



*Advanced Data Processing and Visualization of Python*

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# Python高级数据处理与可视化

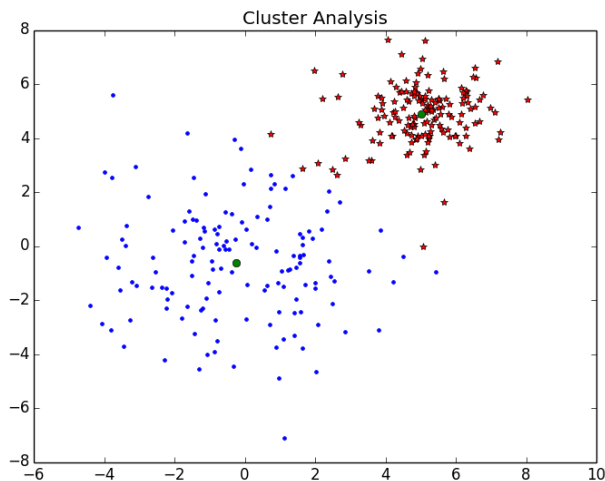
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Department of University Basic Computer Teaching

用Python玩转数据

# 聚类分析



- 聚类分析(cluster analysis)

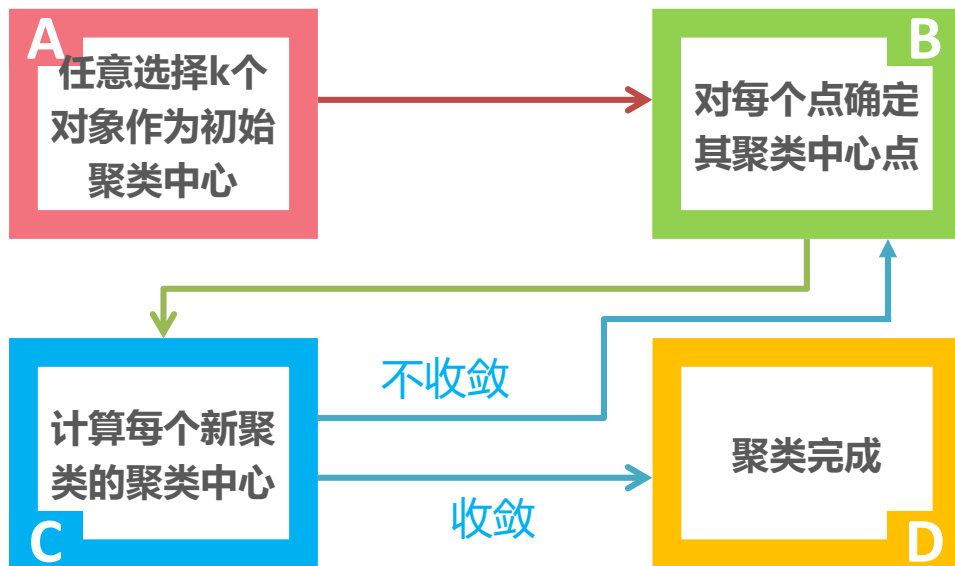
以相似性为基础把相似的对象通过静态分类的方法分成不同的组别或者更多的子集

- 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

Output:

[1 0 0 1 1 0]

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)

# 用专业工具解决

F  
ile

# 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)

```
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



['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]

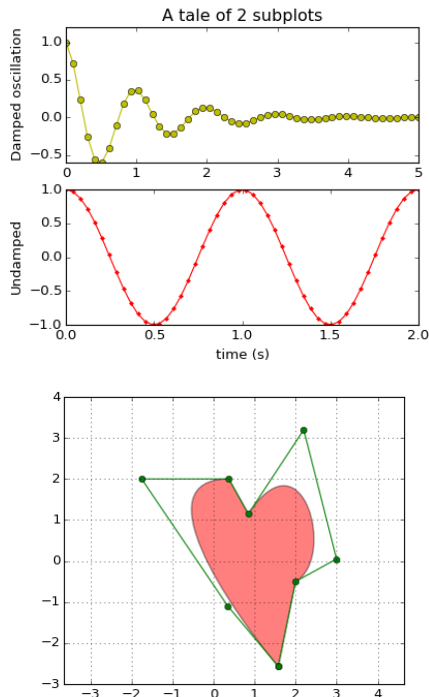
用Python玩转数据

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# 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



```
>>> 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
```

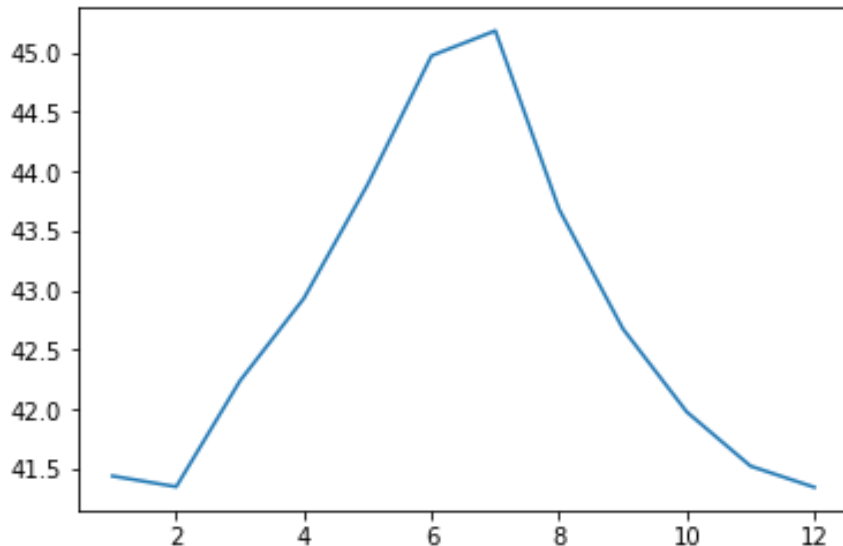
# 折线图



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)
```

