Data statistics, mining and application

Python数据统计挖掘与应用

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用Python玩转数据

1 数据探索之基本数据特征分析

数据探索

检查数据错误

数据探索

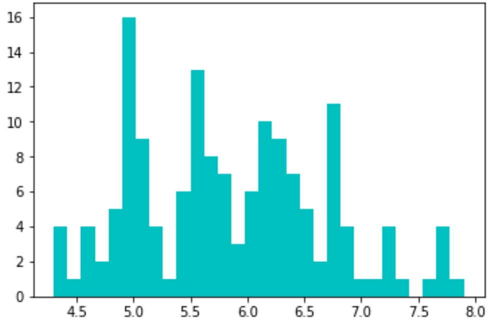
了解数据分布特征和内在规律

检查数据错误

- **缺失值**
- **异常值**
- **不一致的数据**
  - 149　2　->　149　2.0
  - 1569936600　->　2019-10-01

基本数据特征分析方法

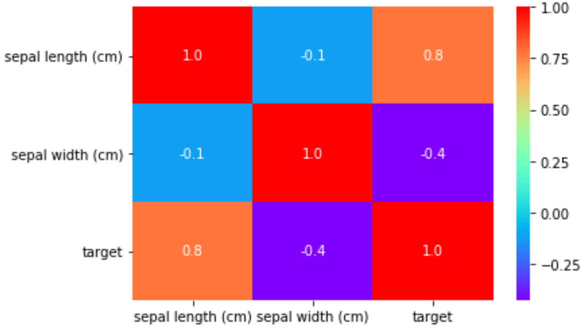
分布分析



统计量分析

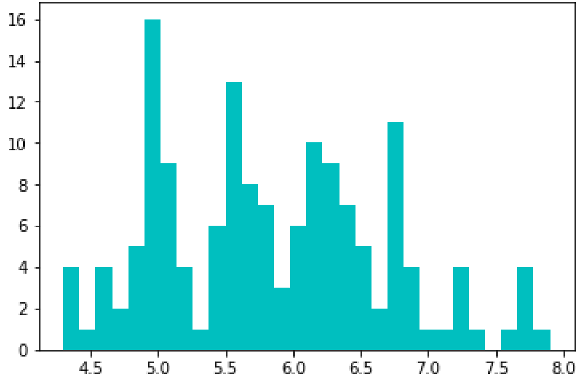
```
iris_df.iloc[:,0].describe()
count    150.000000
mean       5.843333
std        0.828066
min        4.300000
25%        5.100000
50%        5.800000
75%        6.400000
max        7.900000
Name: sepal length (cm), dtype: float64
```

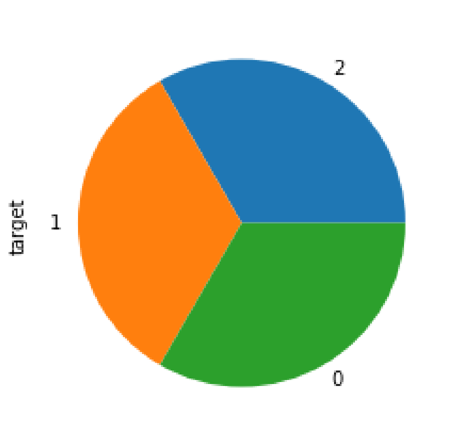
相关分析



分布分析

- 分布分析
  - 定量数据分布分析
  - 定性数据分布分析





定量数据分布分析

直方图

Source

```
>>> plt.hist(iris_df.iloc[:,0], 5, color = 'c')
```

正态分布检验

Source

```
>>> scipy.stats.normaltest(iris_df.iloc[:,0])
```

定性数据分布分析

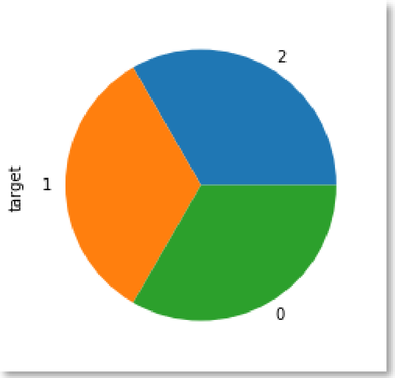
Source

```
>>> iris_df.target.value_counts()
```

```
2    50
1    50
0    50
Name: target, dtype: int64
```

