Advanced Data Processing and Visualization of Python

Python高级数据处理与可视化

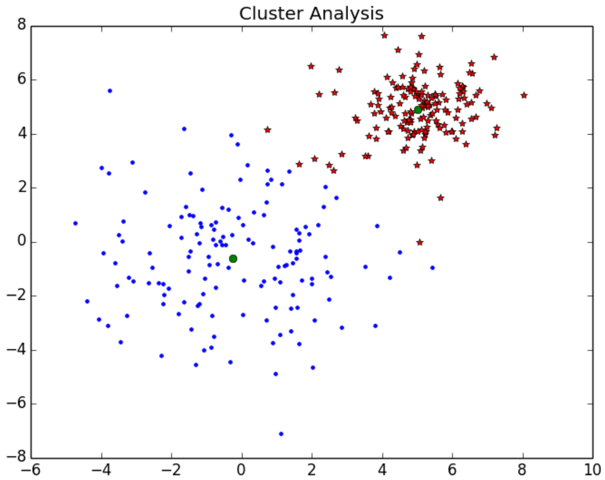
Department of Computer Science and Technology
Department of University Basic Computer Teaching

用Python玩转数据

1

聚类分析

聚类



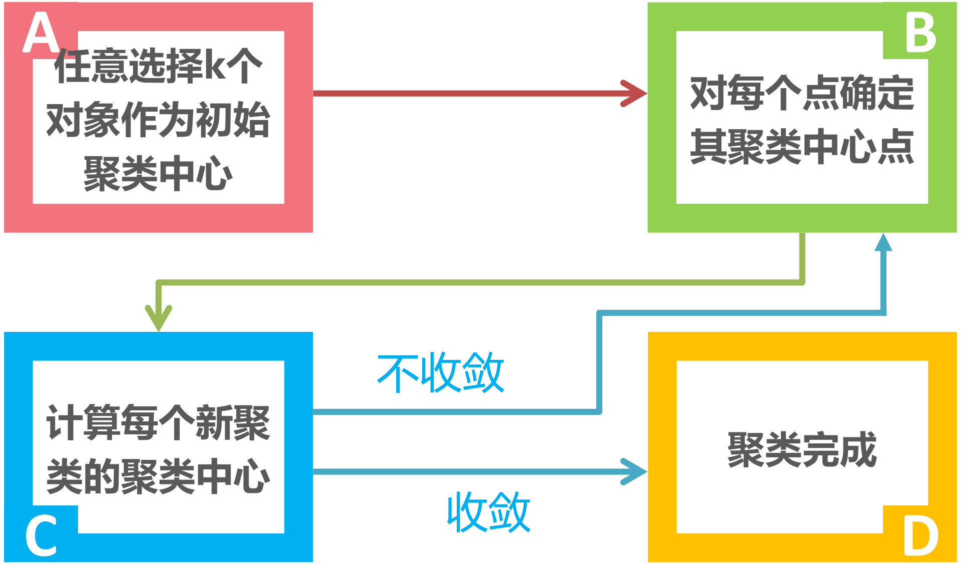
- 聚类分析(cluster analysis)

以相似性为基础把相似的对象通过静态分类的方法分成不同的组别或者更多的子集

- 特性
  - 基于相似性
  - 有多个聚类中心

K-MEANS

K-均值算法表示以空间中k个点为中心进行聚类，对最靠近他们的对象归类。



一个日常小例子

	高数	英语	Python	音乐
小明	88	64	96	85
大明	92	99	95	94
小朋	91	87	99	95
大朋	78	99	97	81
小萌	88	78	98	84
大萌	100	95	100	92

File

```
# Filename: kmeansStu1.py
import numpy as np
from scipy.cluster.vq import vq, kmeans, whiten
list1 = [88.0, 74.0, 96.0, 85.0]
list2 = [92.0, 99.0, 95.0, 94.0]
list3 = [91.0, 87.0, 99.0, 95.0]
list4 = [78.0, 99.0, 97.0, 81.0]
list5 = [88.0, 78.0, 98.0, 84.0]
list6 = [100.0, 95.0, 100.0, 92.0]
data = np.array([list1,list2,list3,list4,list5,list6])
whiten = whiten(data)
centroids,_ = kmeans(whiten, 2)
result,_= vq(whiten, centroids)
print(result)
```

Output:

```
[1 0 0 1 1 0]
```

用专业工具解决

File

```python
# Filename: kmeansStu2.py
import numpy as np
from sklearn.cluster import KMeans
list1 = [88.0,74.0,96.0,85.0]
list2 = [92.0,99.0,95.0,94.0]
list3 = [91.0,87.0,99.0,95.0]
list4 = [78.0,99.0,97.0,81.0]
list5 = [88.0,78.0,98.0,84.0]
list6 = [100.0,95.0,100.0,92.0]
X = np.array([list1,list2,list3,list4,list5,list6])
kmeans = KMeans(n_clusters = 2).fit(X)
pred = kmeans.predict(X)
print(pred)
```

```python
from sklearn import datasets
from sklearn import svm
clf = svm.SVC(gamma=0.001, C=100.)
digits = datasets.load_digits()
clf.fit(digits.data[:-1], digits.target[:-1])
clf.predict(digits.data[-1])
```

Output:

```
[0 1 1 1 0 1]
```

另一个例子

基于10只道指成分股股票近一年来相邻两天的收盘价涨跌数据规律对它们进行聚类

File

['MMM','AXP','AAPL','BA','CAT','CVX','CSCO','KO','DIS','DD']

```
# Filename: kmeansDJI.py
listDji = ['MMM','AXP','AAPL','BA','CAT','CVX','CSCO','KO','DIS','DD']
listTemp = [0] * len(listDji)
for i in range(len(listTemp)):
    listTemp[i] = create_df(listDji[i]).close     # a function for creating a DataFrame
status = [0] * len(listDji)
for i in range(len(status)):
    status[i] = np.sign(np.diff(listTemp[i]))
kmeans = KMeans(n_clusters = 3).fit(status)
pred = kmeans.predict(status)
print(pred)
```

Output:

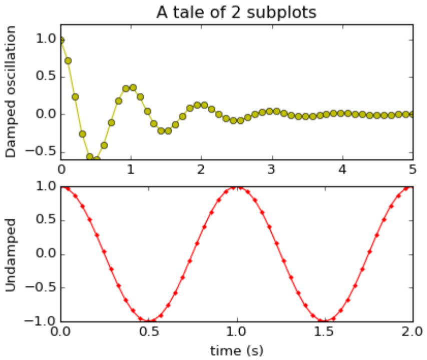
```
[2 0 2 2 0 0 2 2 1 1]
```

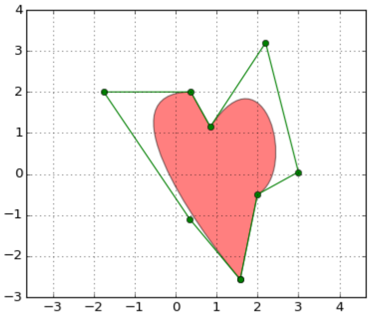
用Python玩转数据

2

MATPLOTLIB 绘图基础

Matplotlib绘图





- **Matplotlib绘图**

  最著名Python绘图库，主要用于二维绘图

  – 画图质量高

  – 方便快捷的绘图模块

    - 绘图API——pyplot模块
    - 集成库——pylab模块（包含NumPy和pyplot中的常用函数）

数据源

可口可乐公司近一年来股票收盘价的月平均价

Source

```
>>> closeMeansKO = tempkodf.groupby('month').close.mean()
>>> closeMeansKO
month
1        41.440500
2        41.350526
3        42.241304
4        42.934210
…
10       41.979524
11       41.523809
12       41.345714
```