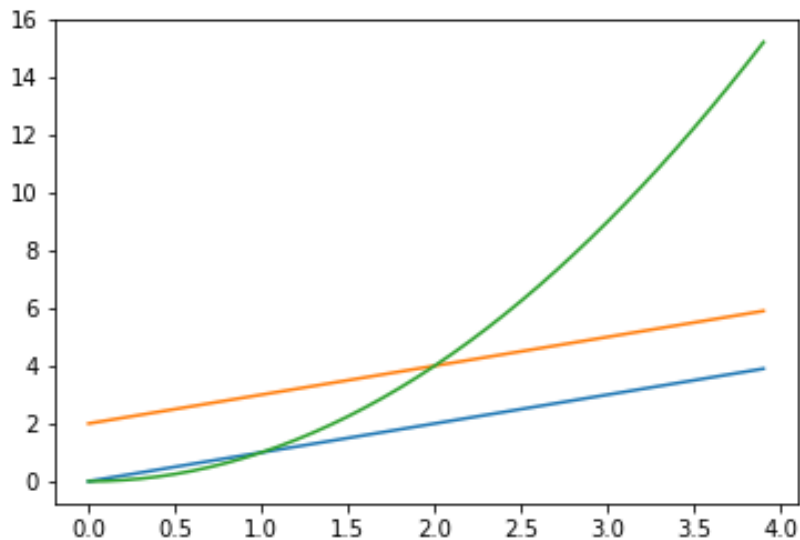


# 折线图

NumPy数组也可以作为  
Matplotlib的参数

**S**<sub>ource</sub>

```
>>> 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

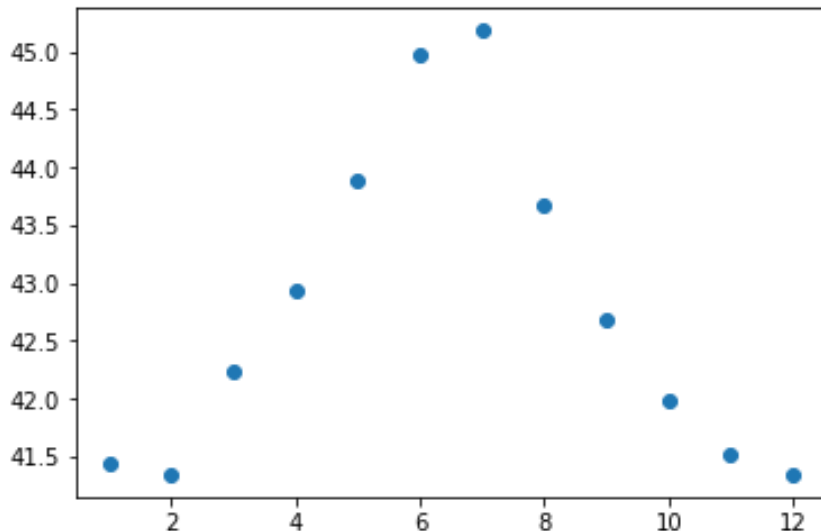


将可口可乐公司近一年来股票收盘价的月平均价绘制成散点图

`plt.plot(x, y)`



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



# 柱状图

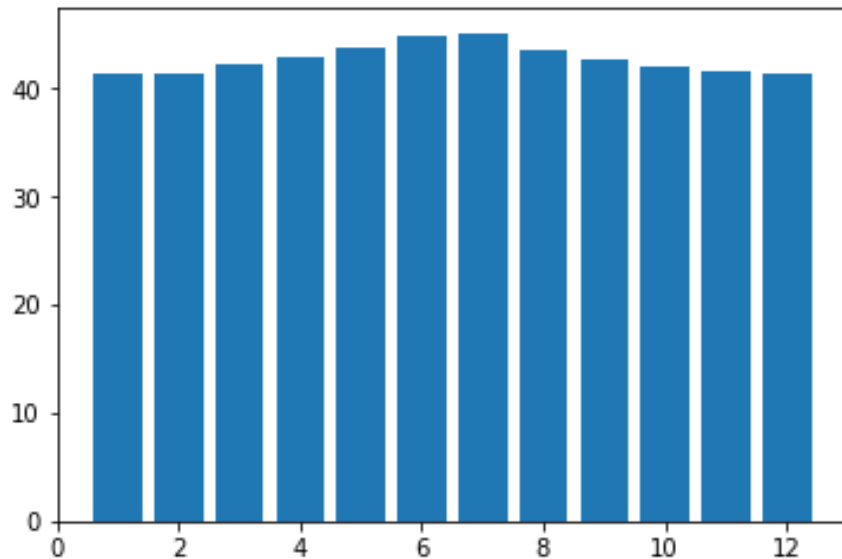


将可口可乐公司近一年来股票收盘价的月平均价绘制成柱状图

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



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

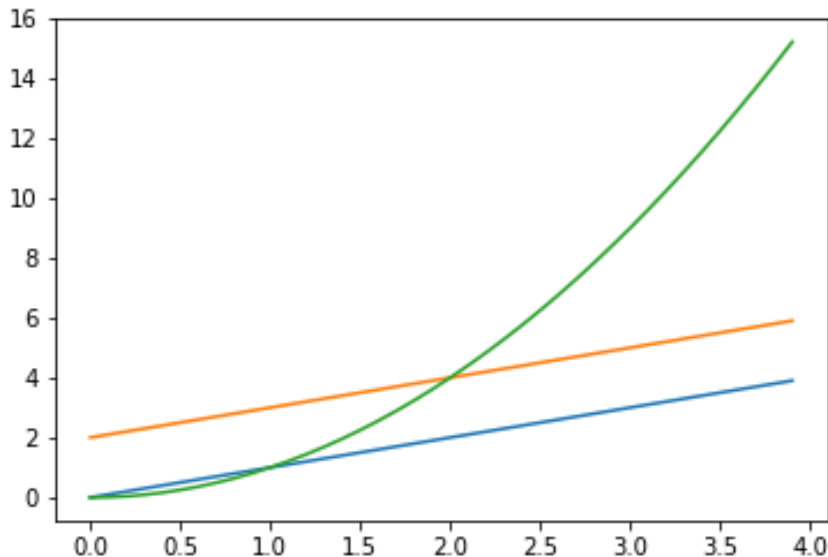


# pylab绘图

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+2,t**2)
```