Source

```
>>> iris_df.target.value_counts().plot(kind = 'pie')
```



统计量分析

- 统计量分析
  - 集中趋势分析Central tendency analysis

    均值，中位数
  - 离中趋势分析Dispersion tendency analysis

    标准差，四分位距

统计量分析

- 统计量分析
  - 集中趋势分析：

    均值mean(), 中位数median()
  - 离中趋势分析

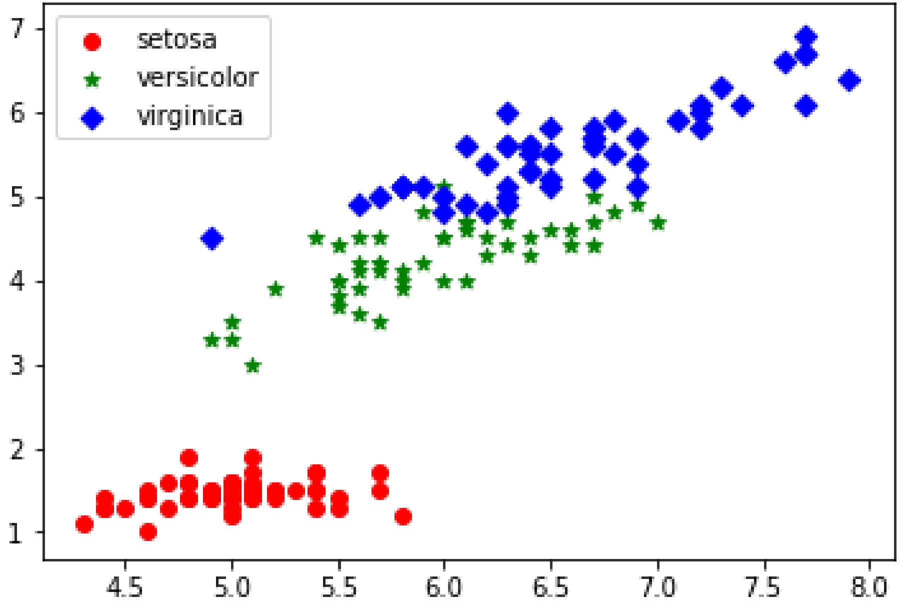
    标准差std()，四分位距quantile()

```
iris_df.iloc[:,0].describe()
```

```
count    150.000000
mean       5.843333
std        0.828066
min        4.300000
25%        5.100000
50%        5.800000
75%        6.400000
max        7.900000
Name: sepal length (cm), dtype: float64
```

相关分析

- 常见方式
  - 单个图
  - 图矩阵
  - 相关系数



相关系数—Pearson相关系数

$$r_{xy} = \frac{\sum (X-\bar{X})(Y-\bar{Y})}{\left(\sqrt{\sum_{i=1}^{n}(X_i-\bar{X})^2}\right)\left(\sqrt{\sum_{i=1}^{n}(Y_i-\bar{Y})^2}\right)}$$

约束条件:

1. 两个变量间有线性关系
2. 均是连续变量
3. 变量均符合正态分布,且二元分布也符合正态分布
4. 两个变量独立

相关系数—Pearson线性相关系数

r的结果:

正相关：$r > 0$

负相关：$r < 0$

不相关：$|r| = 0$

完全线性相关：$|r| = 1$

	sepal length (cm)	sepal width (cm)	target
sepal length (cm)	1.000000	-0.117570	0.782561
sepal width (cm)	-0.117570	1.000000	-0.426658
target	0.782561	-0.426658	1.000000

用Python玩转数据

2 基于PANDAS的数据统计与分析

数据形式

	code	name	price
0	MMM	3M	155.82
1	AXP	American Express	114.41
2	AAPL	Apple	227.01
3	BA	Boeing	375.70
4	CAT	Caterpillar	121.04
5	CVX	Chevron	113.85
6	CSCO	Cisco	47.52
7	KO	Coca-Cola	54.54
8	DIS	Disney	130.27
9	DOW	Dow Chemical	45.34
10	XOM	Exxon Mobil	68.97
11	GS	Goldman Sachs	200.80
12	HD	Home Depot	227.93
13	IBM	IBM	142.99
14	INTC	Intel	50.92
15	JNJ	Johnson & Johnson	133.66
16	JPM	JPMorgan Chase	114.62
17	MCD	McDonald's	211.69
18	MRK	Merck	85.00
19	MSFT	Microsoft	138.12
20	NKE	Nike	93.07
21	PFE	Pfizer	35.93
22	PG	Procter & Gamble	124.00
23	TRV	Travelers Companies Inc	144.96
24	UTX	United Technologies	133.21
25	UNH	UnitedHealth	219.80
26	VZ	Verizon	59.90
27	V	Visa	175.98
28	WMT	Wal-Mart	118.16
29	WBA	Walgreen	52.97

djidf

	close	high	low	open	volume
2018-10-19	106.730003	107.550003	104.059998	104.059998	5726300
2018-10-22	104.510002	106.959999	104.449997	106.610001	5003100
2018-10-23	104.379997	104.519997	101.839996	102.410004	4223800
2018-10-24	101.839996	104.949997	101.510002	104.430000	4056700
2018-10-25	103.599998	104.169998	101.800003	102.480003	3378900
2018-10-26	101.250000	102.660004	100.139999	102.540001	5395700
2018-10-29	101.190002	103.250000	100.040001	102.470001	4238700
2018-10-30	102.080002	102.389999	100.410004	101.599998	3778200
2018-10-31	102.730003	103.709999	102.550003	103.059998	4511300
2018-11-01	104.040001	104.269997	103.019997	103.260002	2786800
2018-11-02	103.709999	105.050003	102.889999	104.930000	4322200
2018-11-05	105.209999	105.400002	103.800003	104.040001	2697700
2018-11-06	104.980003	105.660004	104.370003	104.980003	2856000
2018-11-07	107.309998	107.480003	104.900002	105.730003	3606900
2018-11-08	108.500000	108.629997	107.029999	107.029999	2896700
2018-11-09	108.279999	109.330002	107.349998	108.379997	4444000
2018-11-12	106.489998	108.440002	106.300003	108.160004	3154600
2018-11-13	107.860001	108.199997	106.470001	106.650002	3021800
2018-11-14	107.769997	109.330002	106.889999	108.610001	4978100
2018-11-15	109.599998	109.699997	106.339996	106.680000	3742600

quotesdf

简单筛选与统计

- 求道指成分股中所有股票最近一次成交价的均值。
- 求道指成分股中所有股票最近一次成交价大于等于300的公司名。

Source

```
>>> djidf.price.mean()
133.148
>>> djidf[djidf.price >= 300].name
3    Boeing
Name: name, dtype: object
```