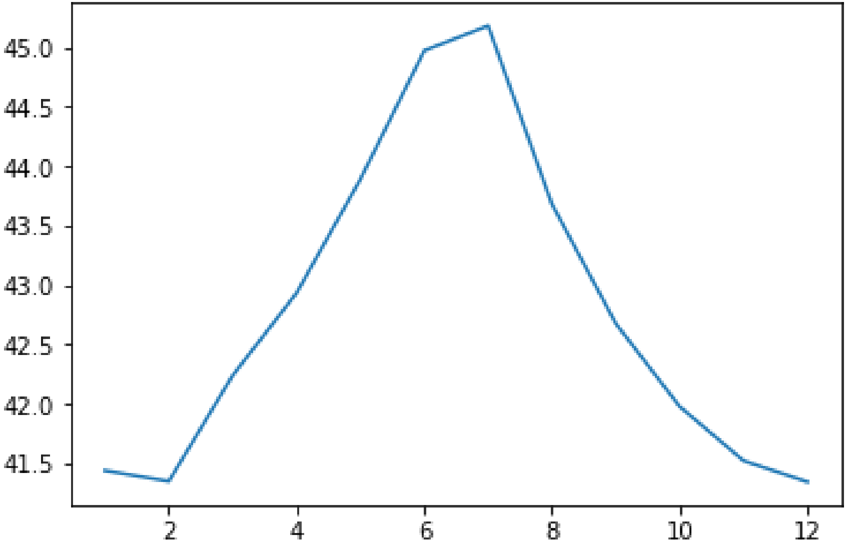
折线图

默认绘制的图

将可口可乐公司近一年来股票收盘价的月平均价绘制成折线图

File

```
# Filename: plotKO.py
import matplotlib.pyplot as plt
...
x = closeMeansKO.index
y = closeMeansKO.values
plt.plot(x, y)
```

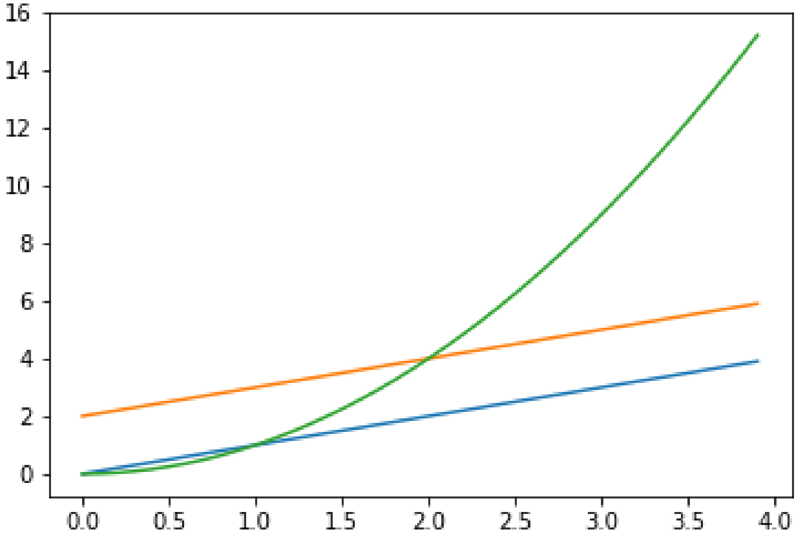


折线图

NumPy数组也可以作为Matplotlib的参数

Source

```
>>> import numpy as np
>>> import matplotlib.pyplot as plt
>>> t=np.arange(0.,4.,0.1)
>>> plt.plot(t, t, t, t+2, t, t**2)
```



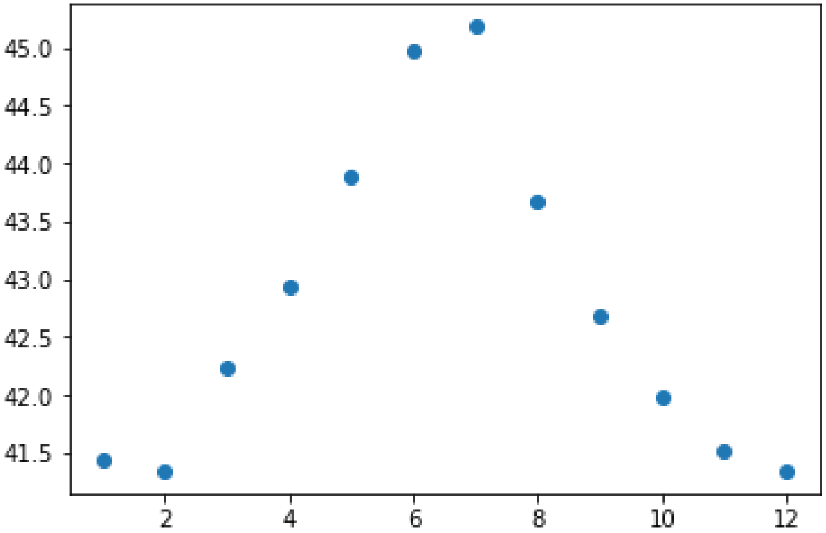
散点图

将可口可乐公司近一年来股票收盘价的月平均价绘制成散点图

```
plt.plot(x, y)
```

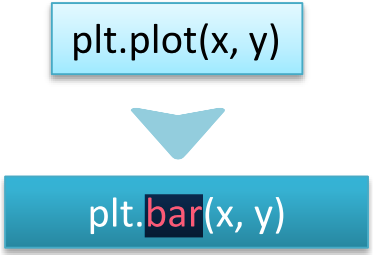
```
plt.plot(x, y, 'o')
```

绘制成散点图



柱状图

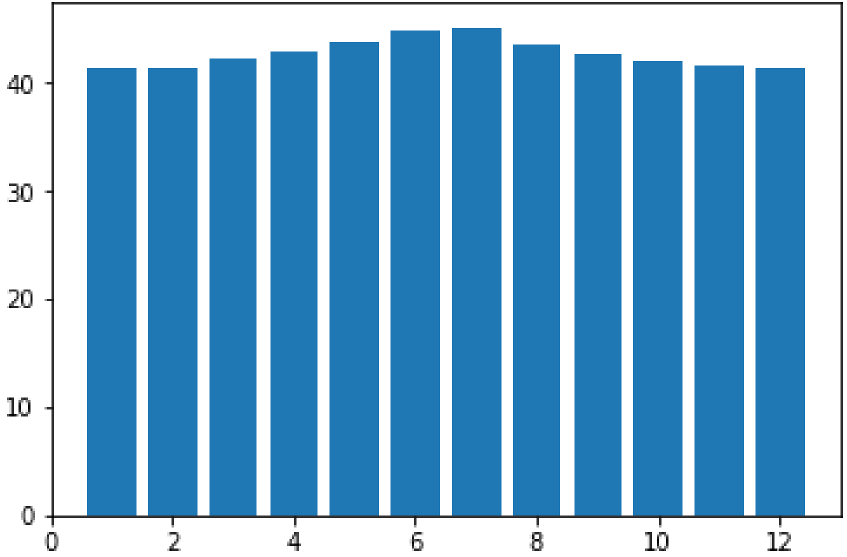
？将可口可乐公司近一年来股票收盘价的月平均价绘制成柱状图



plt.plot(x, y)

plt.bar(x, y)

柱状图的绘制

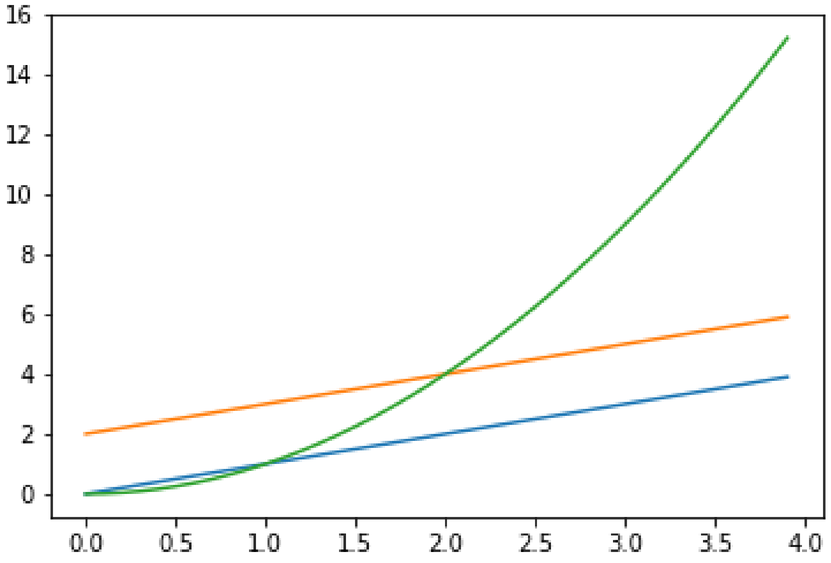


pylab绘图

NumPy数组也可以作为Matplotlib的参数

Source

```
>>> import numpy as np
>>> import pylab as pl
>>> t=np.arange(0.,4.,0.1)
>>> pl.plot(t,t,t,t+2,t,t**2)
```