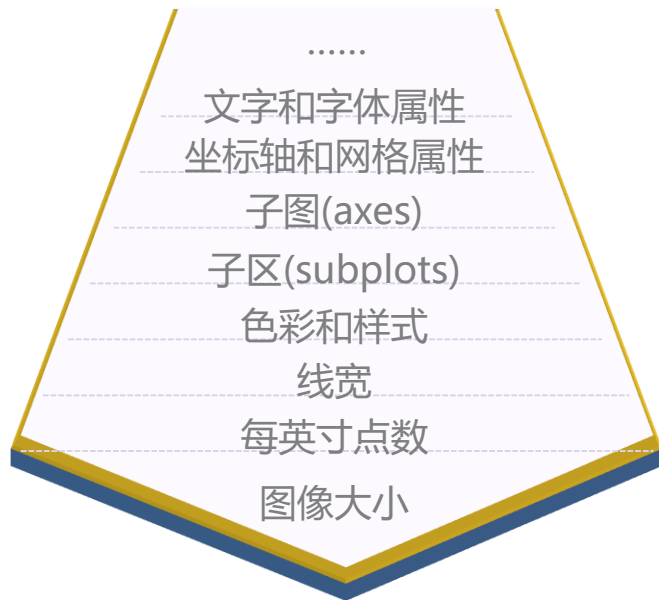
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## MATPLOTLIB 图像属性控制



# Matplotlib属性

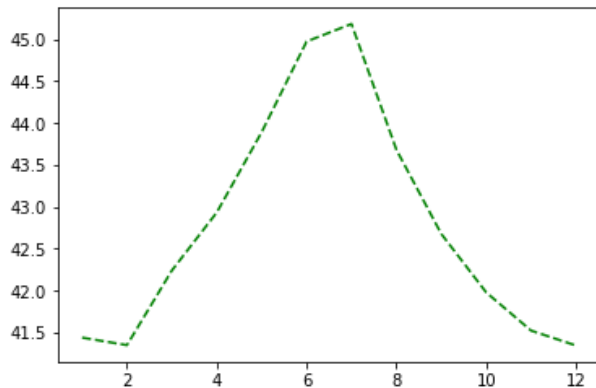


Matplotlib可以控制的默认属性

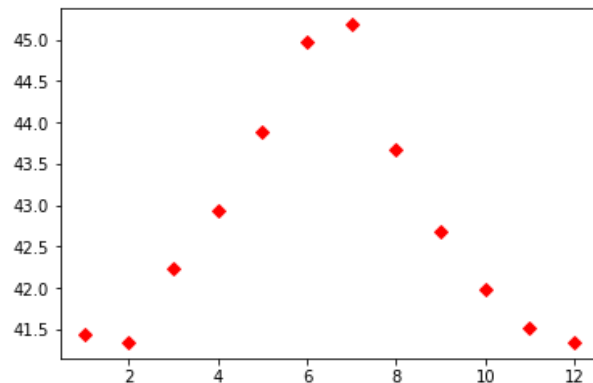
# 色彩和样式



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

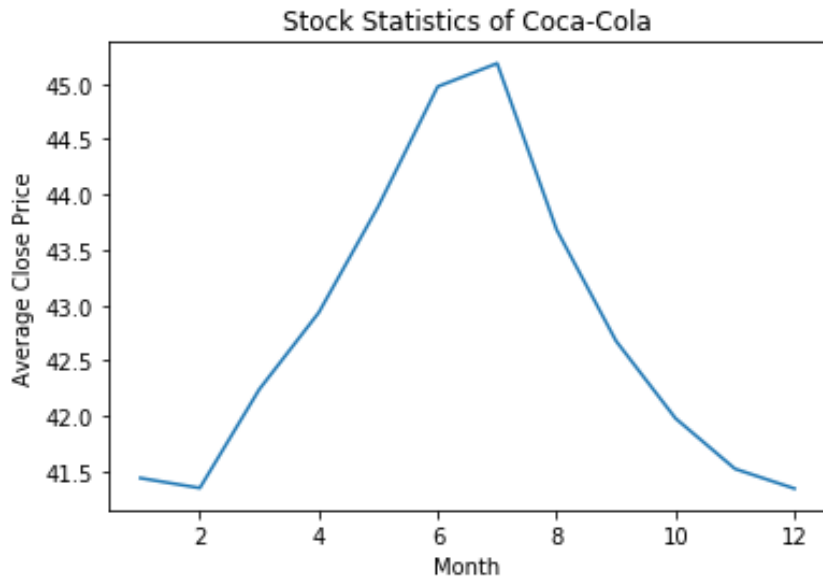
线型	描述
'-'	solid
'--'	dashed
'-.'	dash_dot
':'	dotted
'None'	draw nothing
' '	draw nothing
"	draw nothing

