# Python_Libraries_for_Data_Analytics

Matplotlib, Numpy, Panadas

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# Matplotlib

## Matplotlib Pyplot

使用 import 导入 pyplot 库，并设置一个别名 plt:

> import matplotlib.pyplot as plt

## plot()

syntax:

```
# 画单条线
plot([x], y, [fmt], *, data=None, **kwargs)
# 画多条线
plot([x], y, [fmt], [x2], y2, [fmt2], ..., **kwargs)
```

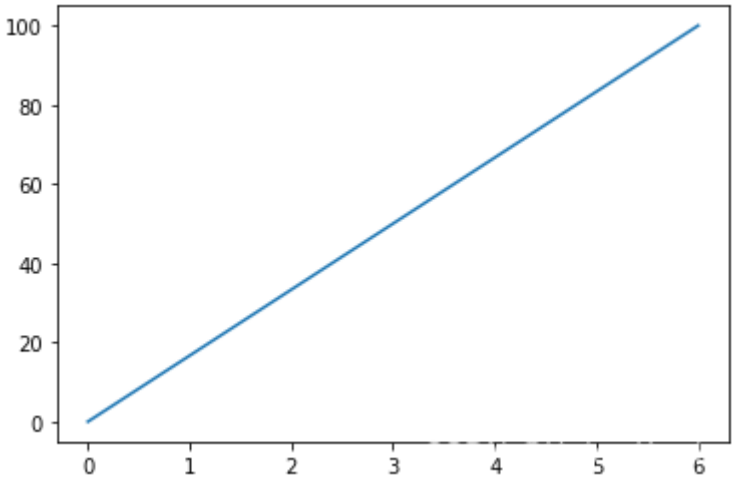
> 参数说明：
> x, y：点或线的节点，x 为 x 轴数据，y 为 y 轴数据，数据可以列表或数组。
> fmt：可选，定义基本格式（如颜色、标记和线条样式）。
> **kwargs：可选，用在二维平面图上，设置指定属性，如标签，线的宽度等。

> 颜色字符：'b' 蓝色，'m' 洋红色，'g' 绿色，'y' 黄色，'r' 红色，'k' 黑色，'w' 白色，'c' 青绿色，'#008000' RGB 颜色符串。多条曲线不指定颜色时，会自动选择不同颜色。

> 线型参数：'-' 实线，'--' 破折线，'-.' 点划线，':' 虚线。
> 标记字符：'.' 点标记，',' 像素标记(极小点)，'o' 实心圈标记，'v' 倒三角标记，'^' 上三角标记，'>' 右三角标记，'<' 左三角标记...等等。

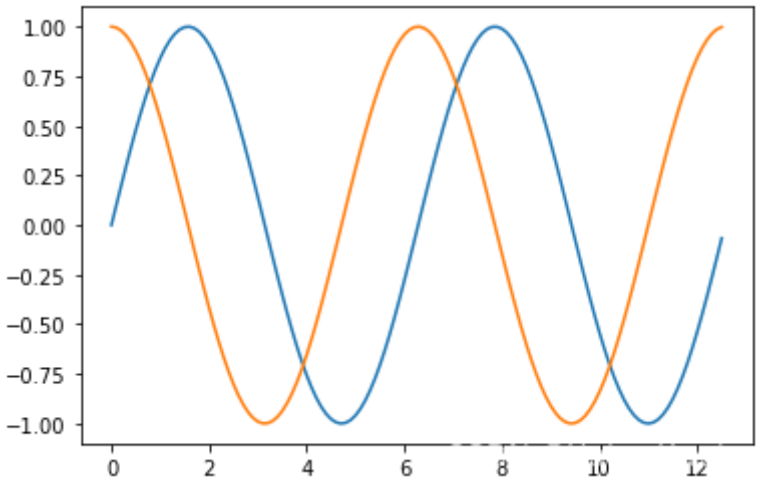
画单条线:

```
import matplotlib.pyplot as plt
import numpy as np

xpoints = np.array([0, 6])
ypoints = np.array([0, 100])

plt.plot(xpoints, ypoints)
plt.show()
```




画多条线:

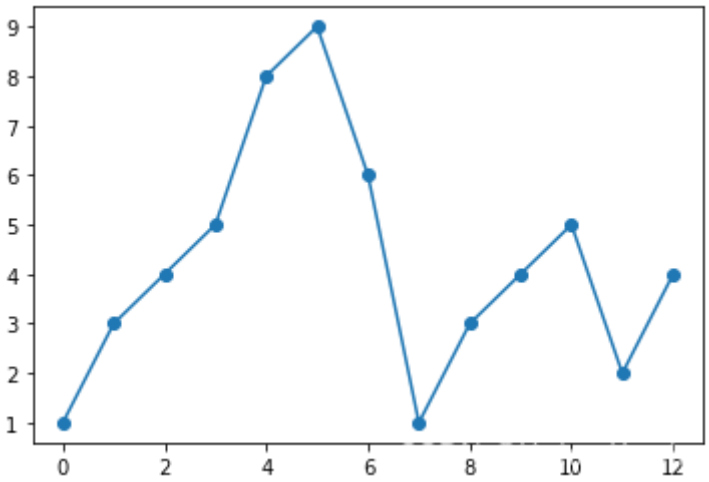
```
import matplotlib.pyplot as plt
import numpy as np

x = np.arange(0,4*np.pi,0.1)   # start,stop,step
y = np.sin(x)
z = np.cos(x)
plt.plot(x,y,x,z)
plt.show()
```



# Marker 标记

坐标自定义一些不一样的标记，可以使用 plot() 方法的 marker 参数来定义:

