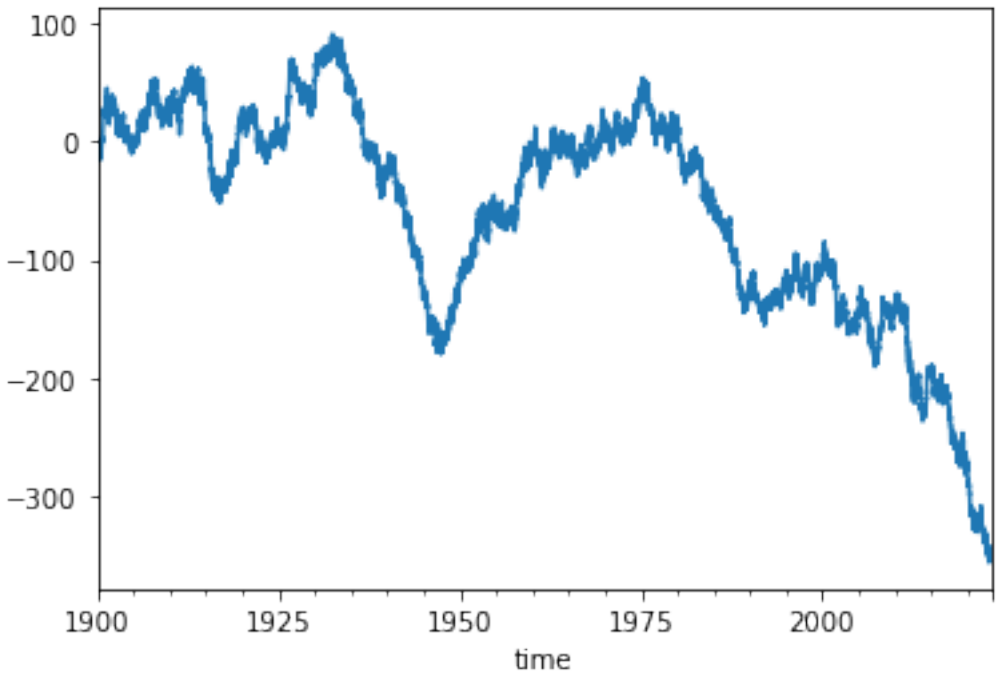
[35]:
```
df2 = pd.read_hdf('foo.h5', 'df')
df2.head()
```

[35]:

time	A	B	C	D
1900-01-01	-1.119065	-0.817026	0.689641	0.007397
1900-01-02	-1.665426	-2.556478	0.842649	0.584647
1900-01-03	-1.711251	-3.010818	1.870059	0.703070
1900-01-04	-3.509781	-3.160236	2.967197	1.926144
1900-01-05	-4.501883	-3.571093	4.061838	2.071578

[36]:
```
df2['A'].plot()
```

[36]:
```
<matplotlib.axes._subplots.AxesSubplot at 0x7fdee840a2e8>
```



2.0.4 File size

[37]:
```
!ls -lh foo* | sort
```

```
-rw-r--r-- 1 lento lento 1.8M Jul 16 19:29 foo.h5
-rw-r--r-- 1 lento lento 2.7M Jul 16 19:29 foo.xlsx
-rw-r--r-- 1 lento lento 3.8M Jul 16 19:29 foo.csv
```

Basic statistical analysis

2.0.5 Load csv data

[38]:
```
df = pd.read_csv('data/brain_size.csv', sep=';', na_values=".")
df.head()
```

[38]:

	Unnamed: 0	Gender	FSIQ	VIQ	PIQ	Weight	Height	MRI_Count
0	1	Female	133	132	124	118.0	64.5	816932
1	2	Male	140	150	124	NaN	72.5	1001121
2	3	Male	139	123	150	143.0	73.3	1038437
3	4	Male	133	129	128	172.0	68.8	965353
4	5	Female	137	132	134	147.0	65.0	951545

[39]:
```
df.columns  # It has columns
```

[39]:
```
Index(['Unnamed: 0', 'Gender', 'FSIQ', 'VIQ', 'PIQ', 'Weight', 'Height',
       'MRI_Count'],
```

```
      dtype='object')
```