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

## 加标题：图、横轴和纵轴



```
# 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



# Filename: multilines.py

```
import pylab as pl
```

```
import numpy as np
```

```
pl.figure(figsize=(8,6),dpi=100)
```

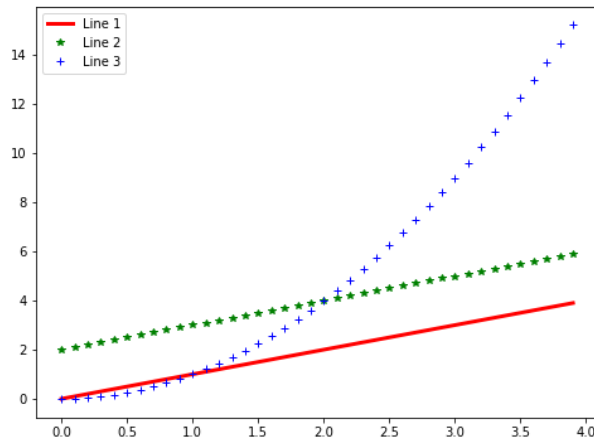
```
t=np.arange(0.,4.,0.1)
```

```
pl.plot(t,t,color='red',linestyle='-',linewidth=3,label='Line 1')
```

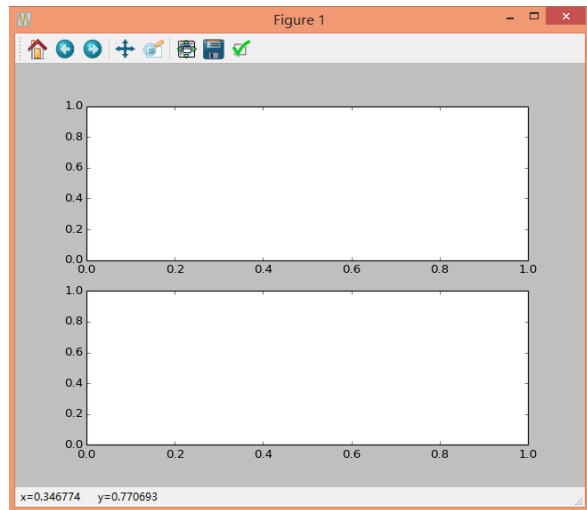
```
pl.plot(t,t+2,color='green',linestyle='',marker='*',linewidth=3,label='Line 2')
```

```
pl.plot(t,t**2,color='blue',linestyle='',marker='+',linewidth=3,label='Line 3')
```

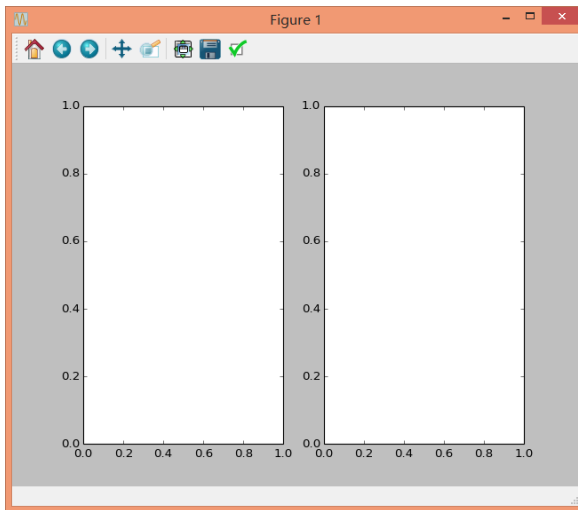
```
pl.legend(loc='upper left')
```



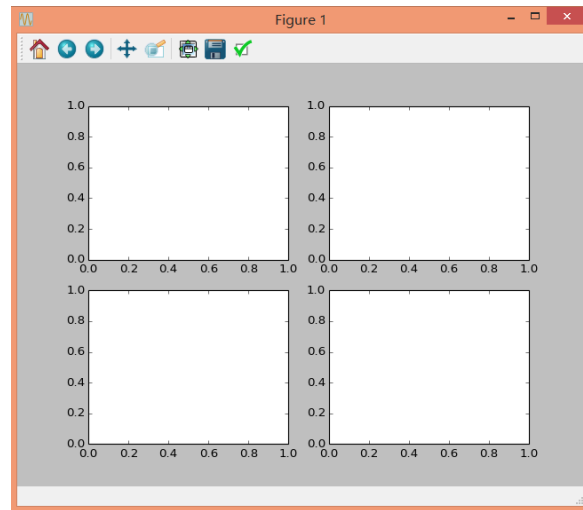
# 多子图-subplots



```
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



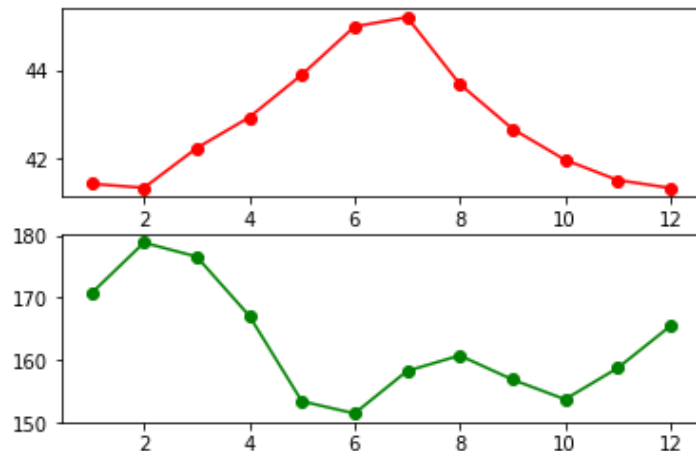
#The data of Coca-Cola and IBM is ready

```
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

File

#The data of Coca-Cola and IBM is ready

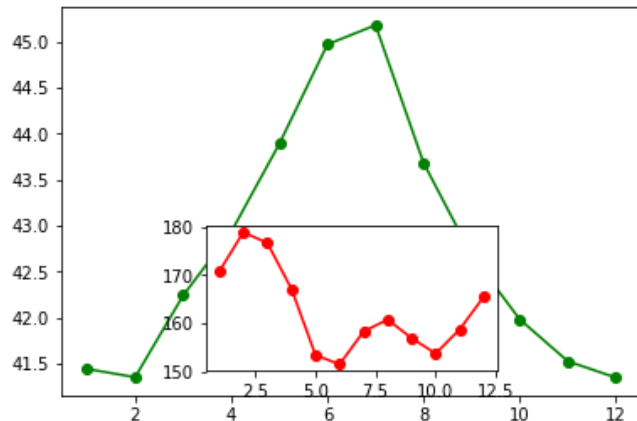
```
plt.axes([.1,.1,0.8,0.8])
```