3

MATPLOTLIB
图像属性控制

Matplotlib属性

……

文字和字体属性

坐标轴和网格属性

子图(axes)

子区(subplots)

色彩和样式

线宽

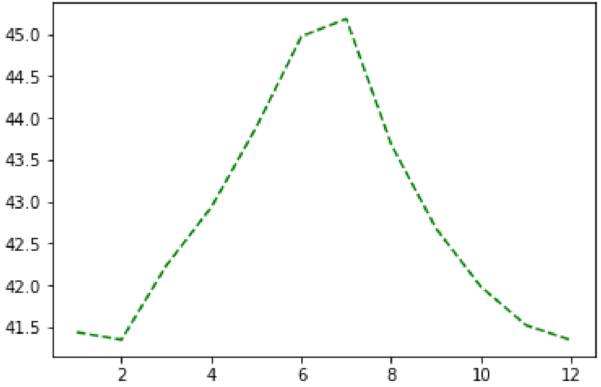
每英寸点数

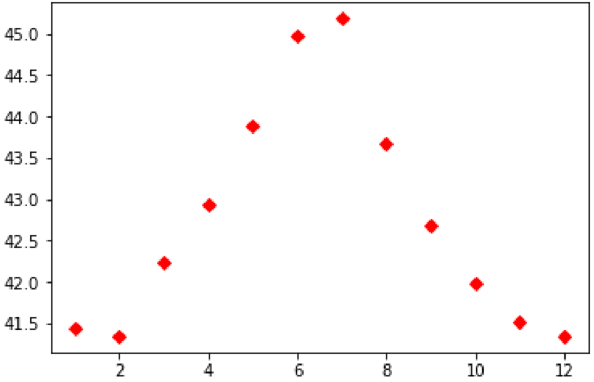
图像大小

Matplotlib可以控制的默认属性

色彩和样式

绘图颜色和线条类型和样式可以更改吗？





```
plt.plot(x, y, 'g--')
```

```
plt.plot(x, y, 'rD')
```

色彩和样式

符号	颜色
b	blue
g	green
r	red
c	cyan
m	magenta
Y	yellow
k	black
w	white

线型	描述
'-'	solid
'--'	dashed
'-.'	dash_dot
':'	dotted
'None'	draw nothing
' '	draw nothing
''	draw nothing

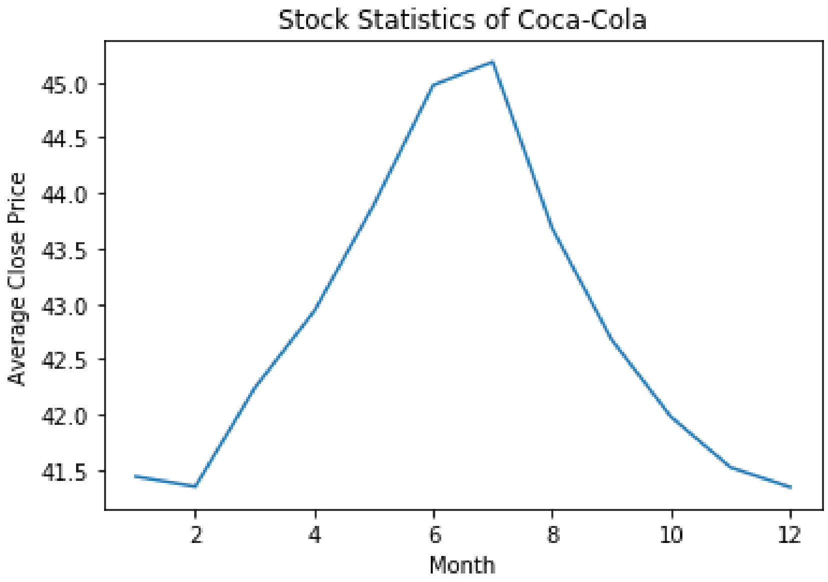
标记	描述
"o"	circle
"v"	triangle_down
"s"	square
"p"	pentagon
"*"	star
"h"	hexagon1
"+"	plus
"D"	diamond
…	…

文字

加标题：图、横轴和纵轴

File

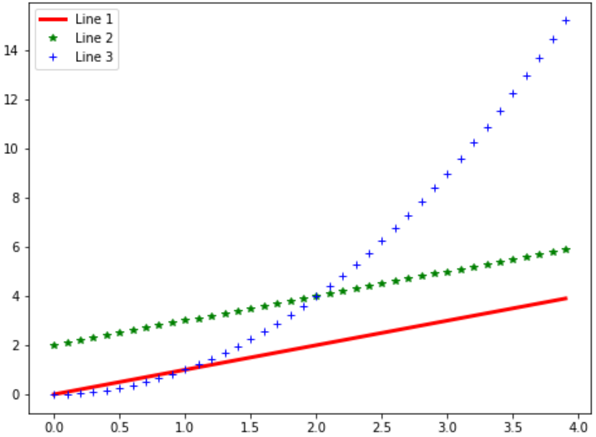
```
# Filename: plotKO.py
import matplotlib.pyplot as plt
…
x = closeMeansKO.index
y = closeMeansKO.values
plt.title('Stock Statistics of Coca-Cola')
plt.xlabel('Month')
plt.ylabel('Average Close Price')
plt.plot(x, y)
```



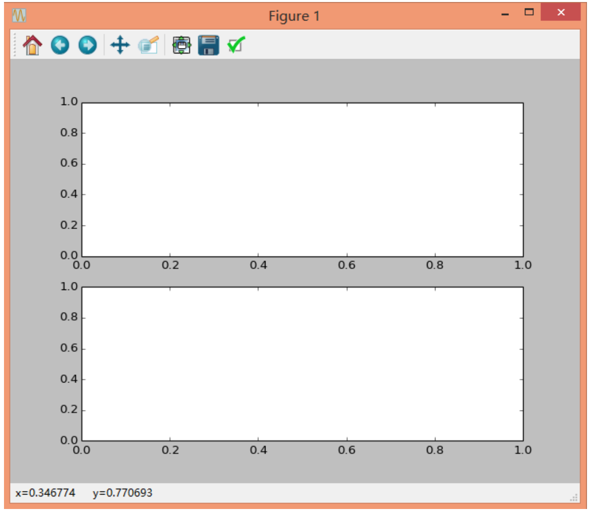
其他属性

File

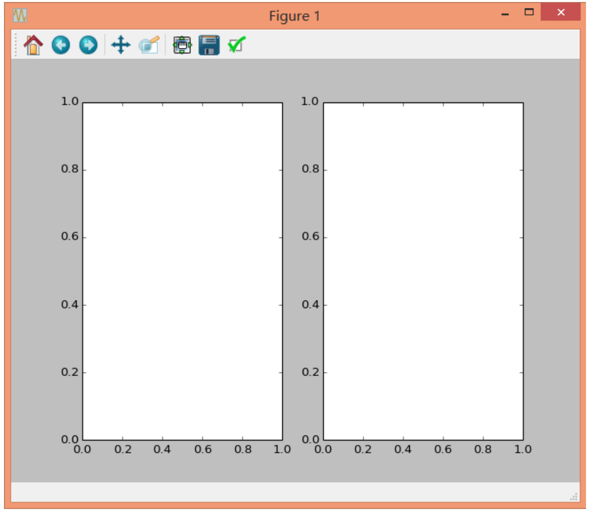
```
# Filename: multilines.py
import pylab as pl
import numpy as np
pl.figure(figsize=(8,6),dpi=100)
t=np.arange(0.,4.,0.1)
pl.plot(t,t,color='red',linestyle='-',linewidth=3,label='Line 1')
pl.plot(t,t+2,color='green',linestyle='',marker='*',linewidth=3,label='Line 2')
pl.plot(t,t**2,color='blue',linestyle='',marker='+',linewidth=3,label='Line 3')
pl.legend(loc='upper left')
```