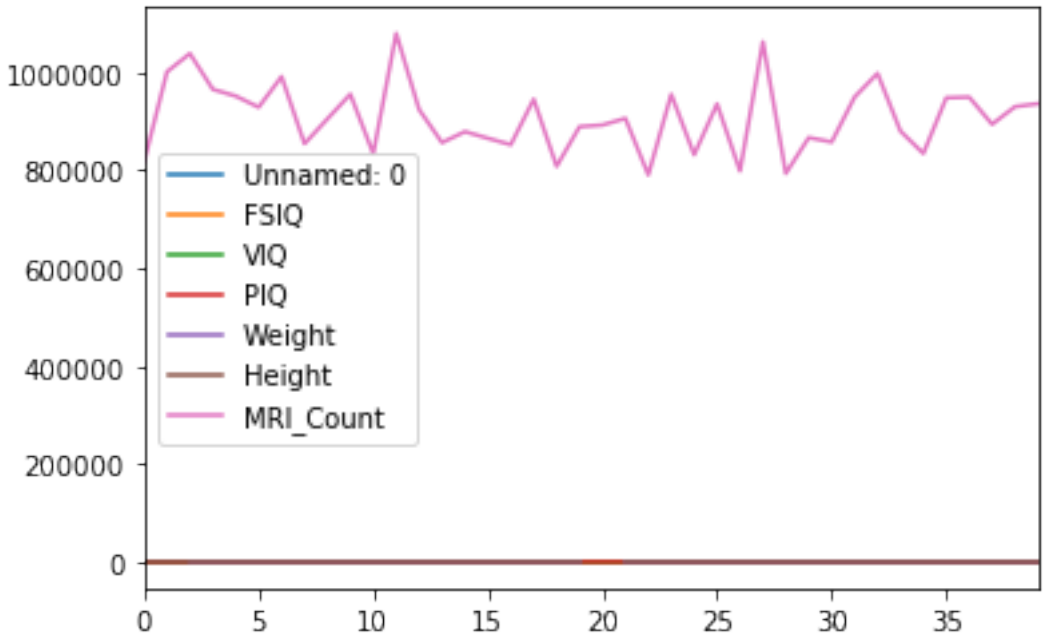
[40]:
```
df['Gender'].head()  # Columns can be addressed by name
```

[40]:
```
0    Female
1      Male
2      Male
3      Male
4    Female
Name: Gender, dtype: object
```

2.0.6 Plot and inspect

[41]:
```
df.plot()
```

[41]:
```
<matplotlib.axes._subplots.AxesSubplot at 0x7fdeeea8a1d0>
```



Let's calculate the *mean* `VIQ` for `Female`

[42]:
```
df.describe()
```

[42]:

	Unnamed: 0	FSIQ	VIQ	PIQ	Weight	Height	\
count	40.000000	40.000000	40.000000	40.00000	38.000000	39.000000	
mean	20.500000	113.450000	112.350000	111.02500	151.052632	68.525641	
std	11.690452	24.082071	23.616107	22.47105	23.478509	3.994649	
min	1.000000	77.000000	71.000000	72.00000	106.000000	62.000000	
25%	10.750000	89.750000	90.000000	88.25000	135.250000	66.000000	
50%	20.500000	116.500000	113.000000	115.00000	146.500000	68.000000	
75%	30.250000	135.500000	129.750000	128.00000	172.000000	70.500000	

```
max     40.000000  144.000000  150.000000  150.00000  192.000000  77.000000
```

```
          MRI_Count
count  4.000000e+01
mean   9.087550e+05
std    7.228205e+04
min    7.906190e+05
25%    8.559185e+05
50%    9.053990e+05
75%    9.500780e+05
max    1.079549e+06
```

[43]:
```
# Simpler selector
df[df['Gender'] == 'Female']['VIQ'].mean()
```

[43]:
```
109.45
```

[44]:
```
groupby_gender = df.groupby('Gender')
for gender, value in groupby_gender['VIQ']:
    print((gender, value.mean()))
```