```
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)



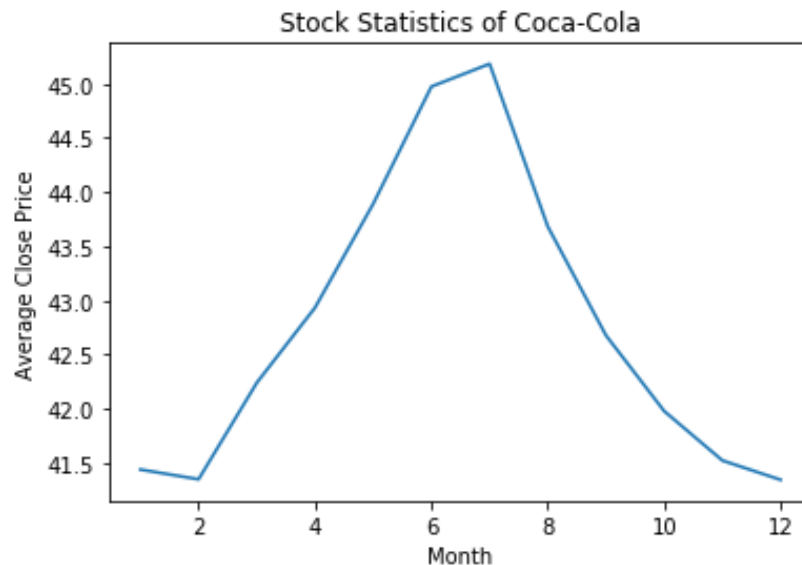
用Python玩转数据

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PANDAS作图

S<sub>ource</sub>

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



# pandas绘图

Source

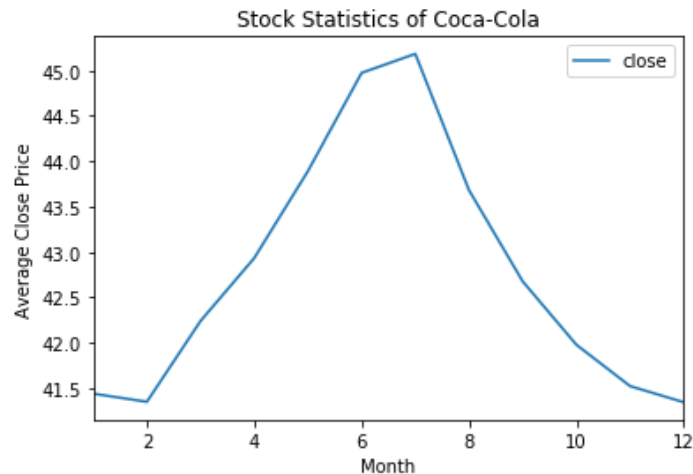
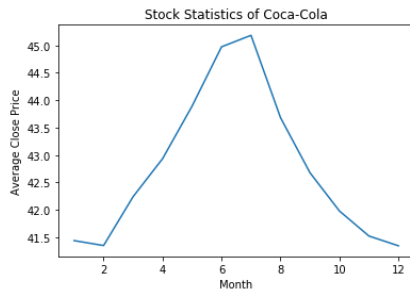
```
>>> import pandas as pd
```

```
>>> 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



# Filename: plot\_volumes.py

...

```
INTC_volumes = create_volumes('INTC')
```

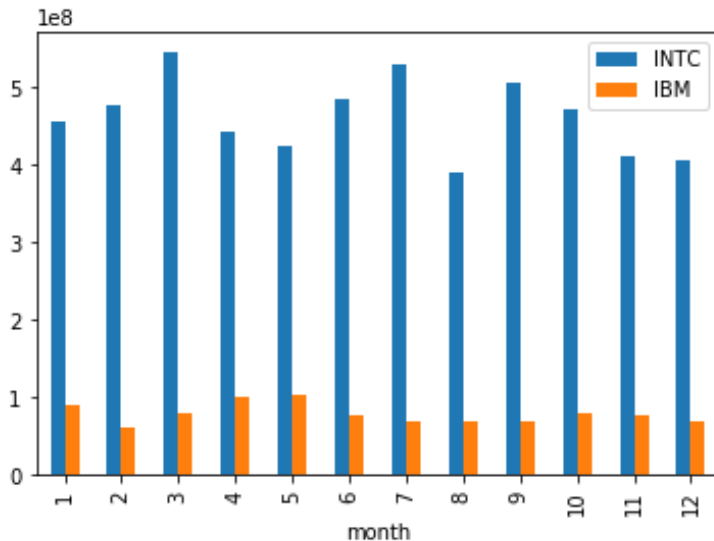
```
IBM_volumes = create_volumes('IBM')
```