简单筛选与统计

- 求道指成分股中股票最近一次成交价大于等于300或小于等于50的公司信息。
- 统计美国运通公司2019年度9月份的股票开盘天数。

Source

```
>>> djidf[(djidf.price >= 300) | (djidf.price <= 50)]
      code              name   price
3       BA            Boeing  372.31
6     CSCO             Cisco   47.01
9      DOW    Dow Chemical   48.13
21     PFE            Pfizer   36.65
>>> t = quotesdf[(quotesdf.index >= '2019-09-01')  &  (quotesdf.index <= '2019-09-30')]
>>> len(t)
20
```

简单筛选与统计

- 统计美国运通公司近一年股票涨和跌分别的天数。

Source

```
>>> len(quotesdf[quotesdf.close > quotesdf.open])
130
>>> len(quotesdf)-130
122
```

- 统计美国运通公司近一年相邻两天收盘价的涨跌情况。

Source

```
>>> status = np.sign(np.diff(quotesdf.close))
>>> status
array([ -1.,  1., -1., ..., 1.,  -1.,  1.])
>>> len(status[status==1])
131
>>> len(status[status==-1])
118
```

简单筛选与统计

- 按最近一次成交价对道指成分股股票进行排序。根据排序结果列出前三甲公司名。

Source

```
>>> tempdf = djidf.sort_values(by = 'price', ascending = False)
>>> tempdf
     code            name    price
3      BA          Boeing   372.31
25    UNH    UnitedHealth   238.50
…
6    CSCO           Cisco    47.01
21    PFE          Pfizer    36.65
>>> tempdf[:3].name
3           Boeing
25    UnitedHealth
12      Home Depot
Name: name, dtype: object
```

分组groupby()

- 统计近一年美国运通公司每个月的股票开盘天数。

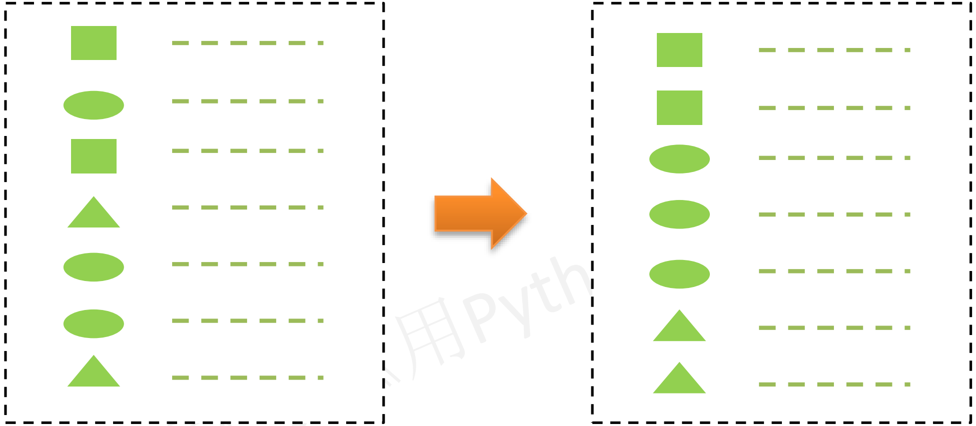
Source

```
>>> month = [item[5:7] for item in quotesdf.index]
>>> x = quotesdf.groupby(month).open.count()
```

Output:

```
01    21
02    19
03    21
04    21
05    22
06    20
07    22
08    22
09    20
10    23
11    21
12    19
Name: close, dtype: int64
```

分组



Grouping的顺序

① Splitting

② Applying

③ Combining

groupby()与apply()

- 统计近一年美国运通公司每个月的股票开盘天数。

Source

```
>>> month = [item[5:7] for item in quotesdf.index]
>>> quotesdf.groupby(month).apply(len)
```

Output:

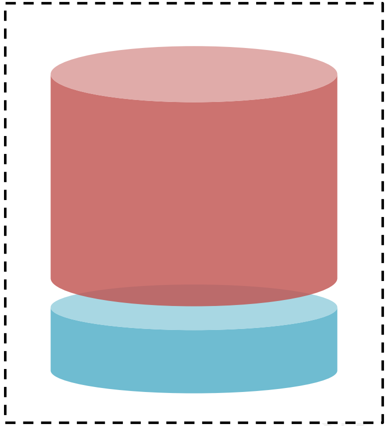
```
01    21
02    19
03    21
04    21
05    22
06    20
07    22
08    22
09    20
10    23
11    21
12    19
Name: close, dtype: int64
```