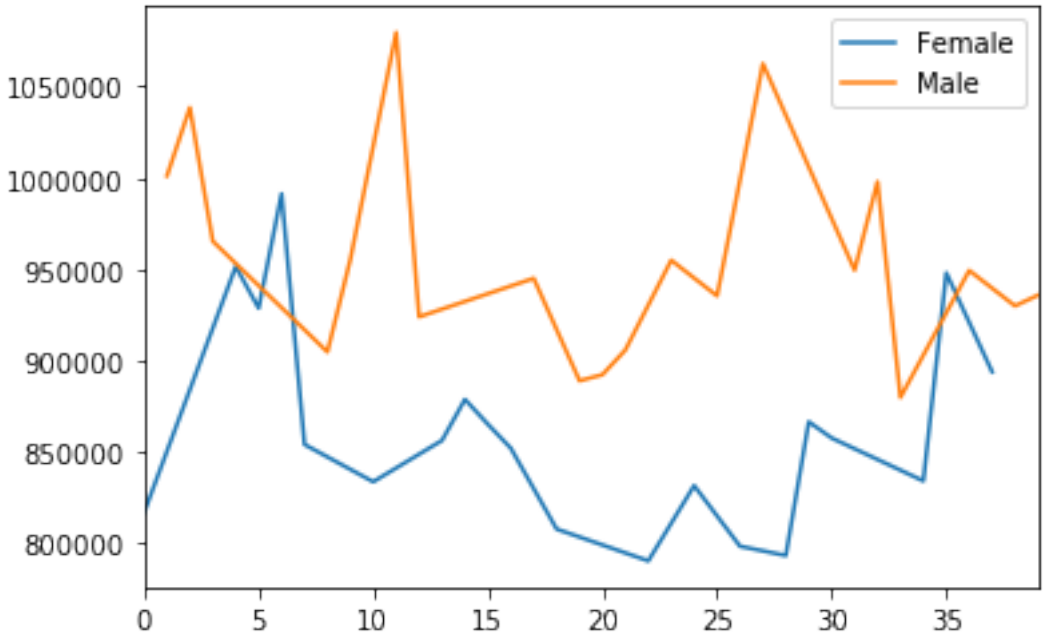
```
('Female', 109.45)
('Male', 115.25)
```

[45]:
```
groupby_gender.mean()
```

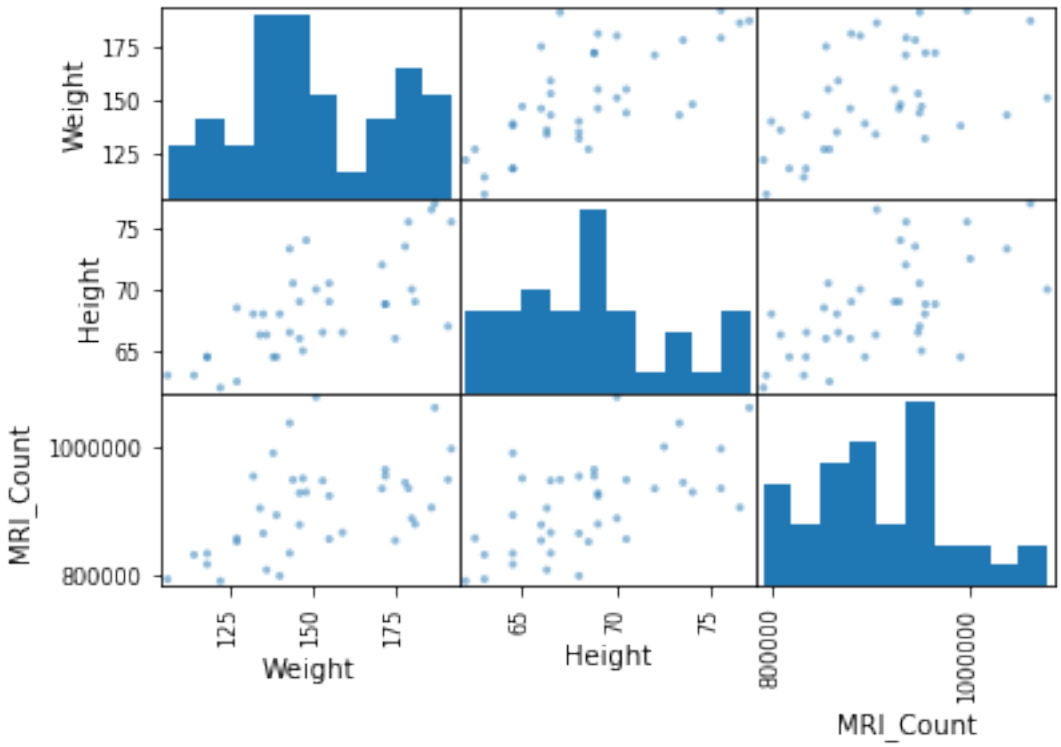
[45]:
```
        Unnamed: 0   FSIQ     VIQ     PIQ      Weight     Height  MRI_Count
Gender
Female       19.65  111.9  109.45  110.45  137.200000  65.765000   862654.6
Male         21.35  115.0  115.25  111.60  166.444444  71.431579   954855.4
```