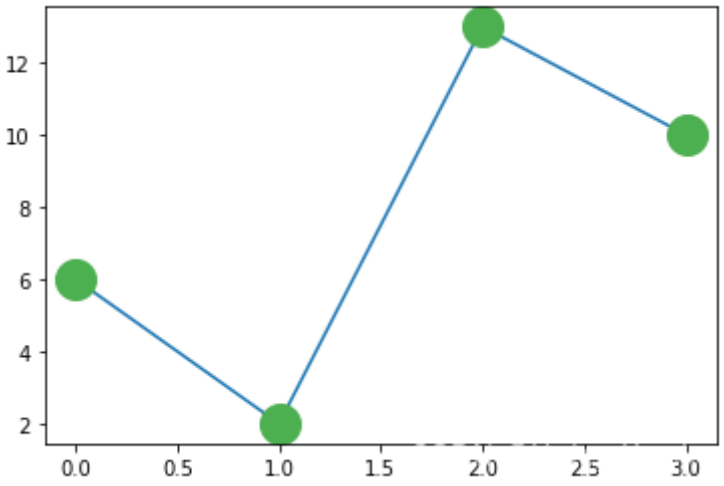
```
import matplotlib.pyplot as plt
import numpy as np

ypoints = np.array([1,3,4,5,8,9,6,1,3,4,5,2,4])

plt.plot(ypoints, marker = 'o')
plt.show()
```




标记大小与颜色:

> markersize，简写为 ms：定义标记的大小。
> markerfacecolor，简写为 mfc：定义标记内部的颜色。
> markeredgecolor，简写为 mec：定义标记边框的颜色。

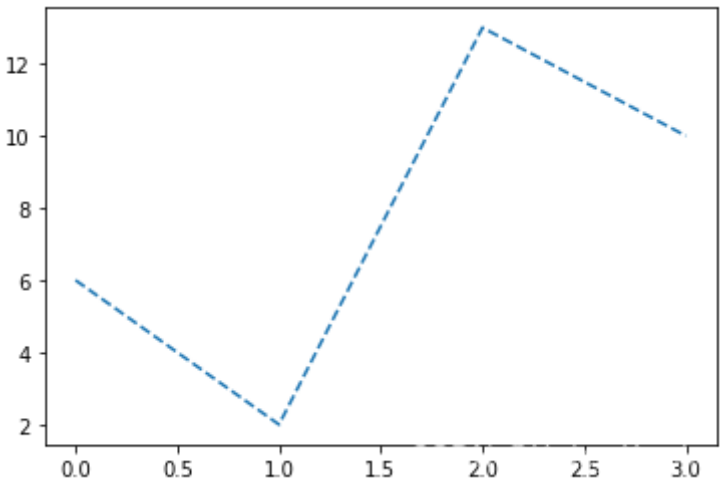
```
import matplotlib.pyplot as plt
import numpy as np

ypoints = np.array([6, 2, 13, 10])
plt.plot(ypoints, marker = 'o', ms = 20, mec = '#4CAF50', mfc = '#4CAF50')
plt.show()
```




# linestyle 自定义线的样式，包括线的类型、颜色和大小等

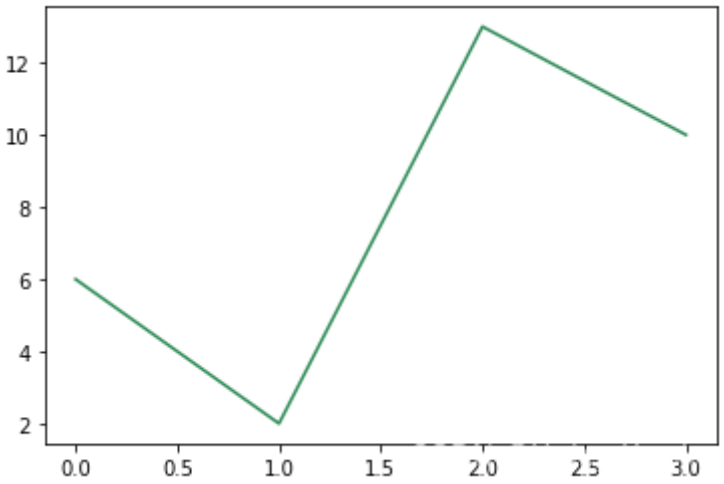
> 线的类型可以使用 linestyle 参数来定义，简写为 ls:

```
import matplotlib.pyplot as plt
import numpy as np

ypoints = np.array([6, 2, 13, 10])

plt.plot(ypoints, linestyle = 'dashed')
plt.show()
```



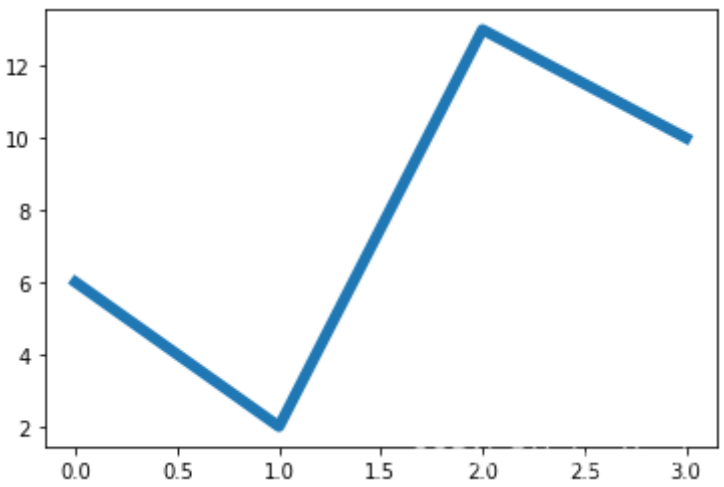

> 线的颜色可以使用 color 参数来定义，简写为 c:

```
import matplotlib.pyplot as plt
import numpy as np

ypoints = np.array([6, 2, 13, 10])

plt.plot(ypoints, c = 'SeaGreen')
plt.show()
```




> 线的宽度可以使用 linewidth 参数来定义，简写为 lw，值可以是浮点数

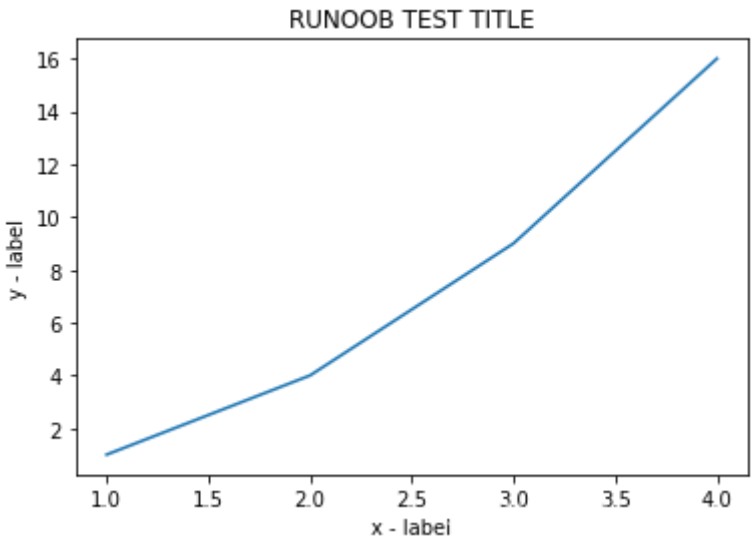
```
import matplotlib.pyplot as plt
import numpy as np

ypoints = np.array([6, 2, 13, 10])

plt.plot(ypoints, linewidth = '5.5')
plt.show()
```