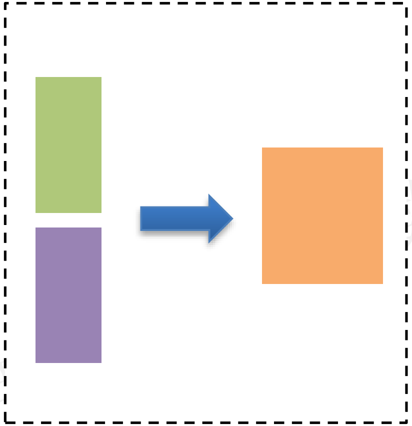
apply()

Source

```
>>> quotesdf.max()
>>> quotesdf.max(axis = 1)
>>> quotesdf.loc[:, ['close', 'open']].astype(int)
>>> quotesdf.apply(max)
>>> quotesdf.apply(max, axis = 1)
>>> quotesdf.loc[:, ['close', 'open']].apply(np.int32)
>>> quotesdf.loc[:, ['close', 'open']].apply(int)
>>> quotesdf.loc[:, ['close', 'open']].applymap(int)
>>> quotesdf.volume.apply(float)  # apply()也可作用在一个Series的每一个元素上
>>> quotesdf.loc[:, ['close', 'open']]= quotesdf.loc[:, ['close', 'open']].apply(np.int32)
```

合并





Merge的形式

- Append
  - 加行到DataFrame
- Concat
  - 连接pandas对象
- Join
  - SQL类型的连接

Append

- 把美国运通公司2019年9月1日至9月5日间的股票交易信息追加到2019年6月最后2天的股票交易信息中。

Source

```
>>> p = quotesdf['2019-06-01':'2019-06-30'][-2:]
>>> p
                 close        high         low        open   volume
2019-06-27  123.940002  124.410004  123.559998  123.690002  1504300
2019-06-28  123.440002  124.550003  123.199997  124.290001  4338900
>>> q = quotesdf['2019-09-01':'2019-09-05']
>>> q
                 close        high         low        open   volume
2019-09-03  117.599998  120.279999  117.519997  119.860001  3198700
2019-09-04  118.400002  118.730003  117.800003  118.419998  3746900
2019-09-05  120.669998  121.629997  119.500000  119.500000  5261100
>>> p.append(q)
                 close        high         low        open   volume
2019-06-27  123.940002  124.410004  123.559998  123.690002  1504300
2019-06-28  123.440002  124.550003  123.199997  124.290001  4338900
2019-09-03  117.599998  120.279999  117.519997  119.860001  3198700
2019-09-04  118.400002  118.730003  117.800003  118.419998  3746900
2019-09-05  120.669998  121.629997  119.500000  119.500000  5261100
```

Concat

- 将美国运通公司2019年9月股票数据中的前3个和后3个合并。

Source

```
>>> tempdf = quotesdf[(quotesdf.index >= '2019-09-01') & (quotesdf.index <= '2019-09-30')]
>>> pieces = [tempdf[:3], tempdf[-3:]]
>>> pd.concat(pieces)
                 close        high         low        open   volume
2019-09-03  117.599998  120.279999  117.519997  119.860001  3198700
2019-09-04  118.400002  118.730003  117.800003  118.419998  3746900
2019-09-05  120.669998  121.629997  119.500000  119.500000  5261100
2019-09-26  118.910004  120.029999  118.839996  119.309998  3411200
2019-09-27  118.589996  119.620003  117.980003  119.129997  2909200
2019-09-30  118.279999  119.239998  118.139999  119.050003  2345800
```

Join

code	name
AXP	
KO	

volume	code	month
	AXP	
	AXP	
	KO	
	KO	

→

code	name	volume	month
AXP			
AXP			
KO			
KO			

Join

- 将美国运通公司和可口可乐公司近一年中每个月的成交量均值（包含公司代码）与道琼斯成分股股票信息合并。

code|name|volume|month

	code	name	price
0	MMM	3M	155.82
1	AXP	American Express	114.41
2	AAPL	Apple	227.01
3	BA	Boeing	375.70
4	CAT	Caterpillar	121.04
5	CVX	Chevron	113.85
6	CSCO	Cisco	47.52
7	KO	Coca-Cola	54.54
8	DIS	Disney	130.27
9	DOW	Dow Chemical	45.34
10	XOM	Exxon Mobil	68.97
11	GS	Goldman Sachs	200.80
12	HD	Home Depot	227.93
13	IBM	IBM	142.99
14	INTC	Intel	50.92
15	JNJ	Johnson & Johnson	133.66
16	JPM	JPMorgan Chase	114.62
17	MCD	McDonald's	211.69
18	MRK	Merck	85.00
19	MSFT	Microsoft	138.12
20	NKE	Nike	93.07
21	PFE	Pfizer	35.93
22	PG	Procter & Gamble	124.00
23	TRV	Travelers Companies Inc	144.96
24	UTX	United Technologies	133.21
25	UNH	UnitedHealth	219.80
26	VZ	Verizon	59.90
27	V	Visa	175.98
28	WMT	Wal-Mart	118.16
29	WBA	Walgreen	52.97