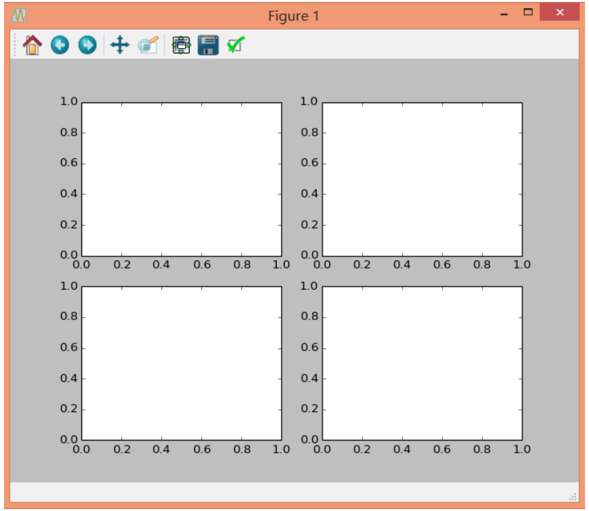
多子图-subplots



```
plt.subplot(211)
plt.subplot(212)
```



```
plt.subplot(121)
plt.subplot(122)
```



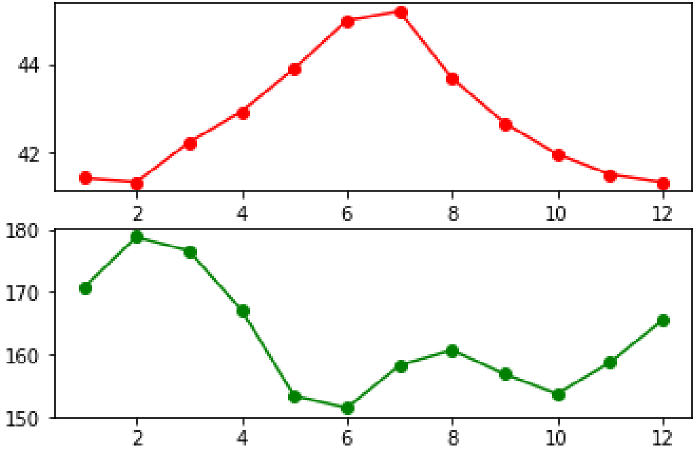
```
plt.subplot(221)
plt.subplot(222)
plt.subplot(223)
plt.subplot(224)
```

多子图-subplots

？ 将可口可乐公司和IBM公司近一年来股票收盘价的月平均价绘制在一张图中

File

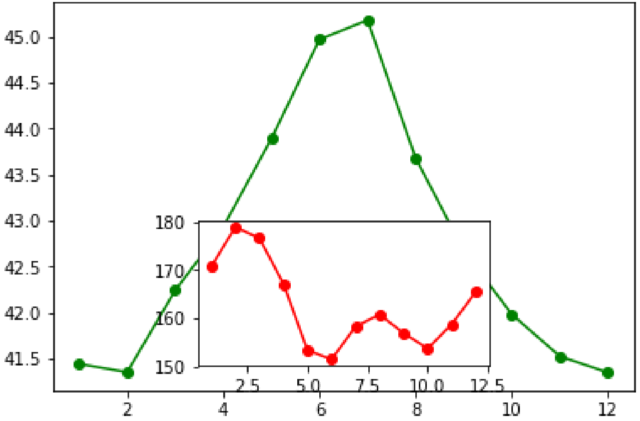
```
#The data of Coca-Cola and IBM is ready
plt.subplot(211)
plt.plot(x,y,color='r',marker='o')
plt.subplot(212)
plt.plot(xi,yi,color='green',marker='o')
```



子图-axes

将可口可乐公司和IBM公司近一年来股票收盘价的月平均价绘制在一张图中

```
#The data of Coca-Cola and IBM is ready
plt.axes([.1,.1,0.8,0.8])
plt.plot(x,y,color='green',marker='o')
plt.axes([.3,.15,0.4,0.3])
plt.plot(xi,yi,color='r',marker='o')
plt.savefig('1.jpg')
```



axes([left,bottom,width,height])
参数范围为(0,1)

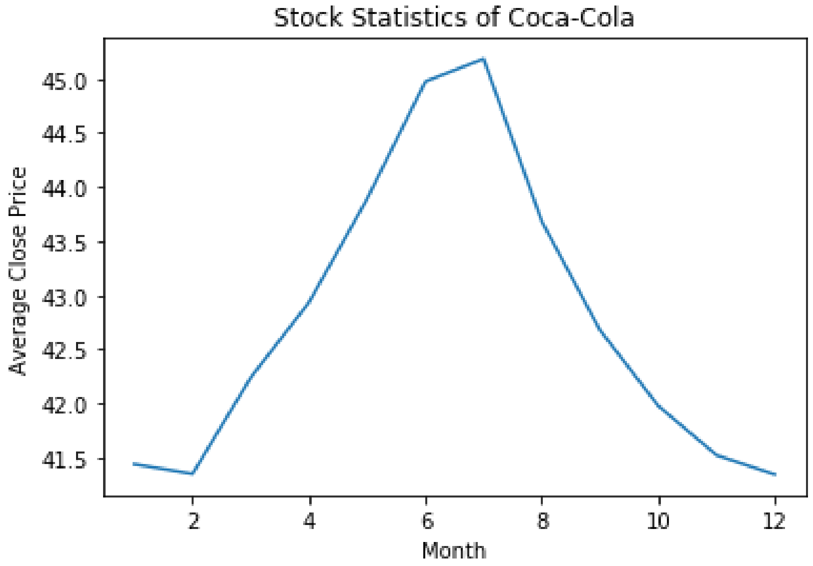
用Python玩转数据

4 PANDAS作图

Python实例

Source

```
>>> plt.title('Stock Statistics of Coca-Cola')
>>> plt.xlabel('Month')
>>> plt.ylabel('Average Close Price')
>>> plt.plot(closeMeansKO)
```

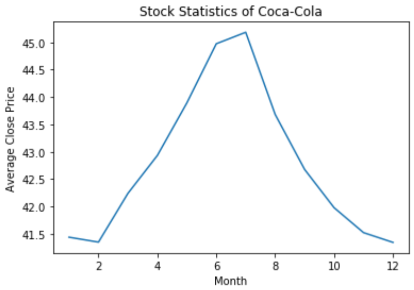


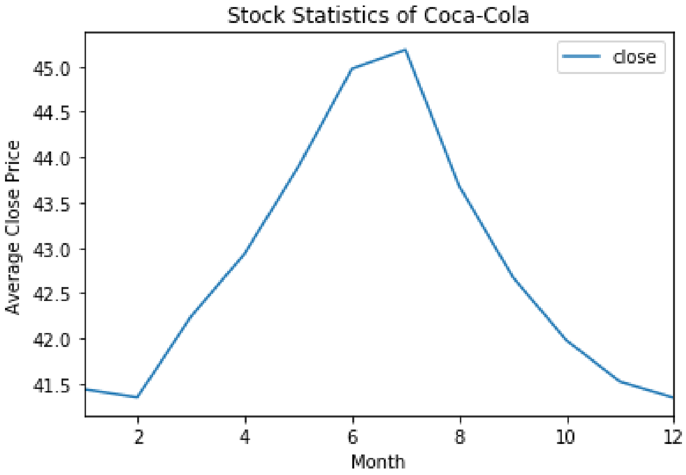
Pandas可以绘图，还可以结合matplotlib联合绘图

pandas绘图

Source

```
>>> import pandas as pd
>>> closeMeansKO.plot()
>>> plt.title('Stock Statistics of Coca-Cola')
>>> plt.xlabel('Month')
>>> plt.ylabel('Average Close Price')
```



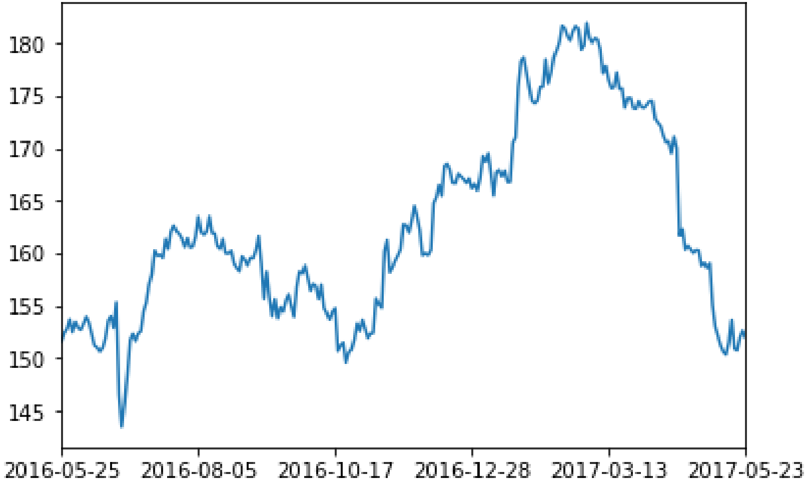


pandas绘图

绘制IBM公司近一年来的股票收盘价折线图

# Filename: quotesdfplot.py

```
...
quotes = retrieve_quotes_historical('IBM')
quotesdfIBM = pd.DataFrame(quotes)
quotesdfIBM.close.plot()
```