```
quotesIldf = pd.DataFrame()
```

```
quotesIldf['INTC'] = INTC_volumes
```

```
quotesIldf['IBM'] = IBM_volumes
```

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



# pandas控制图像形式

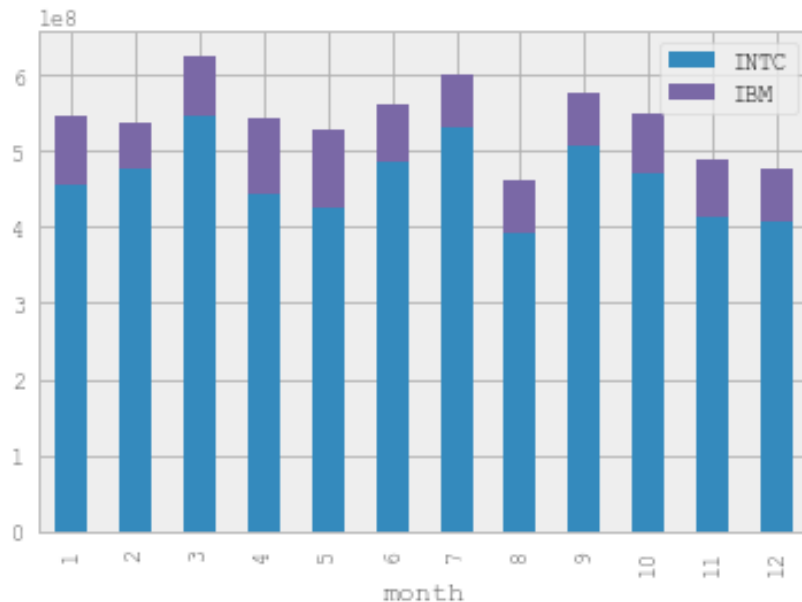


用柱状图比较Intel和IBM这两家科技公司近一年来的股票成交量

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



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



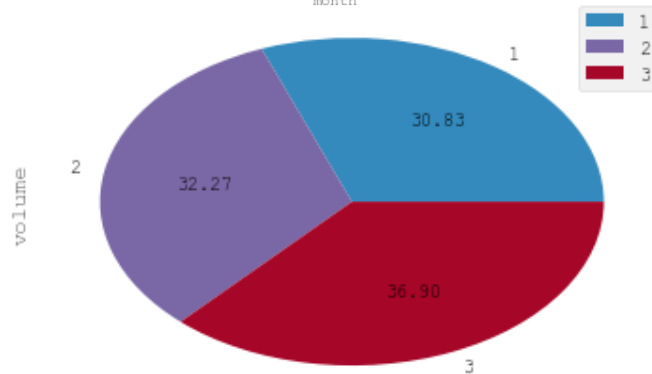
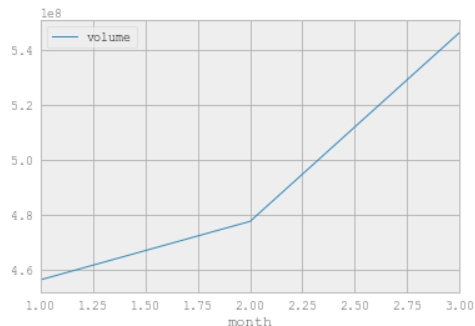
# pandas控制图像形式



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')
```