djidf

	volume	code	month
01	4.216338e+06	AXP	01
02	3.096963e+06	AXP	02
03	3.366676e+06	AXP	03
04	3.439100e+06	AXP	04
05	3.163909e+06	AXP	05
06	2.856915e+06	AXP	06
07	3.324177e+06	AXP	07
08	3.291932e+06	AXP	08
09	3.936210e+06	AXP	09
10	3.572539e+06	AXP	10
11	3.437376e+06	AXP	11
12	5.076395e+06	AXP	12
01	1.384537e+07	KO	01
02	2.045106e+07	KO	02
03	1.733149e+07	KO	03
04	1.133406e+07	KO	04
05	1.173954e+07	KO	05
06	1.242934e+07	KO	06
07	1.171300e+07	KO	07
08	1.235928e+07	KO	08
09	1.082578e+07	KO	09
10	1.389021e+07	KO	10
11	1.333130e+07	KO	11
12	1.621624e+07	KO	12

AKdf

Join

Source

```
>>> pd.merge(djidf.drop(['price'], axis = 1), AKdf, on = 'code')
    code             name        volume  month
0    AXP  American Express  4.216338e+06    01
1    AXP  American Express  3.096963e+06    02
2    AXP  American Express  3.366676e+06    03
…
11   AXP  American Express  5.076395e+06    12
12    KO         Coca-Cola  1.384537e+07    01
13    KO         Coca-Cola  2.045106e+07    02
…
21    KO         Coca-Cola  1.389021e+07    10
22    KO         Coca-Cola  1.333130e+07    11
23    KO         Coca-Cola  1.621624e+07    12
```

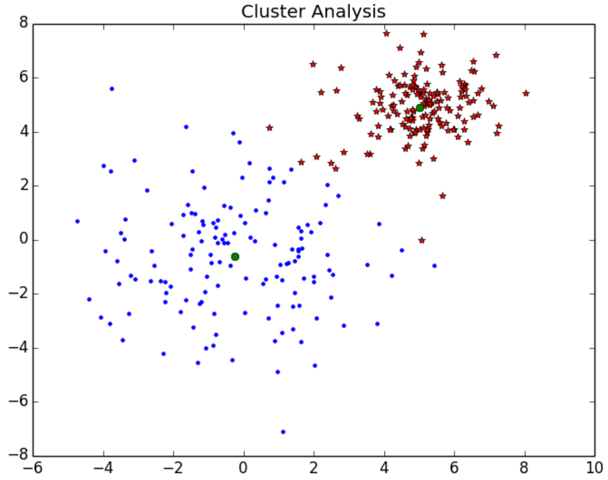
```
   code              name        volume month
0   AXP  American Express  4.216338e+06    01
1   AXP  American Express  3.096963e+06    02
2   AXP  American Express  3.366676e+06    03
3   AXP  American Express  3.439100e+06    04
4   AXP  American Express  3.163909e+06    05
5   AXP  American Express  2.856915e+06    06
6   AXP  American Express  3.324177e+06    07
7   AXP  American Express  3.291932e+06    08
8   AXP  American Express  3.936210e+06    09
9   AXP  American Express  3.572539e+06    10
10  AXP  American Express  3.437376e+06    11
11  AXP  American Express  5.076395e+06    12
12   KO         Coca-Cola  1.384537e+07    01
13   KO         Coca-Cola  2.045106e+07    02
14   KO         Coca-Cola  1.733149e+07    03
15   KO         Coca-Cola  1.133406e+07    04
16   KO         Coca-Cola  1.173954e+07    05
17   KO         Coca-Cola  1.242934e+07    06
18   KO         Coca-Cola  1.171300e+07    07
19   KO         Coca-Cola  1.235928e+07    08
20   KO         Coca-Cola  1.082578e+07    09
21   KO         Coca-Cola  1.389021e+07    10
22   KO         Coca-Cola  1.333130e+07    11
23   KO         Coca-Cola  1.621624e+07    12
```

3

用Python玩转数据

聚类分析

聚类



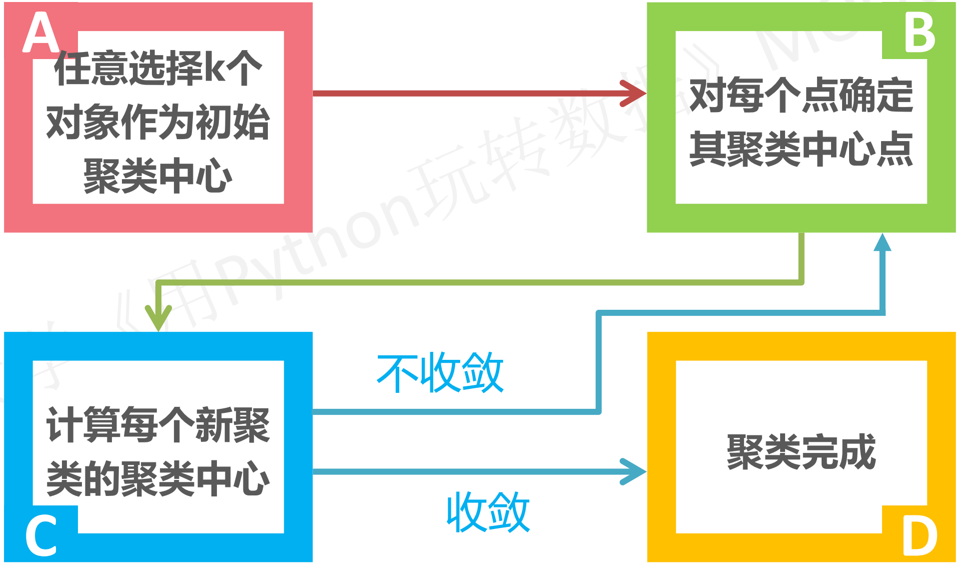
- **聚类分析(cluster analysis)**

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

Output:

[1 0 0 1 1 0]

```
# 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.vstack([list1,list2,list3,list4,list5,list6])
wh = whiten(data)
centroids,_ = kmeans(wh, 2)
result,_= vq(wh, centroids)
print(result)
```

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].reshape(1,-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

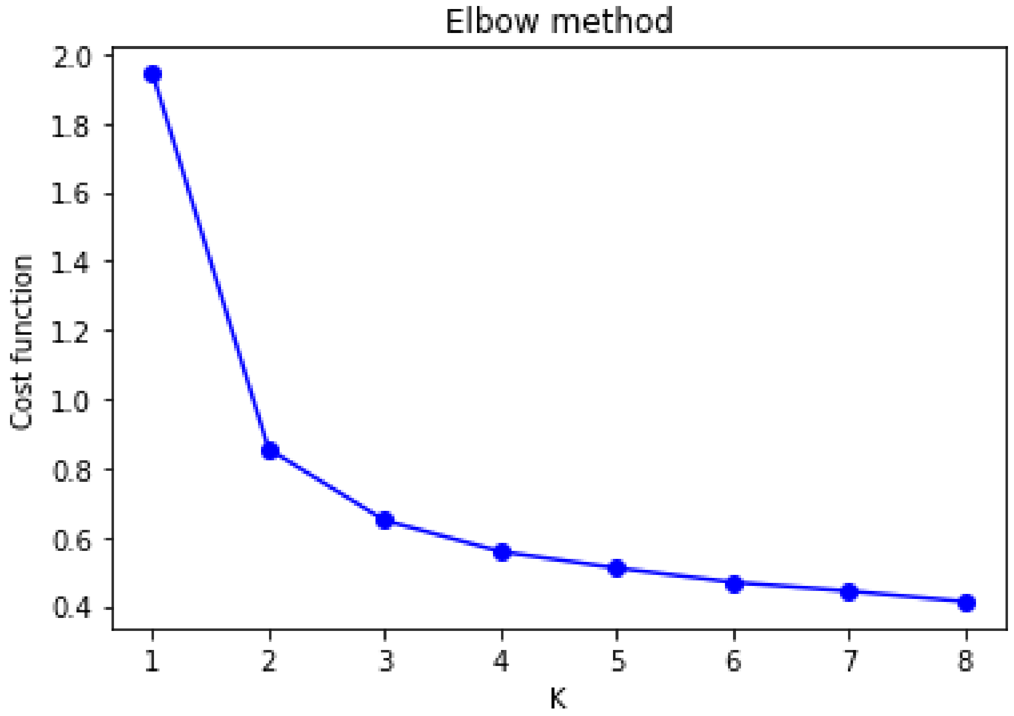
File ['MMM','AXP','AAPL','BA','CAT','CVX','CSCO','KO','DIS','DD']

```
# 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]

模型选择与评估


Elbow method
2.0
1.8
1.6
1.4
1.2
1.0
0.8
0.6
0.4
Cost function
1
2
3
4
5
6
7
8
K

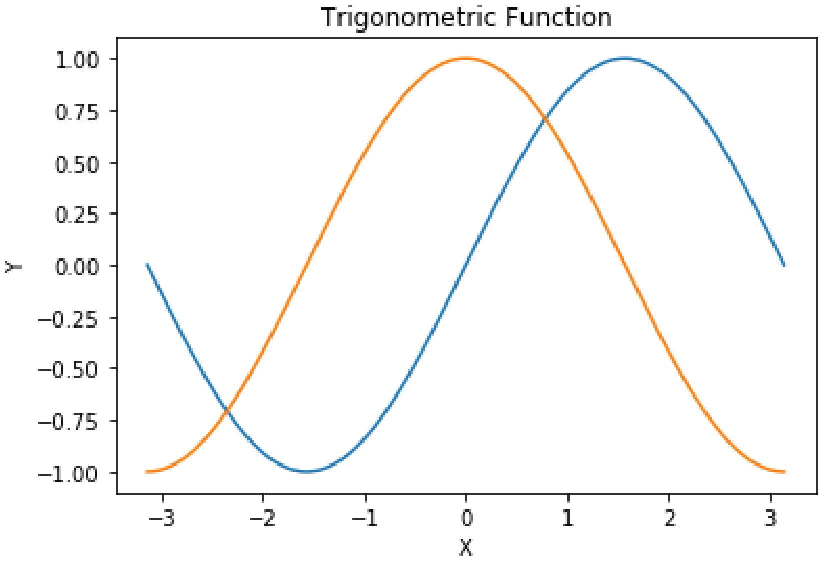
用Python玩转数据

4 PYTHON的理工类应用

简单的三角函数计算

File

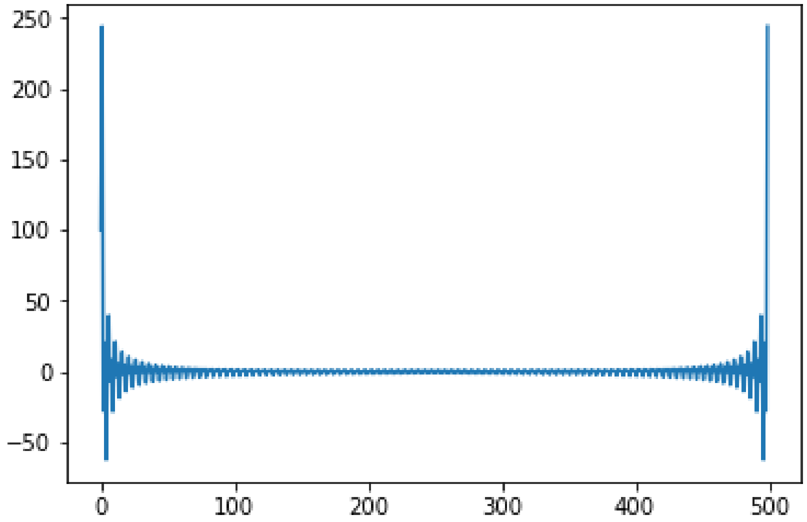
```
# Filename: mathA.py
import numpy as np