# label 轴标签和标题

> 使用 xlabel() 和 ylabel() 方法来设置 x 轴和 y 轴的标签
> 使用 title() 方法来设置标题

```
import numpy as np
import matplotlib.pyplot as plt

x = np.array([1, 2, 3, 4])
y = np.array([1, 4, 9, 16])
plt.plot(x, y)

plt.title("RUNOOB TEST TITLE")
plt.xlabel("x - label")
plt.ylabel("y - label")

plt.show()
```




# grid 网格线

> 使用 pyplot 中的 grid() 方法来设置图表中的网格线
> syntax:

```
matplotlib.pyplot.grid(b=None, which='major', axis='both', )
```

> 参数说明：
> b：可选，默认为 None，可以设置布尔值，true 为显示网格线，false 为不显示，如果设置

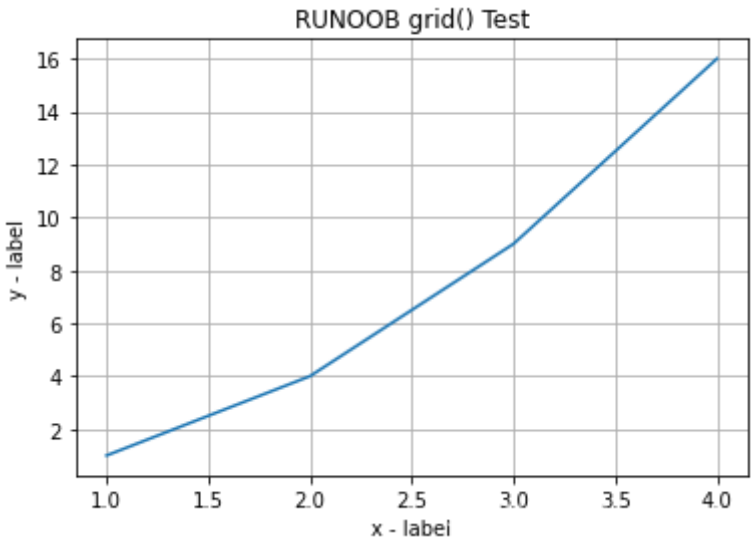
> **kwargs 参数，则值为 true。

> which：可选，可选值有 'major'、'minor' 和 'both'，默认为 'major'，表示应用更改的网格线。

> axis：可选，设置显示哪个方向的网格线，可以是取 'both'（默认），'x' 或 'y'，分别表示两个方向，x 轴方向或 y 轴方向。

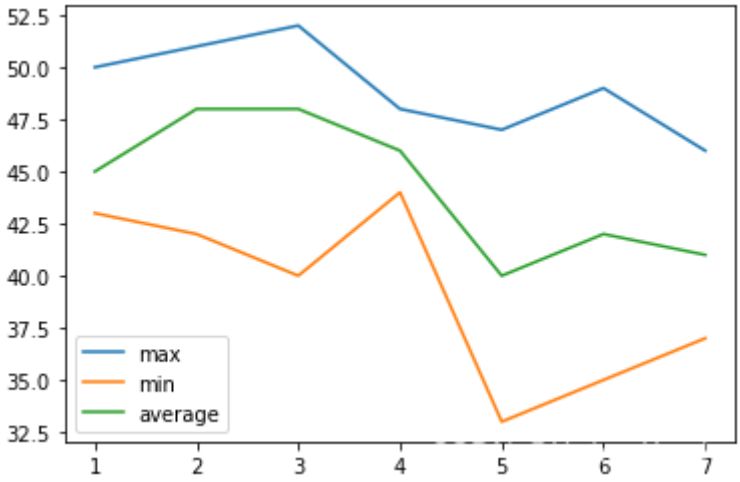
> **kwargs：可选，设置网格样式，可以是 color='r', linestyle='-' 和 linewidth=2，分别表示网格线的颜色，样式和宽度。

```
import numpy as np
import matplotlib.pyplot as plt

x = np.array([1, 2, 3, 4])
y = np.array([1, 4, 9, 16])


plt.title("RUNOOB grid() Test")
plt.xlabel("x - label")
plt.ylabel("y - label")

plt.plot(x, y)

plt.grid()
# plt.grid(color = 'r', linestyle = '--', linewidth = 0.5) 做装饰

plt.show()
```




# legend

```
# Show legend
plt.plot(days, max_t, label="max")
plt.plot(days, min_t, label="min")
plt.plot(days, avg_t, label="average")

plt.legend(loc='best')
# plt.legend(loc='upper right',shadow=True,fontsize='large')
# plt.legend(loc='upper right', fontsize="large", shadow=True)
```