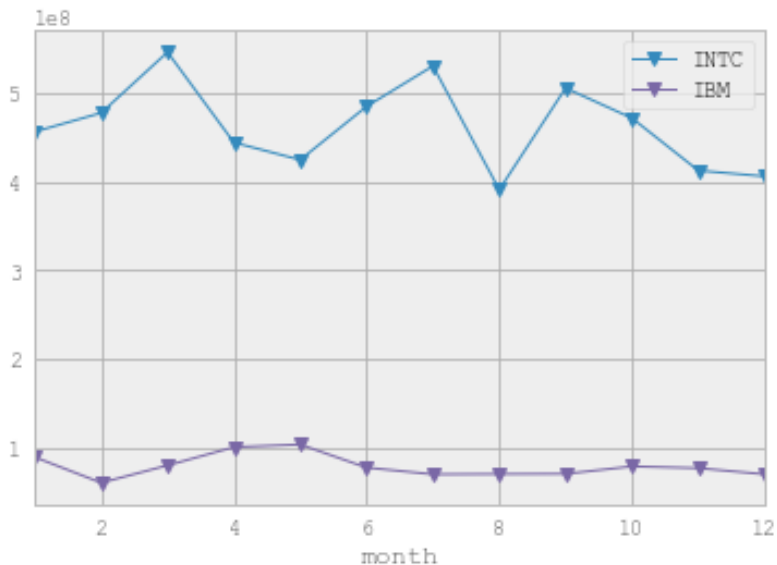


# pandas控制图像属性

Source

#The data of Intel and IBM is ready

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





# 箱形图

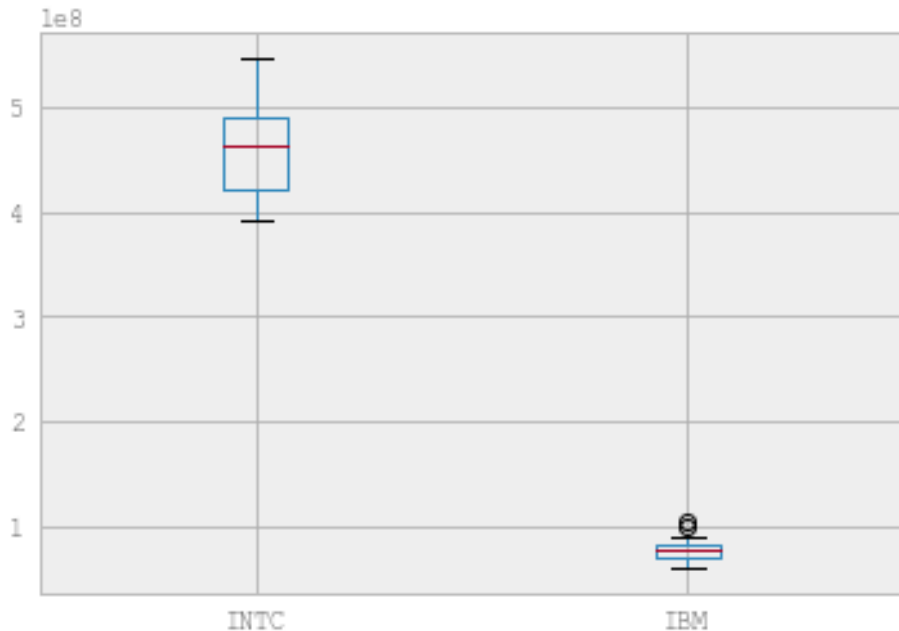


用箱形图比较Intel和IBM这两家科技公司近一年来的股票成交量

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



```
quotesIldf.boxplot()
```



上边缘, 上四分位数, 中位数, 下四分位数, 下边缘

# 5

用Python玩转数据

## 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



```
# 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	close, date, high, low, open, volume			
7	5	77.49	149459580	76.80000305, 1495200600, 77.34999847, 76.30000305, 76.55000305, 3278200			
8	6	77.92	149450941	76.37999725, 1495114200, 76.84999847, 75.97000122, 76.26999664, 3545700			
9	7	78.65	149442302	76.37000275, 1495027800, 78.12999725, 76.23999786, 78.12999725, 4441600			
10	8	78.44	149433663	78.12999725, 1494941400, 78.63999939, 77.83999634, 78.59999847, 2457500			
11	9	78.16	149425024	78.33000183, 1494855000, 78.62000275, 77.48000336, 77.48000336, 3327000			
12	10	78.32	149399105	77.48999786, 1494595800, 77.80999756, 77.22000122, 77.69999695, 2865800			
13	11	78.33	149390466	77.91999817, 1494509400, 78.44999695, 77.25, 78.19999695, 3780600			
				78.65000153, 1494423000, 78.66000366, 78.13999939, 78.27999878, 2396900			
				78.44000244, 1494336600, 78.73999786, 78.08999634, 78.16000366, 2570600			
				78.16000366, 1494250200, 78.73999786, 77.94999695, 78.5, 2608600			
				78.31999969, 1493991000, 78.73000336, 77.87999725, 78.61000061, 2936700			
				78.33000183, 1493904600, 79.41999817, 77.98999786, 79.23000336, 3902200			

# csv格式数据存取

S

```
>>> 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

File

# 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

File

# 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

# 6

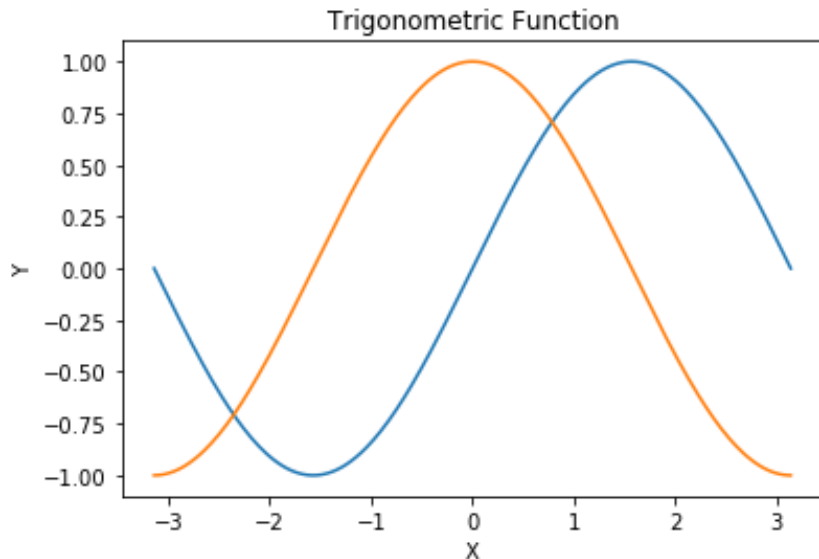
用Python玩转数据

## 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)
```



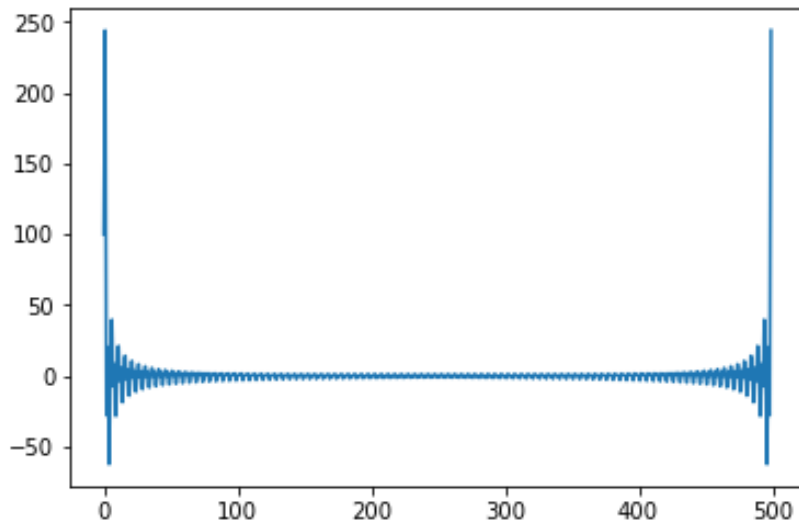


# 一组数据的快速傅里叶变换

数组: [1,1,...,1,-1,-1,...,1,1,1...,1]

File

```
# 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



```
# 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)
out = im2.rotate(45)
im1.paste(out, (50,50))
```