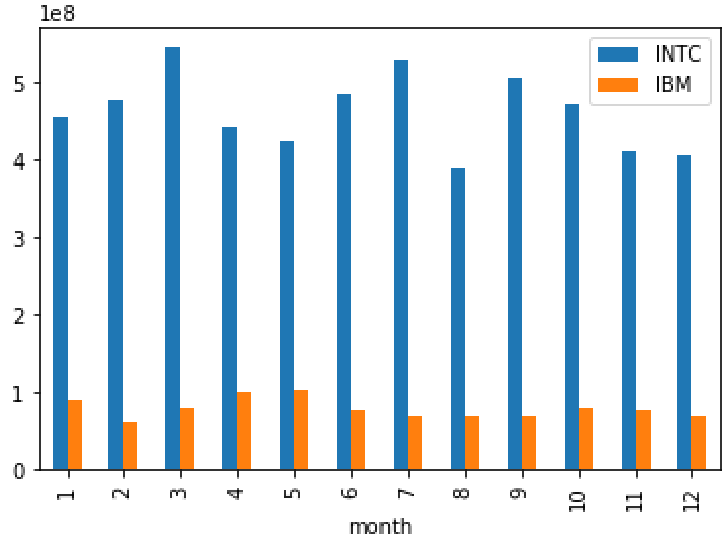


pandas控制图像形式

？ 用柱状图比较Intel和IBM这两家科技公司近一年来股票成交量

File

```
# Filename: plot_volumes.py
…
INTC_volumes = create_volumes('INTC')
IBM_volumes = create_volumes('IBM')
quotesIIdf = pd.DataFrame()
quotesIIdf['INTC'] = INTC_volumes
quotesIIdf['IBM'] = IBM_volumes
quotesIIdf.plot(kind = 'bar')
```

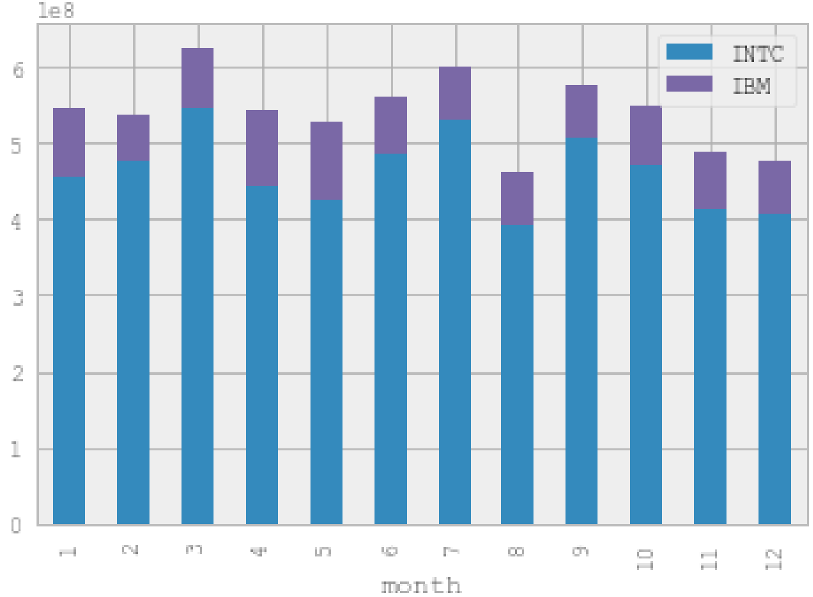


pandas控制图像形式

用柱状图比较Intel和IBM这两家科技公司近一年来的股票成交量

```
quotesIIdf.plot(kind='bar')
```

```
quotesIIdf.plot(kind='bar',stacked = True)
```



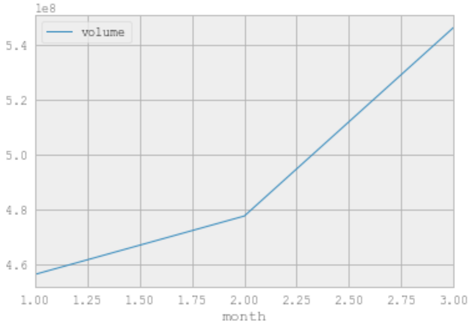
pandas控制图像形式

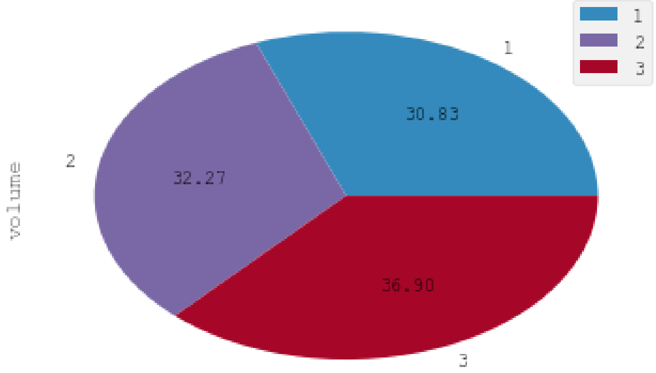
?

Intel公司本年度前3个月每个月股票收盘价的占比

```
quotesINTC.plot()
```

```
quotesINTC.plot(kind = 'pie',
subplots = True, autopct = '%.2f')
```



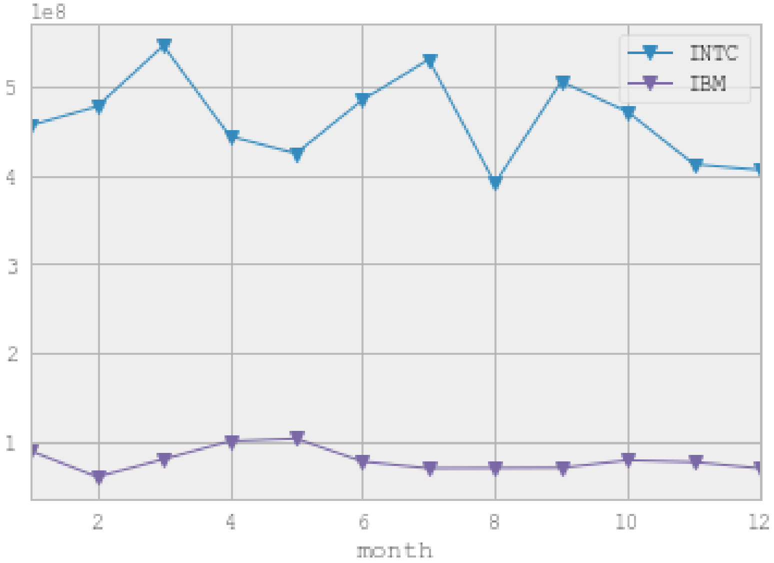


pandas控制图像属性

Source

#The data of Intel and IBM is ready

```
>>> quotesIIdf.plot(marker='v')
```

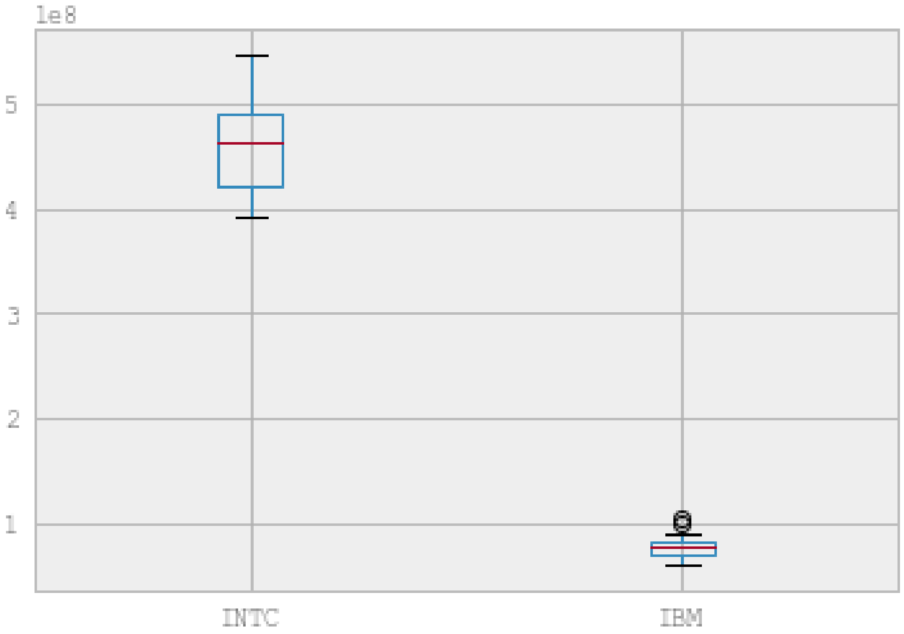


箱形图

用箱形图比较Intel和IBM这两家科技公司近一年来的股票成交量

quotesIIdf.plot(kind='bar')

quotesIIdf.boxplot()