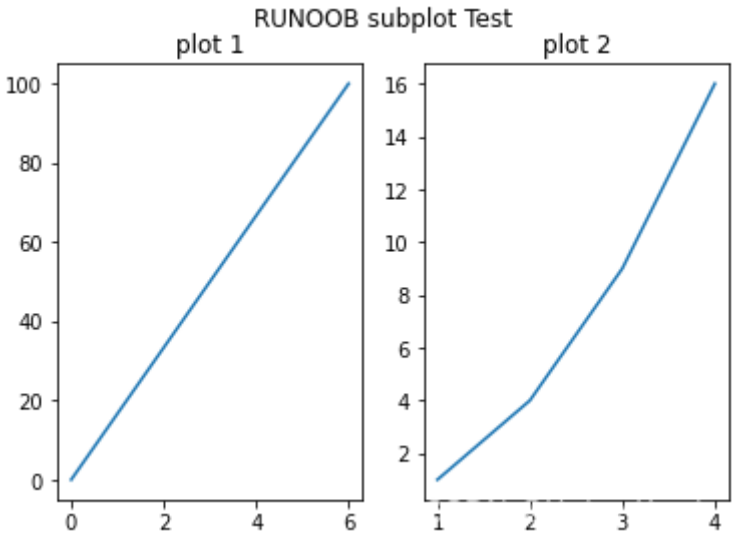

# subplot() 绘制多图

使用 pyplot 中的 subplot() 和 subplots() 方法来绘制多个子图; subplot() 方法在绘图时需要指定位置，subplots() 方法可以一次生成多个，在调用时只需要调用生成对象的 ax 即可

syntax:

```
subplot(nrows, ncols, index, **kwargs)
subplot(pos, **kwargs)
subplot(**kwargs)
subplot(ax)


matplotlib.pyplot.subplots(nrows=1, ncols=1, *, sharex=False, sharey=False, squeeze=True
```

```
import matplotlib.pyplot as plt
import numpy as np

#plot 1:
xpoints = np.array([0, 6])
ypoints = np.array([0, 100])

plt.subplot(1, 2, 1) # 1 row, 2 columns, 1st subplot
plt.plot(xpoints,ypoints)
plt.title("plot 1")

#plot 2:
x = np.array([1, 2, 3, 4])
y = np.array([1, 4, 9, 16])

plt.subplot(1, 2, 2) # 1 row, 2 columns, 2nd subplot
plt.plot(x,y)
plt.title("plot 2")

plt.suptitle("RUNOOB subplot Test")
plt.show()
```

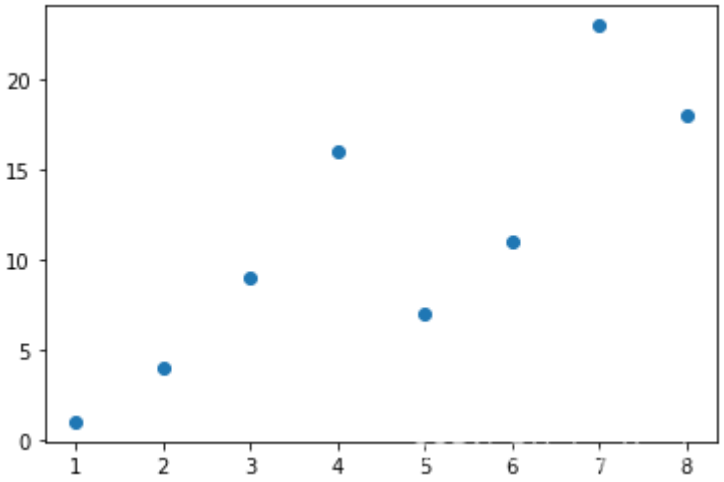



# scatter 散点图

使用 pyplot 中的 scatter() 方法来绘制散点图:

> matplotlib.pyplot.scatter(x, y, s=None, c=None, marker=None, cmap=None, norm=None, vmin=None, vmax=None, alpha=None, linewidths=None, *, edgecolors=None, plotnonfinite=False, data=None, **kwargs)

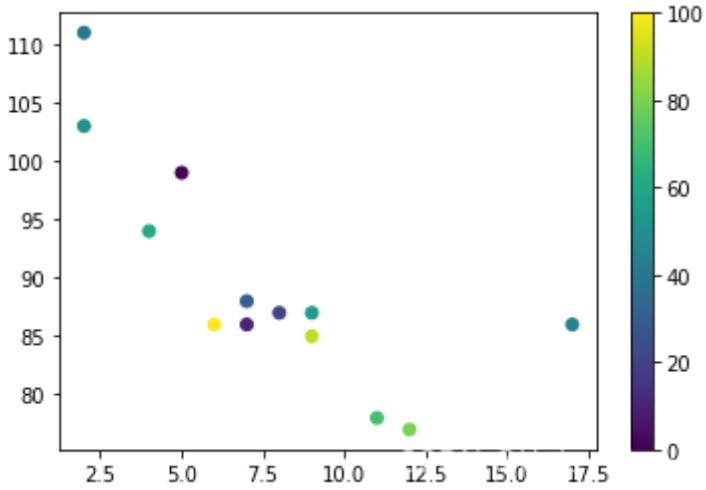
```
import matplotlib.pyplot as plt
import numpy as np

x = np.array([1, 2, 3, 4, 5, 6, 7, 8])
y = np.array([1, 4, 9, 16, 7, 11, 23, 18])
# sizes = np.array([20,50,100,200,500,1000,60,90]) 设置图标大小
# colors = np.array(["red","green","black","orange","purple","beige","cyan","magenta"])

plt.scatter(x, y)
plt.show()
```




## 颜色条 Colormap

使用 plt.colorbar() 方法：

```
import matplotlib.pyplot as plt
import numpy as np

x = np.array([5,7,8,7,2,17,2,9,4,11,12,9,6])
y = np.array([99,86,87,88,111,86,103,87,94,78,77,85,86])
colors = np.array([0, 10, 20, 30, 40, 45, 50, 55, 60, 70, 80, 90, 100])

plt.scatter(x, y, c=colors, cmap='viridis') # 换个颜色条参数， cmap 设置为 afmhot_r

plt.colorbar()

plt.show()
```




# barchart 柱形图

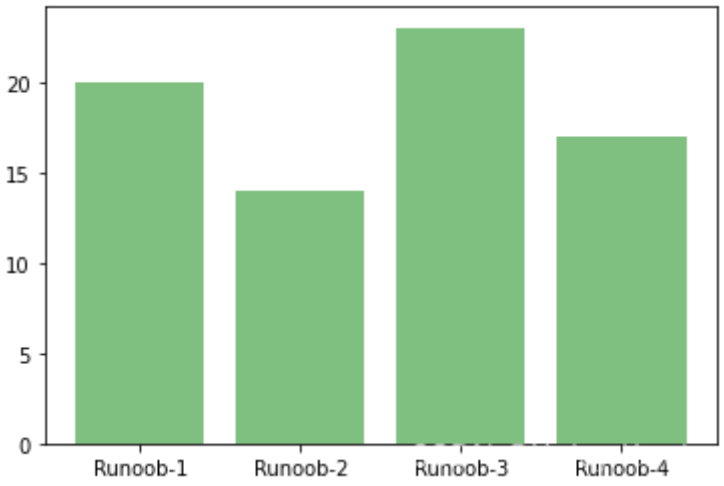
使用 pyplot 中的 bar() 方法来绘制柱形图:

syntax:

```
matplotlib.pyplot.bar(x, height, width=0.8, bottom=None, *, align='center', data=None, 
```