import matplotlib.pyplot as plt
x = np.linspace(-np.pi, np.pi, 256)
s = np.sin(x)
c = np.cos(x)
plt.title('Trigonometric Function')
plt.xlabel('X')
plt.ylabel('Y')
plt.plot(x, s)
plt.plot(x, c)
```



一组数据的快速傅里叶变换

数组：[1,1,...,1,-1,-1,...,1,1,1...,1]

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



图像处理库

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

File

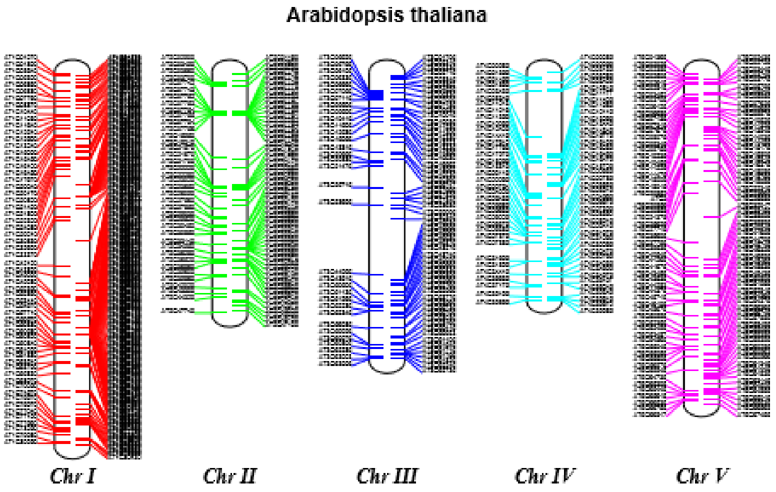
```python
# Filename: pasteimg.py
from PIL import Image
im1 = Image.open('1.jpg')
print(im1.size, im1.format, im1.mode)
Image.open('1.jpg').save('2.png')
im2 = Image.open('2.png')
size = (288, 180)
im2.thumbnail(size)
out = im2.rotate(45)
im1.paste(out, (50,50))
```

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
```