上边缘，上四分位数，中位数，下四分位数，下边缘

5

数据存取

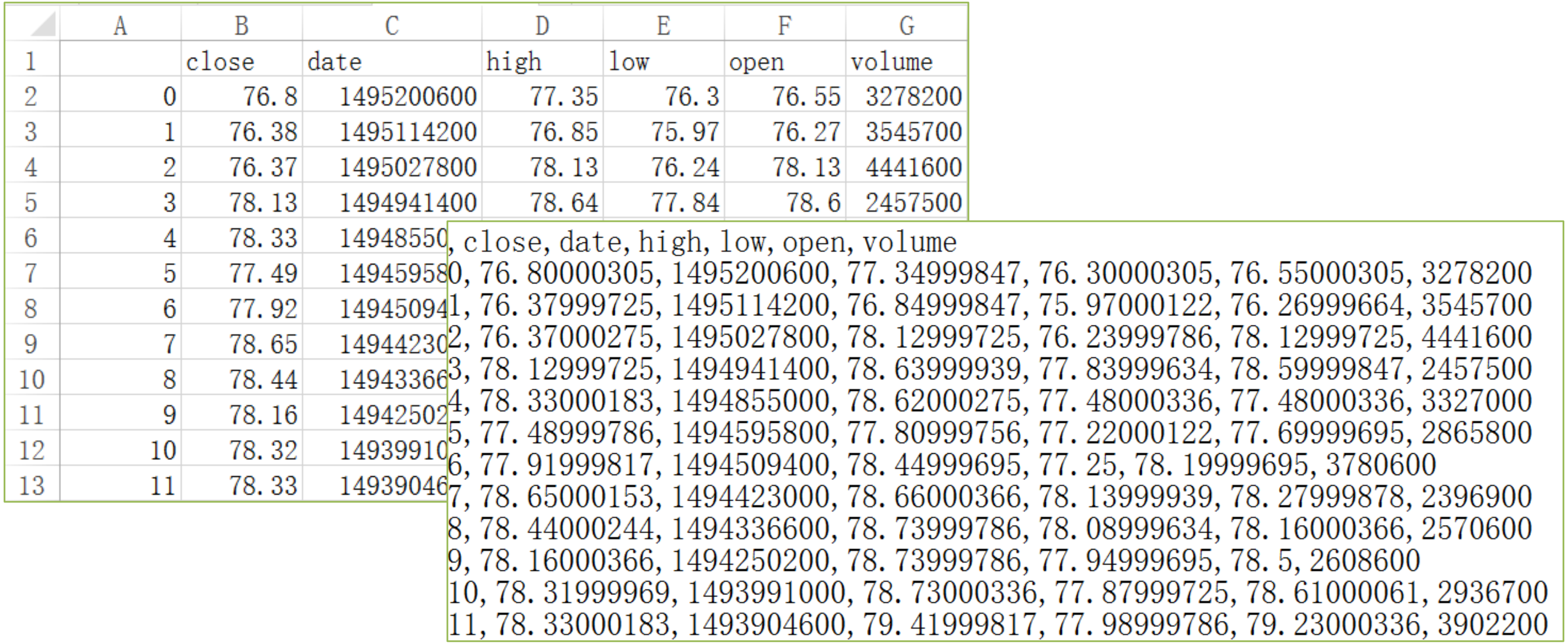
csv格式数据存取

将美国通用公司近一年来的股票基本信息存入文件stockAXP.csv中

File

```
# Filename: to_csv.py
import pandas as pd
…
quotes = retrieve_quotes_historical('AXP')
df = pd.DataFrame(quotes)
df.to_csv('stockAXP.csv')
```

csv格式数据存取



	A	B	C	D	E	F	G
1		close	date	high	low	open	volume
2	0	76.8	1495200600	77.35	76.3	76.55	3278200
3	1	76.38	1495114200	76.85	75.97	76.27	3545700
4	2	76.37	1495027800	78.13	76.24	78.13	4441600
5	3	78.13	1494941400	78.64	77.84	78.6	2457500
6	4	78.33	14948550				
7	5	77.49	14945958				
8	6	77.92	14945094				
9	7	78.65	14944230				
10	8	78.44	14943366				
11	9	78.16	14942502				
12	10	78.32	14939910				
13	11	78.33	14939046				

```
,close,date,high,low,open,volume
0,76.80000305,1495200600,77.34999847,76.30000305,76.55000305,3278200
1,76.37999725,1495114200,76.84999847,75.97000122,76.26999664,3545700
2,76.37000275,1495027800,78.12999725,76.23999786,78.12999725,4441600
3,78.12999725,1494941400,78.63999939,77.83999634,78.59999847,2457500
4,78.33000183,1494855000,78.62000275,77.48000336,77.48000336,3327000
5,77.48999786,1494595800,77.80999756,77.22000122,77.69999695,2865800
6,77.91999817,1494509400,78.44999695,77.25,78.19999695,3780600
7,78.65000153,1494423000,78.66000366,78.13999939,78.27999878,2396900
8,78.44000244,1494336600,78.73999786,78.08999634,78.16000366,2570600
9,78.16000366,1494250200,78.73999786,77.94999695,78.5,2608600
10,78.31999969,1493991000,78.73000336,77.87999725,78.61000061,2936700
11,78.33000183,1493904600,79.41999817,77.98999786,79.23000336,3902200
```

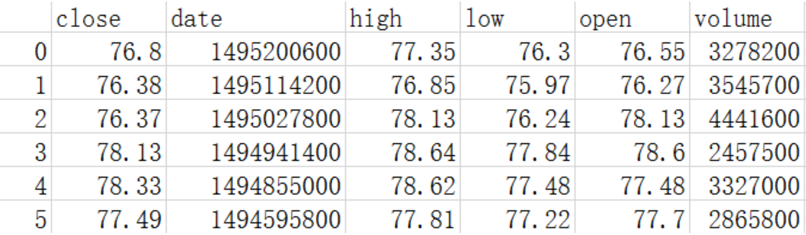
csv格式数据存取

Source

```
>>> result = pd.read_csv('stockAXP.csv')
>>> result
   Unnamed: 0      close        date       high        low       open  \
0           0  76.800003  1495200600  77.349998  76.300003  76.550003
1           1  76.379997  1495114200  76.849998  75.970001  76.269997
2           2  76.370003  1495027800  78.129997  76.239998  78.129997
3           3  78.129997  1494941400  78.639999  77.839996  78.599998
…
>>> print(result['close'])
0      76.800003
1      76.379997
2      76.370003
3      78.129997
…
```

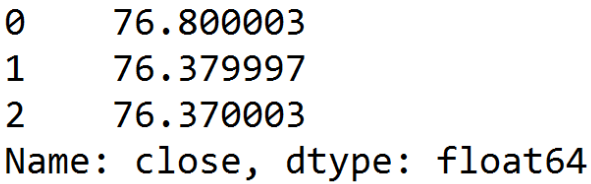
excel数据存取

```
# Filename: to_excel.py
…
quotes = retrieve_quotes_historical('AXP')
df = pd.DataFrame(quotes)
df.to_excel('stockAXP.xlsx', sheet_name='AXP')
```



	close	date	high	low	open	volume
0	76.8	1495200600	77.35	76.3	76.55	3278200
1	76.38	1495114200	76.85	75.97	76.27	3545700
2	76.37	1495027800	78.13	76.24	78.13	4441600
3	78.13	1494941400	78.64	77.84	78.6	2457500
4	78.33	1494855000	78.62	77.48	77.48	3327000
5	77.49	1494595800	77.81	77.22	77.7	2865800

```
# Filename: read_excel.py
…
df = pd.read_excel('stockAXP.xlsx')
print(df['close'][:3])
```



```
0    76.800003
1    76.379997
2    76.370003
Name: close, dtype: float64
```