> 参数说明：
> x：浮点型数组，柱形图的 x 轴数据。
> height：浮点型数组，柱形图的高度。
> width：浮点型数组，柱形图的宽度。
> bottom：浮点型数组，底座的 y 坐标，默认 0。
> align：柱形图与 x 坐标的对齐方式，'center' 以 x 位置为中心，这是默认值。 'edge'：将柱形图的左边缘与 x 位置对齐。要对齐右边缘的条形，可以传递负数的宽度值及 align='edge'。
> **kwargs：：其他参数。

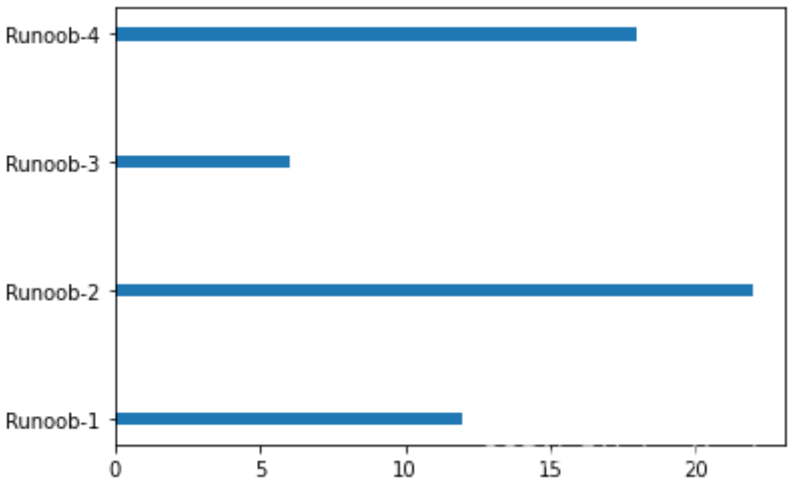
```
import matplotlib.pyplot as plt
import numpy as np

x = np.array(['Runoob-1', 'Runoob-2', 'Runoob-3', 'Runoob-4'])
y = np.array([20, 14, 23, 17])

plt.bar(x, y, align='center', color='green', alpha=0.5)
plt.show()
```




## Horizontal Bars

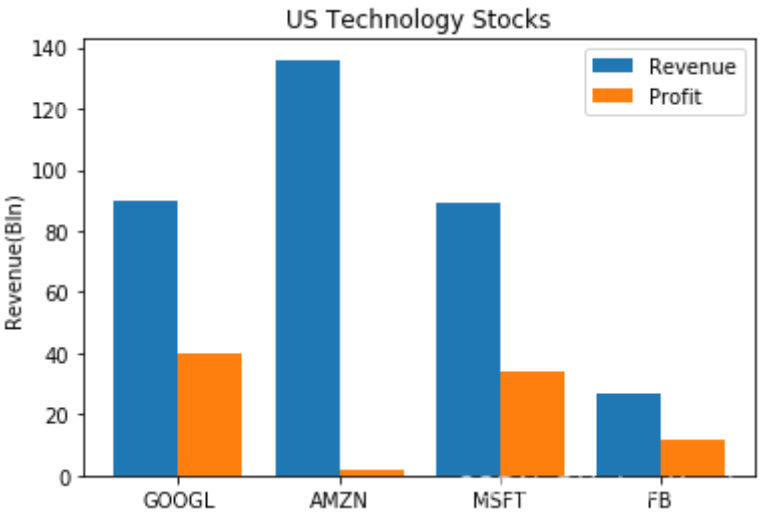
垂直方向的柱形图可以使用 barh() 方法来设置:

```
import matplotlib.pyplot as plt
import numpy as np

x = np.array(["Runoob-1", "Runoob-2", "Runoob-3", "Runoob-4"])
y = np.array([12, 22, 6, 18])

plt.barh(x, y, height = 0.1)
plt.show()
```




## Multiple Bars

```
plt.bar(xpos-0.2,revenue, width=0.4, label="Revenue")
plt.bar(xpos+0.2,profit, width=0.4,label="Profit")

plt.xticks(xpos,company)
plt.ylabel("Revenue(Bln)")
plt.title('US Technology Stocks')
plt.legend()
```




# Pie 饼图

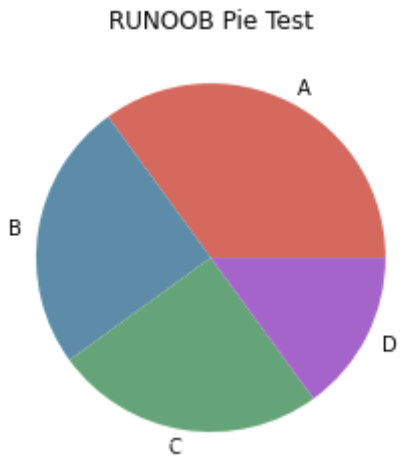
使用 pyplot 中的 pie() 方法来绘制饼图:

syntax:

```
matplotlib.pyplot.pie(x, explode=None, labels=None, colors=None, autopct=None, pctdistar
```

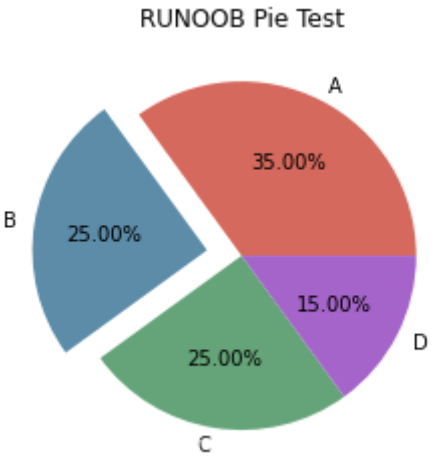
```
import matplotlib.pyplot as plt
import numpy as np

y = np.array([35, 25, 25, 15])

plt.pie(y)
plt.show()
```

```
import matplotlib.pyplot as plt
import numpy as np

y = np.array([35, 25, 25, 15])

plt.pie(y,
        labels=['A','B','C','D'], # 设置饼图标签
        colors=["#d5695d", "#5d8ca8", "#65a479", "#a564c9"], # 设置饼图颜色
       )
plt.title("RUNOOB Pie Test") # 设置标题
plt.show()
```