[46]:
```
groupby_gender['MRI_Count'].plot(legend='True')
```

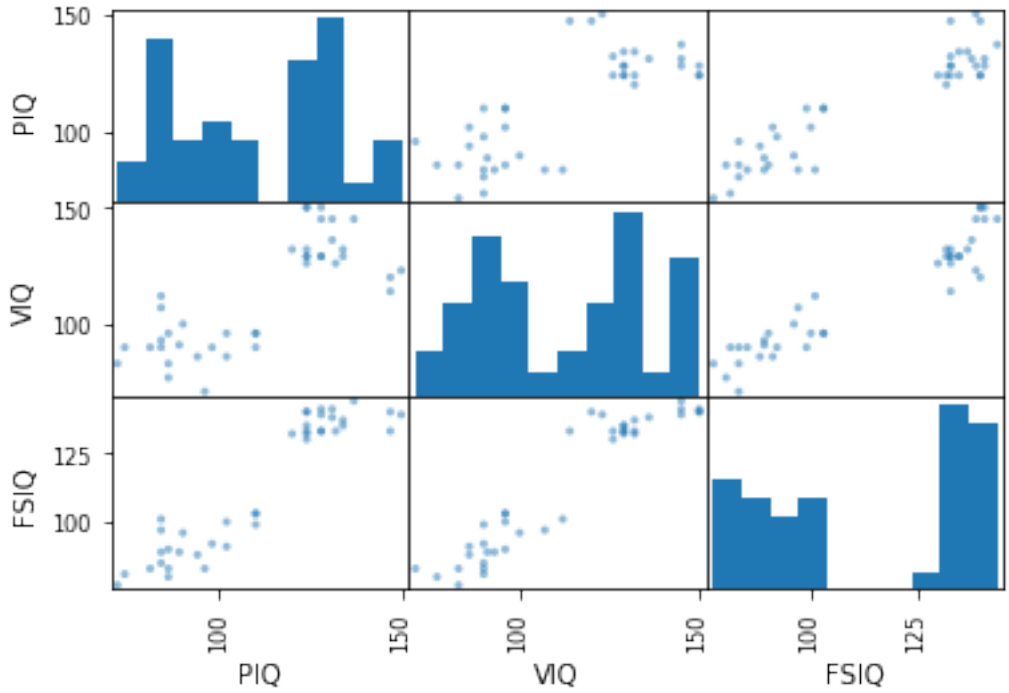
[46]:
```
Gender
Female    AxesSubplot(0.125,0.125;0.775x0.755)
Male      AxesSubplot(0.125,0.125;0.775x0.755)
Name: MRI_Count, dtype: object
```



[47]:
```
pd.plotting.scatter_matrix(df[['Weight', 'Height', 'MRI_Count']]);
```



[48]:
```
pd.plotting.scatter_matrix(df[['PIQ', 'VIQ', 'FSIQ']]);
```



3 cleanup

[49]:
```
!rm foo.csv foo.xlsx foo.h5
```