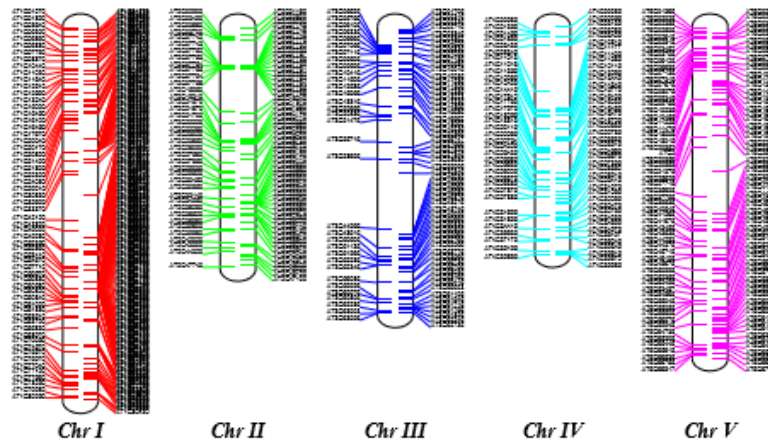


- 来源于一个使用Python开发计算分子生物学工具的国际社团Biopython
- 序列、字母表和染色体图

Source

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

*Arabidopsis thaliana*

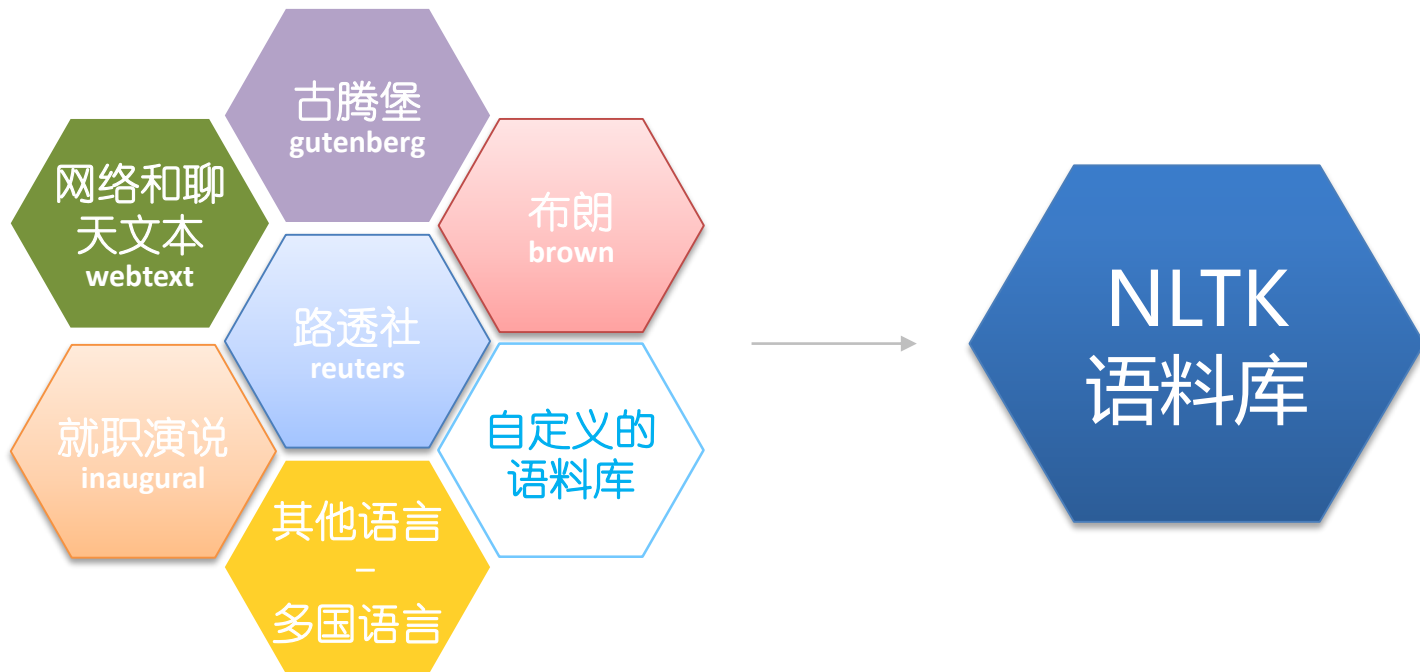


用Python玩转数据

7

# PYTHON的 人文社科类应用

# NLTK语料库



- 计算NLTK中目前收录的古滕堡项目的书



```
>>> from nltk.corpus import gutenbergl
>>> gutenbergl.fileids()
['austen-emma.txt', 'austen-persuasion.txt', 'austen-sense.txt', 'bible-
kjk.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']
```

- 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']
```



# Filename: freqG20.py

```
from nltk.corpus import gutenber
```

```
from nltk.probability import *
```

```
fd2 = FreqDist([sx.lower() for sx in allwords if sx.isalpha()])
```

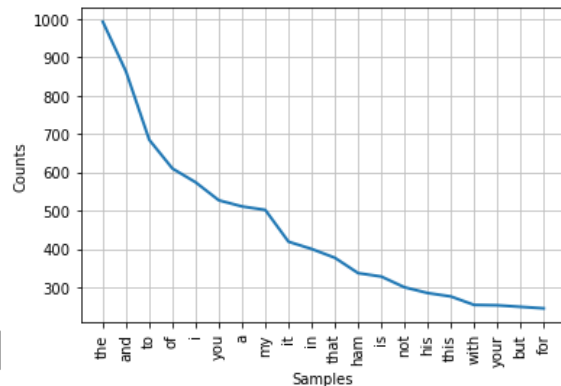
```
print(fd2.B())
```

```
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



S  
ource

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

F  
ile

```
# 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()
```

## Output:

```
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, ...}))))]
```