突出显示第二个扇形，并格式化输出百分比：

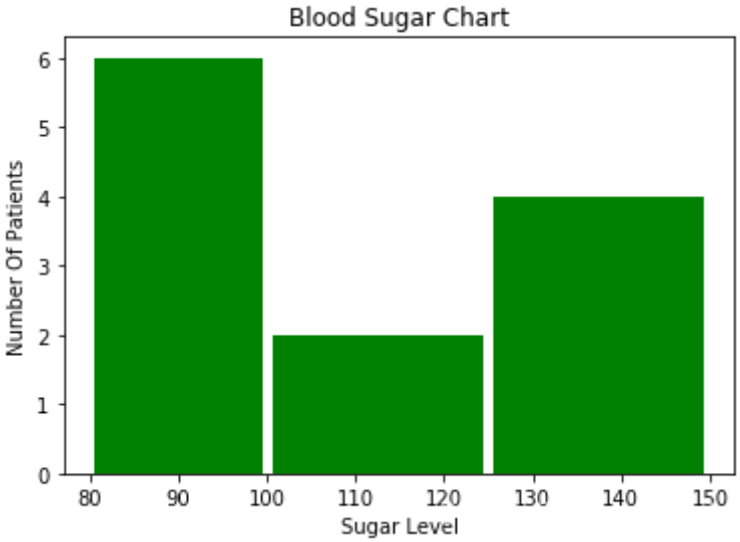
```
import matplotlib.pyplot as plt
import numpy as np

y = np.array([35, 25, 25, 15])

plt.pie(y,
        labels=['A','B','C','D'],
        colors=["#d5695d", "#5d8ca8", "#65a479", "#a564c9"],
        explode=(0, 0.2, 0, 0), # 第二部分突出显示，值越大，距离中心越远
        autopct='%.2f%%', # 输出百分比
       )
plt.title("RUNOOB Pie Test")
plt.show()
```




# histograms 直方图

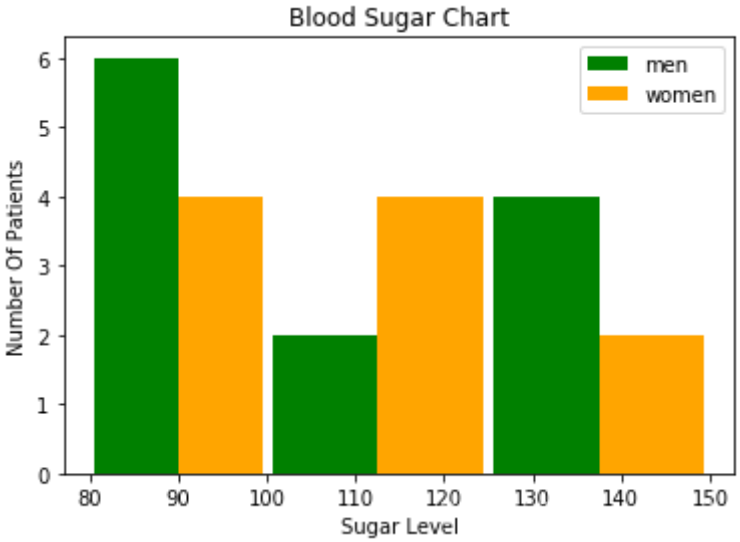
在直方图中，X轴包含一个变量，Y轴将是该变量的频率:

```
plt.xlabel("Sugar Level")
plt.ylabel("Number Of Patients")
plt.title("Blood Sugar Chart")

plt.hist(blood_sugar, bins=[80,100,125,150], rwidth=0.95, color='g')
```




## Multiple

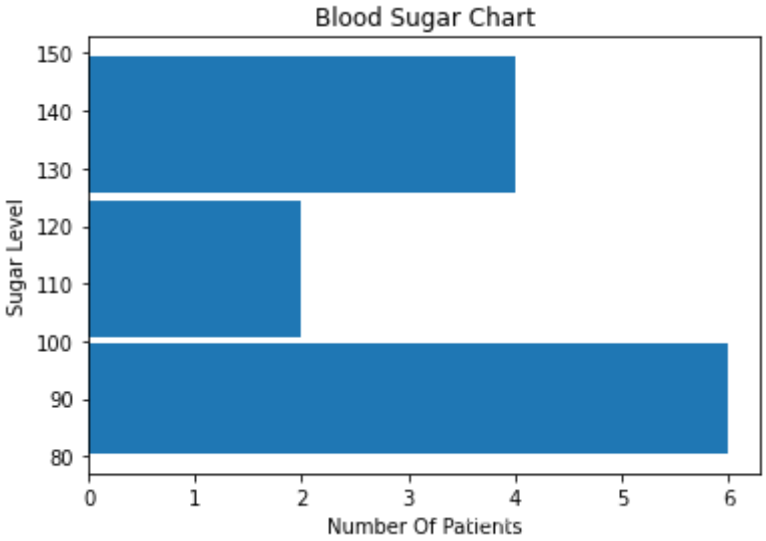
```
plt.xlabel("Sugar Level")
plt.ylabel("Number Of Patients")
plt.title("Blood Sugar Chart")

blood_sugar_men = [113, 85, 90, 150, 149, 88, 93, 115, 135, 80, 77, 82, 129]
blood_sugar_women = [67, 98, 89, 120, 133, 150, 84, 69, 89, 79, 120, 112, 100]

plt.hist([blood_sugar_men,blood_sugar_women], bins=[80,100,125,150], rwidth=0.95, color=
plt.legend() # 右上角的标签
```