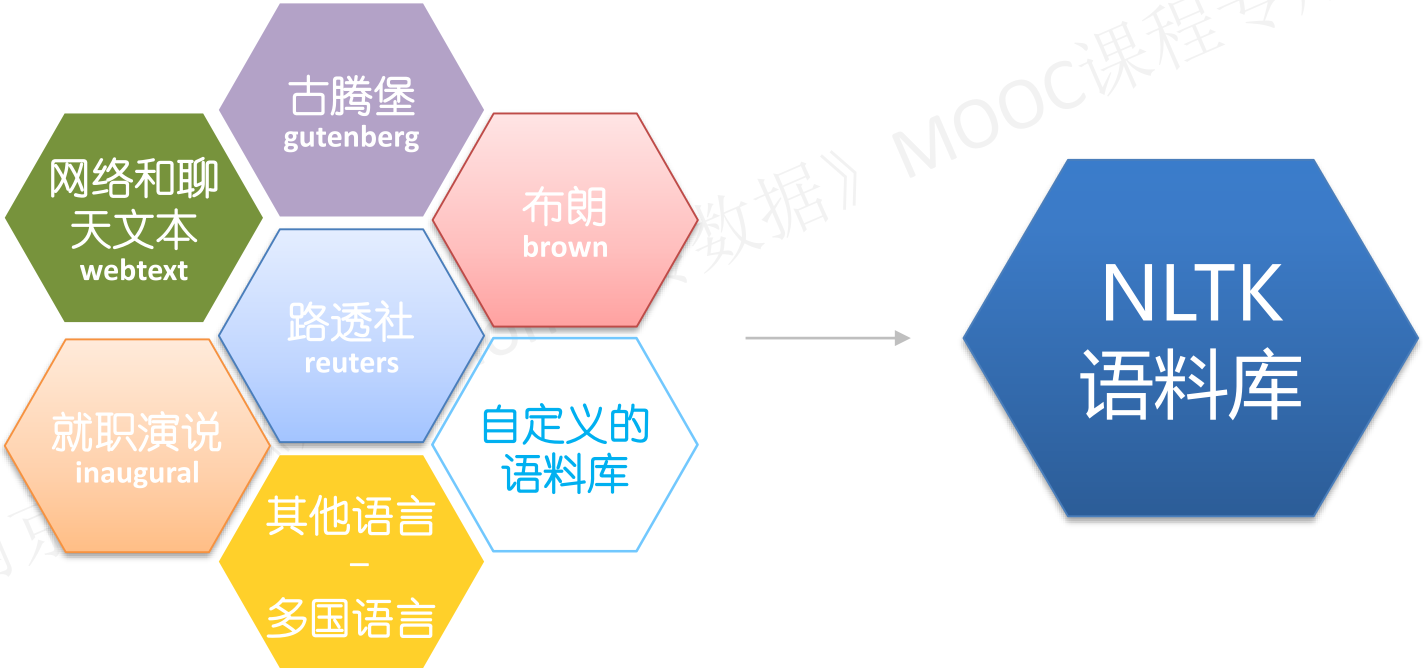


5

用Python玩转数据

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))
```

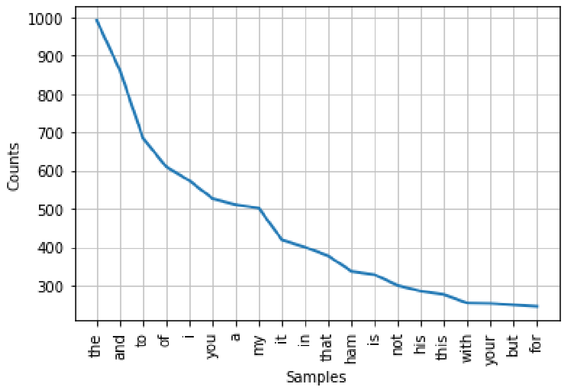
Output:

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

古滕堡项目

File

```python
# 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

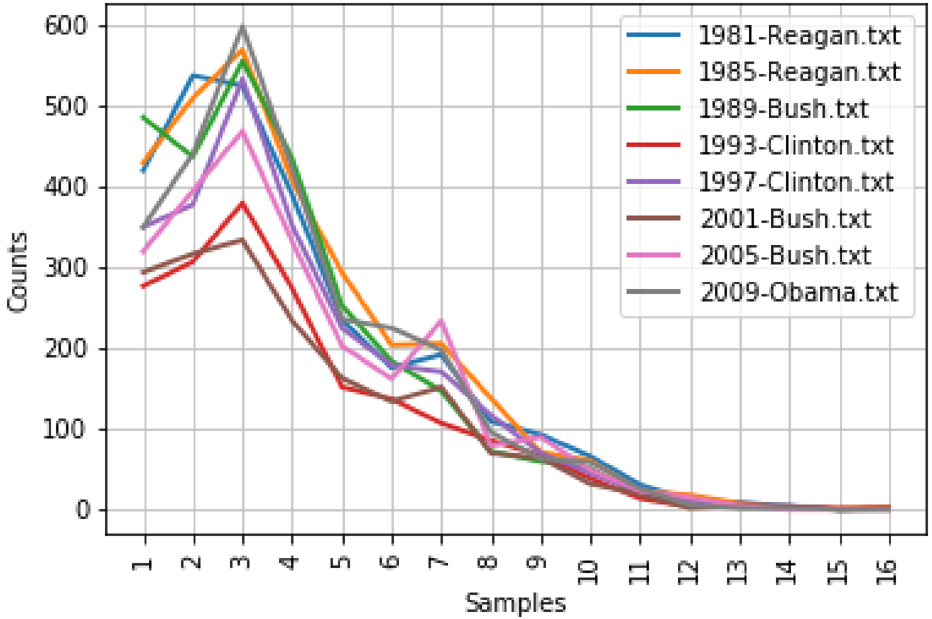
```
>>> from nltk.corpus import inaugural
>>> from nltk.probability import *
>>> fd3 = FreqDist([s for s in inaugural.words()])
>>> print(fd3.freq('freedom'))
0.00119394791917
```

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, ...}))])



小结

第六周 Python数据统计挖掘与应用

- 6.1 数据探索之基本数据特征分析
  - 分布分析，统计量分析，相关分析
- 6.2 基于pandas的数据统计与分析
  - 简单筛选与统计，分组之groupby()，apply()，合并之append()，concat()和merge()
- 6.3 聚类分析
  - 聚类基本思想，K-均值示例，分类模型简单示例
- 6.4 Python的理工类应用
  - 数学函数与绘图，图像处理之加水印示例，生物信息学Biopython项目简单示例
- 6.5 Python的人文社科类应用
  - 基于自然语言处理包NLTK的古腾堡项目图书统计，美国总统就职演说语言习惯挖掘示例
- 拓展1：基于movielens数据集的男女电影评分差异分析
- 拓展2：基于随机森林模型的红葡萄酒数据分类分析