用Python玩转数据

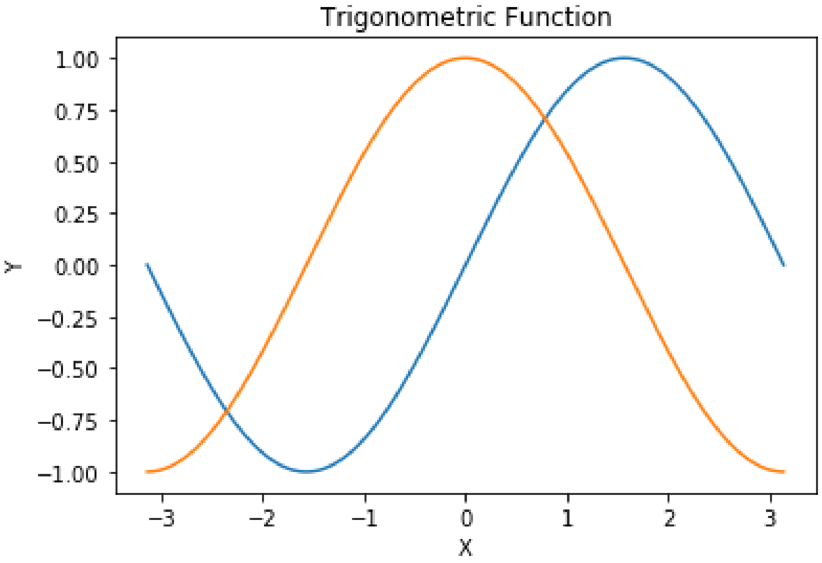
6

PYTHON的理工类应用

简单的三角函数计算

File

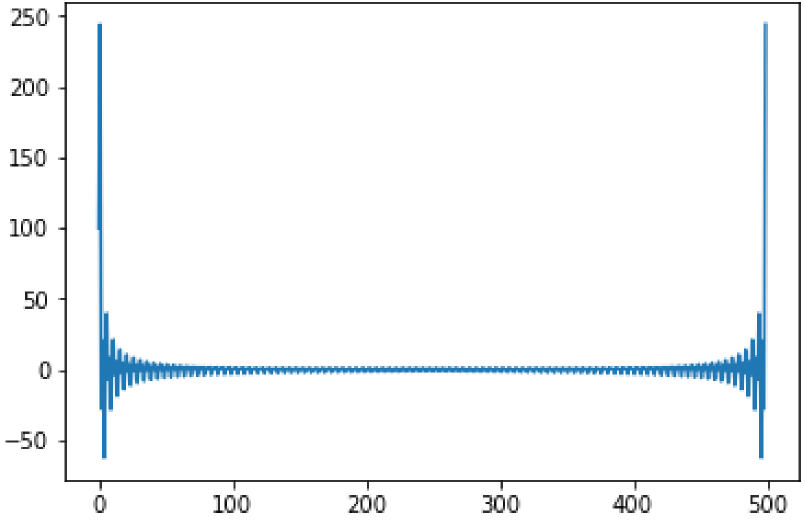
```
# Filename: mathA.py
import numpy as np
import pylab as pl
x = np.linspace(-np.pi, np.pi, 256)
s = np.sin(x)
c = np.cos(x)
pl.title('Trigonometric Function')
pl.xlabel('X')
pl.ylabel('Y')
pl.plot(x,s)
pl.plot(x,c)
```



一组数据的快速傅里叶变换

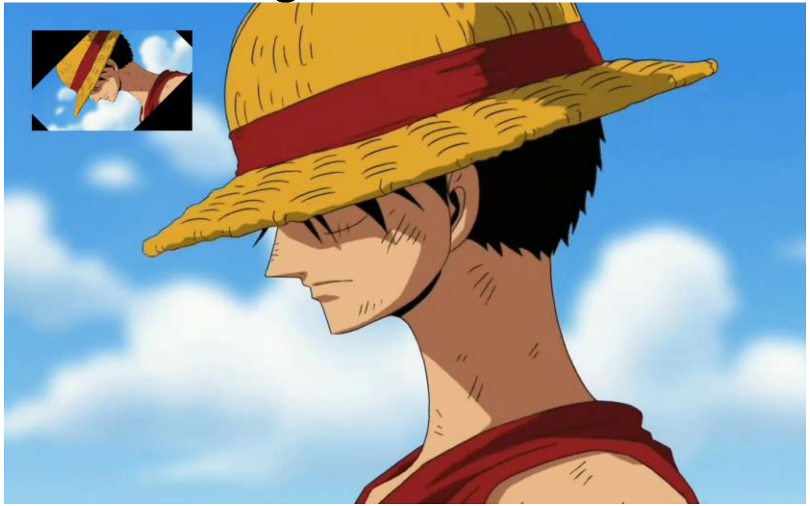
数组：[1,1,…,1,-1,-1,…,1,1,1…,1]

```
# Filename: mathB.py
import scipy as sp
import pylab as pl
listA = sp.ones(500)
listA[100:300] = -1
f = sp.fft(listA)
pl.plot(f)
```



图像处理库

- 常用Python图像处理库
  - Pillow(PIL)
  - OpenCV
  - Skimage



File

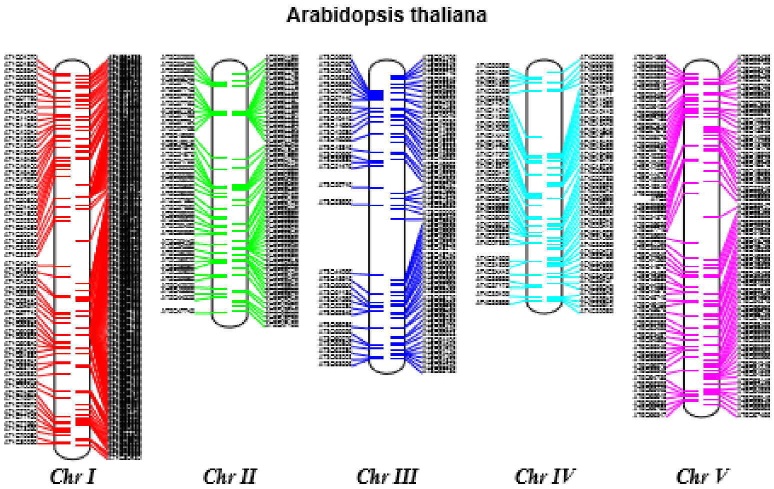
```
# Filename: pasteimg.py
from PIL import Image
im1 = Image.open('1.jpg')
print(im1.size, im1.format, im1.mode)
Image.open('1.jpg').save('2.png')
im2 = Image.open('2.png')
size = (288, 180)
im2.thumbnail(size)制作缩略图
out = im2.rotate(45) 逆时针旋转45度
im1.paste(out, (50,50))
```

Biopython

- 来源于一个使用Python开发计算分子生物学工具的国际社团Biopython
- 序列、字母表和染色体图

Source

```
>>> from Bio.Seq import Seq
>>> my_seq = Seq("AGTACACTGGT")
>>> my_seq.alphabet
Alphabet()
>>> print(my_seq)
AGTACACTGGT
```