## Horizontal

横向，orientation='horizontal'：

```
plt.xlabel("Number Of Patients")
plt.ylabel("Sugar Level")
plt.title("Blood Sugar Chart")

plt.hist(blood_sugar, bins=[80,100,125,150], rwidth=0.95, orientation='horizontal') # 橫
```




# Numpy

NumPy 最重要的一个特点是其 N 维数组对象 ndarray，它是一系列同类型数据的集合，以 0 下标为开始进行集合中元素的索引。

## NumPy 数据类型

numpy 支持的数据类型比 Python 内置的类型要多很多，基本上可以和 C 语言的数据类型对应上，其中部分类型对应为 Python 内置的类型。比如bool, int, int16, int32, float16, float32, float64, complex。

## NumPy 数组属性

NumPy 数组的维数称为秩（rank），秩就是轴的数量，即数组的维度，一维数组的秩为 1，二维数组的秩为 2，以此类推。
每一个线性的数组称为是一个轴（axis），也就是维度（dimensions）。比如说，二维数组相当于是两个一维数组，其中第一个一维数组中每个元素又是一个一维数组。

> 声明 axis：axis=0，表示沿着第 0 轴进行操作，即对每一列进行操作；axis=1，表示沿着第1轴进行操作，即对每一行进行操作。

## ndarray.ndim

ndarray.ndim 用于返回数组的维数，等于rank

```
import numpy as np

a = np.arange(24)
print (a.ndim) # one d

b = a.reshape(2,4,3)  # three d
print (b.ndim)

# return
1
3
```

## ndarray.shape

ndarray.shape 表示数组的维度，返回一个元组，这个元组的长度就是维度的数目，即 ndim 属性(秩)。比如，一个二维数组，其维度表示"行数"和"列数"。
ndarray.shape 也可以用于调整数组大小。

```
import numpy as np

a = np.array([[1,2,3],[4,5,6]])
a.shape =  (3,2)
print (a)


import numpy as np

a = np.array([[1,2,3],[4,5,6]])
b = a.reshape(3,2)
print (b)

# return
[[1, 2]
 [3, 4]
 [5, 6]]
```

# 创建数组

> numpy.empty/ones/zeros(shape, dtype = float, order = 'C')

```
import numpy as np

# 默认为浮点数
x = np.zeros(5)
print(x)

# 设置类型为整数
y = np.zeros((5,), dtype = int)
print(y)

# 自定义类型
z = np.zeros((2,2), dtype = [('x', 'i4'), ('y', 'i4')])
print(z)

# return
[0. 0. 0. 0. 0.]
[0 0 0 0 0]
[[(0, 0) (0, 0)]
 [(0, 0) (0, 0)]]
```

# 从已有的数组创建数组

## numpy.asarray

numpy.asarray 类似 numpy.array，但 numpy.asarray 参数只有三个，比 numpy.array 少两个。

> numpy.asarray(a, dtype = None, order = None)

> 参数说明：
> a 任意形式的输入参数，可以是，列表, 列表的元组, 元组, 元组的元组, 元组的列表，多维数组
> dtype 数据类型，可选
> order 可选，有"C"和"F"两个选项,分别代表，行优先和列优先，在计算机内存中的存储元素的顺序。

```
# 将列表转换为 ndarray:
import numpy as np

x =  [1,2,3]
a = np.asarray(x)
print (a)

# return
[1 2 3]

# 将元组转换为 ndarray:
import numpy as np

x =  (1,2,3)
a = np.asarray(x)
print (a)

# return
[1 2 3]
```

# 从数值范围创建数组

根据 start 与 stop 指定的范围以及 step 设定的步长，生成一个 ndarray:

> numpy.arange(start, stop, step, dtype)

```
import numpy as np
x = np.arange(10,20,2)
print (x)

# return
[10 12 14 16 18]
```

# 切片和索引

## 一位数组

与python一样

```
import numpy as np

a = np.arange(10)
s = slice(2,7,2)   # 从索引 2 开始到索引 7 停止，间隔为2
print (a[s])
```

```
import numpy as np

a = np.arange(10)
b = a[2:7:2]   # 从索引 2 开始到索引 7 停止，间隔为 2
print(b)

# return
[2 4 6]
[2 4 6]
```

# 多维数组

```
import numpy as np

a = np.array([[1,2,3],[3,4,5],[4,5,6]])
print(a)
# 从某个索引处开始切割
print('从数组索引 a[1:] 处开始切割')
print(a[1:])

# return
[[1 2 3]
 [3 4 5]
 [4 5 6]]
从数组索引 a[1:] 处开始切割
[[3 4 5]
 [4 5 6]]
```

切片还可以包括省略号 …，来使选择元组的长度与数组的维度相同。 如果在行位置使用省略号，它将返回包含行中元素的 ndarray。

**行 列**

```
import numpy as np

a = np.array([[1,2,3],[3,4,5],[4,5,6]])
print (a[...,1])   # 第2列元素
print (a[1,...])   # 第2行元素
print (a[...,1:])  # 第2列及剩下的所有元素

# return
[2 4 5]
[3 4 5]
[[2 3]
 [4 5]
 [5 6]]
```

# 高级索引

## 整数数组索引

以下实例获取数组中(0,0)，(1,1)和(2,0)位置处的元素。

```
import numpy as np

x = np.array([[1,  2],  [3,  4],  [5,  6]])
y = x[[0,1,2],  [0,1,0]]
print (y)

# return
[1  4  5]
```

获取 4X3 数组中的四个角的元素。 行索引是 [0,0] 和 [3,3]，而列索引是 [0,2] 和 [0,2]。

```
import numpy as np

x = np.array([[  0,  1,  2],[  3,  4,  5],[  6,  7,  8],[  9,  10,  11]])
print ('我们的数组是：' )
print (x)
print ('\n')
rows = np.array([[0,0],[3,3]])
cols = np.array([[0,2],[0,2]])
y = x[rows,cols]
print  ('这个数组的四个角元素是：')
print (y)

# return
我们的数组是：
[[ 0  1  2]
 [ 3  4  5]
 [ 6  7  8]
 [ 9 10 11]]


这个数组的四个角元素是：
[[ 0  2]
 [ 9 11]]
```