用Python玩转数据

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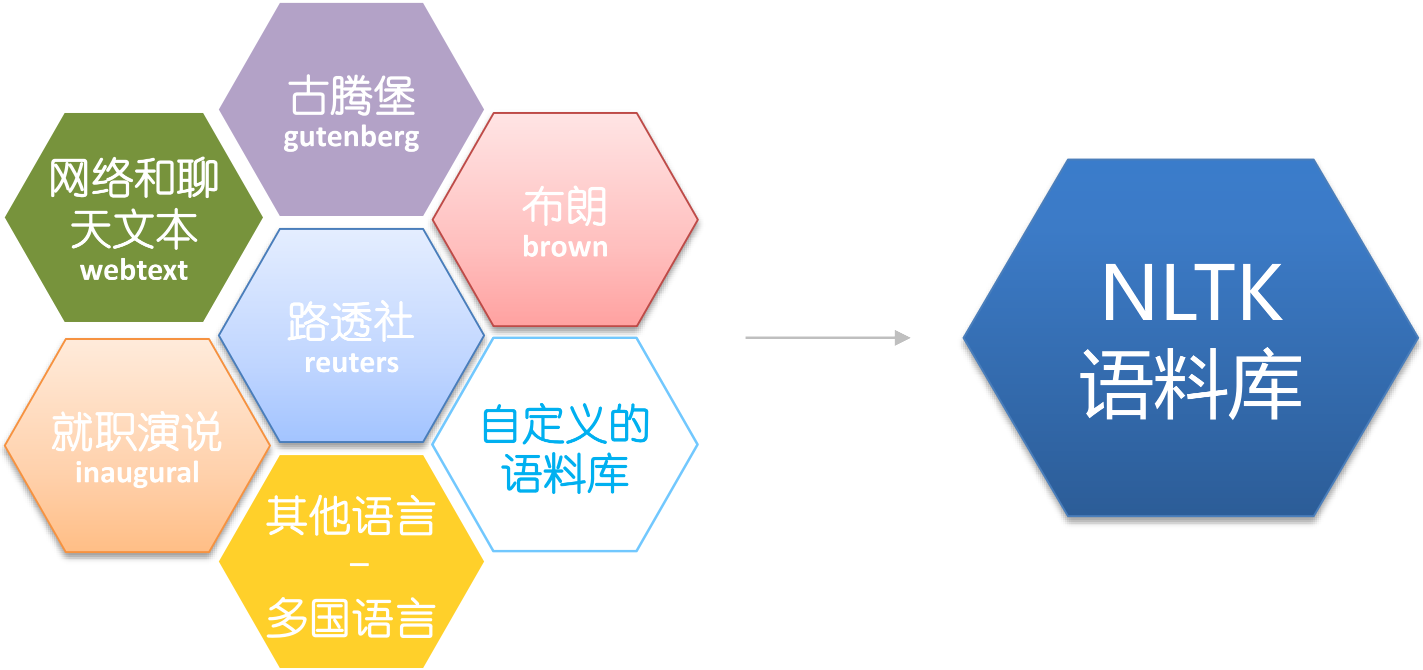
PYTHON的
人文社科类应用

NLTK语料库



古腾堡 gutenberg

网络和聊天文本 webtext

布朗 brown

路透社 reuters

就职演说 inaugural

自定义的语料库

其他语言 – 多国语言

NLTK 语料库

古滕堡项目

- 计算NLTK中目前收录的古滕堡项目的书

Source

```
>>> from nltk.corpus import gutenberg
>>> gutenberg.fileids()
['austen-emma.txt', 'austen-persuasion.txt', 'austen-sense.txt', 'bible-
kjv.txt', 'blake-poems.txt', 'bryant-stories.txt', 'burgess-
busterbrown.txt', 'carroll-alice.txt', 'chesterton-ball.txt', 'chesterton-
brown.txt', 'chesterton-thursday.txt', 'edgeworth-parents.txt',
'melville-moby_dick.txt', 'milton-paradise.txt', 'shakespeare-caesar.txt',
'shakespeare-hamlet.txt', 'shakespeare-macbeth.txt', 'whitman-
leaves.txt']
```

古滕堡项目

- 一些简单的计算

Source

```
>>> from nltk.corpus import gutenberg
>>> allwords = gutenberg.words('shakespeare-hamlet.txt')
>>> len(allwords)
37360
>>> len(set(allwords))
5447
>>> allwords.count('Hamlet')
99
>>> A = set(allwords)
>>> longwords = [w for w in A if len(w) > 12]
>>> print(sorted(longwords))
```

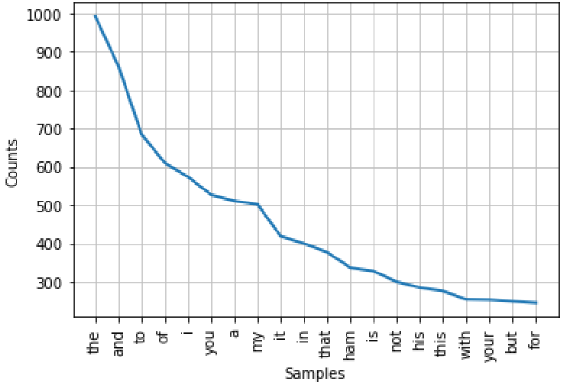
Output:

```
['Circumstances',
'Guildensterne',
'Incontinencie',
'Recognizances',
'Vnderstanding',
'determination',
'encompassement',
'entertainment',
'imperfections',
'indifferently',
'instrumentall',
'reconcilement',
'stubbornnesse',
'transformation',
'vnderstanding']
```

古滕堡项目

File

```
# Filename: freqG20.py
from nltk.corpus import gutenberg
from nltk.probability import *
fd2 = FreqDist([sx.lower() for sx in allwords if sx.isalpha()])
print(fd2.B())
print(fd2.N())
fd2.tabulate(20)
fd2.plot(20)
fd2.plot(20, cumulative = True)
```



Output:

```
4699
30266
 the  and   to   of    i  you    a  my   it   in that  ham
is  not  his this with your  but  for
 993  863  685  610  574  527  511  502  419  400
377  337  328  300  285  276  254  253  249  245
```

就职演说语料库

Source

```
>>> from nltk.corpus import inaugural
>>> from nltk.probability import *
>>> fd3 = FreqDist([s for s in inaugural.words()])
>>> print(fd3.freq('freedom'))
0.00119394791917
```

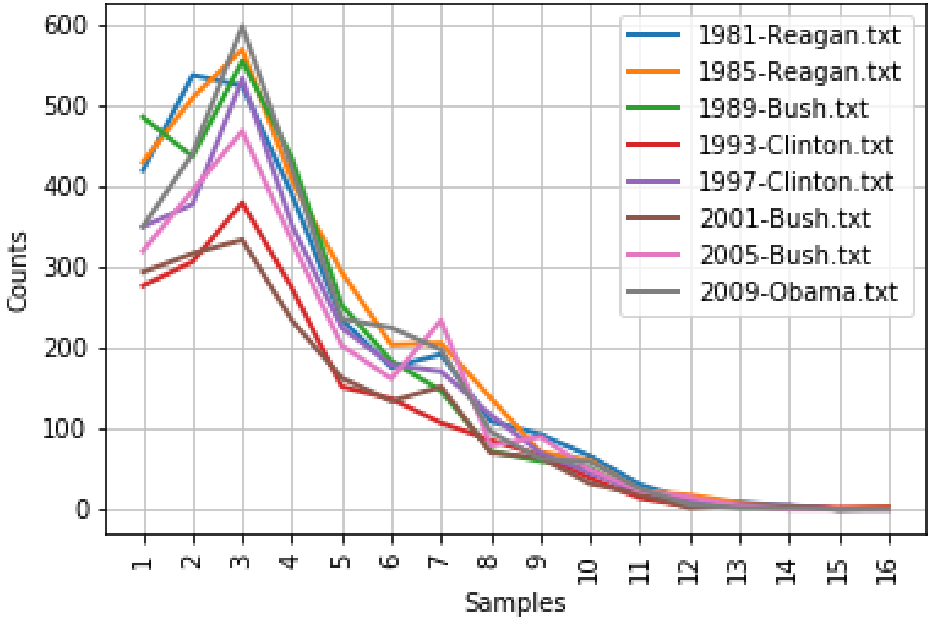
File

```
# Filename: inaugural.py
from nltk.corpus import inaugural
from nltk.probability import *
cfd = ConditionalFreqDist(
            (fileid, len(w))
            for fileid in inaugural.fileids()
            for w in inaugural.words(fileid)
            if fileid > '1980' and fileid < '2010')
print(cfd.items())
cfd.plot()
```

就职演说语料库

<u>Output</u>:

```
dict_items([('1981-Reagan.txt',
FreqDist({2: 538, 3: 525, 1: 420, 4:
390, 5: 235, 7: 192, 6: 176, 8: 109, 9:
93, 10: 66, ...})), ... , ('2005-Bush.txt',
FreqDist({3: 469, 2: 395, 4: 332, 1:
320, 7: 234, 5: 203, 6: 162, 9: 90, 8:
79, 10: 49, ...})), ('2009-Obama.txt',
FreqDist({3: 599, 2: 441, 4: 422, 1:
350, 5: 236, 6: 225, 7: 198, 8: 96, 9:
63, 10: 59, ...}))])
```


Counts
Samples
1981-Reagan.txt
1985-Reagan.txt
1989-Bush.txt
1993-Clinton.txt
1997-Clinton.txt
2001-Bush.txt
2005-Bush.txt
2009-Obama.txt