借助切片 : 或 … 与索引数组组合：

```
import numpy as np

a = np.array([[1,2,3], [4,5,6],[7,8,9]])
b = a[1:3, 1:3]
c = a[1:3,[1,2]]
d = a[...,1:]
print(b)
print(c)
print(d)

# return
[[5 6]
 [8 9]]
[[5 6]
 [8 9]]
[[2 3]
 [5 6]
 [8 9]]
```

# 布尔索引

布尔索引通过布尔运算（如：比较运算符）来获取符合指定条件的元素的数组
获取大于 5 的元素：

```
import numpy as np

x = np.array([[  0,  1,  2],[  3,  4,  5],[  6,  7,  8],[  9,  10,  11]])
print ('我们的数组是：')
print (x)
print ('\n')
# 现在我们会打印出大于 5 的元素
print  ('大于 5 的元素是：')
print (x[x >  5])


# return
我们的数组是：
[[ 0  1  2]
 [ 3  4  5]
 [ 6  7  8]
 [ 9 10 11]]


大于 5 的元素是：
[ 6  7  8  9 10 11]
```

# 广播(Broadcast)

如果两个数组 a 和 b 形状相同，即满足 a.shape == b.shape，那么 a*b 的结果就是 a 与 b 数组对应位相乘。这要求维数相同，且各维度的长度相同。

```
import numpy as np

a = np.array([1,2,3,4])
b = np.array([10,20,30,40])
c = a * b
print (c)

# return
[ 10  40  90 160]
```

当运算中的 2 个数组的形状不同时，numpy 将自动触发广播机制。如：

```
import numpy as np

a = np.array([[ 0, 0, 0],
              [10,10,10],
              [20,20,20],
              [30,30,30]])
b = np.array([0,1,2])
print(a + b)

# return
[[ 0  1  2]
 [10 11 12]
 [20 21 22]
 [30 31 32]]
```

# Pandas

Pandas 是 Python 语言的一个扩展程序库，用于数据分析；名字衍生自术语 "panel data"（面板数据）和 "Python data analysis"（Python 数据分析）。

## Series

主要数据结构是 Series （一维数据）与 DataFrame（二维数据）：Series 是一种类似于一维数组的对象，它由一组数据（各种Numpy数据类型）以及一组与之相关的数据标签（即索引）组成

syntax:

```
pandas.Series( data, index, dtype, name, copy)
```

> data：一组数据(ndarray 类型)。
> index：数据索引标签，如果不指定，默认从 0 开始。
> dtype：数据类型，默认会自己判断。
> name：设置名称。
> copy：拷贝数据，默认为 False。

```
import pandas as pd

a = ["Google", "Runoob", "Wiki"]

myvar = pd.Series(a, index = ["x", "y", "z"])

print(myvar)

# return
x    Google
y    Runoob
z      Wiki
```

```
import pandas as pd

sites = {1: "Google", 2: "Runoob", 3: "Wiki"}

myvar = pd.Series(sites)

print(myvar)

# return
1    Google
2    Runoob
3      Wiki
```

# DataFrame

DataFrame 是一个表格型的数据结构，它含有一组有序的列，每列可以是不同的值类型（数值、字符串、布尔型值）。DataFrame 既有行索引也有列索引，它可以被看做由 Series 组成的字典（共同用一个索引）

syntax:

```
pandas.DataFrame( data, index, columns, dtype, copy)
```

> data：一组数据(ndarray、series, map, lists, dict 等类型)。
> index：索引值，或者可以称为行标签。
> columns：列标签，默认为 RangeIndex (0, 1, 2, …, n) 。
> dtype：数据类型。
> copy：拷贝数据，默认为 False。

```
import pandas as pd

data = [['Google',10],['Runoob',12],['Wiki',13]]

df = pd.DataFrame(data,columns=['Site','Age'],dtype=float)

print(df)
```

或者：

```
import pandas as pd

data = {'Site':['Google', 'Runoob', 'Wiki'], 'Age':[10, 12, 13]}

df = pd.DataFrame(data)

print (df)

# return
     Site   Age
0  Google  10.0
1  Runoob  12.0
2    Wiki  13.0
```

# 读写数据

## CSV 文件

CSV（Comma-Separated Values，逗号分隔值，有时也称为字符分隔值，因为分隔字符也可以不是逗号），其文件以纯文本形式存储表格数据（数字和文本）。

```
import pandas as pd
df = pd.read_csv('nba.csv')
print(df)
```

### skiprows/ header = 1

```
df = pd.read_csv("stock_data.csv", skiprows=1) # skip first line
```

或者

```
df = pd.read_csv("stock_data.csv", header=1)
```

## names

```
df = pd.read_csv("stock_data.csv", header=None, names = ["ticker","eps","revenue","peop

# return
        ticker  eps     revenue people
tickers eps     revenue price   people
GOOGL   27.82   87      845     larry page
WMT     4.61    484     65      n.a.
MSFT    -1      85      64      bill gates
RIL     not available   50      1023    mukesh ambani
TATA    5.6     -1      n.a.    ratan tata
```

## nrows

```
df = pd.read_csv("stock_data.csv",  nrows=2)

# return
        tickers eps     revenue price   people
0       GOOGL   27.82   87      845     larry page
1       WMT     4.61    484     65      n.a.
```

## na_values

```
df = pd.read_csv("stock_data.csv", na_values=["n.a.", "not available"]) # n.a. replaced

# return
        tickers eps     revenue price   people
0       GOOGL   27.82   87      845.0   larry page
1       WMT     4.61    484     65.0    NaN
2       MSFT    -1.00   85      64.0    bill gates
3       RIL     NaN     50      1023.0  mukesh ambani
4       TATA    5.60    -1      NaN     ratan tata
```

```
df = pd.read_csv("stock_data.csv",  na_values={
        'eps': ['not available'],
        'revenue': [-1],
        'people': ['not available','n.a.'] # not available replaced by n.a.
    })

# return
tickers eps     revenue price   people
0       GOOGL   27.82   87.0    845     larry page
1       WMT     4.61    484.0   65      NaN
2       MSFT    -1.00   85.0    64      bill gates
3       RIL     NaN     50.0    1023    mukesh ambani
4       TATA    5.60    NaN     n.a.    ratan tata
```

## Excel

```
df=pd.read_excel('')


# want to fill the na with specific data
def convert_people_cell(cell):
    if cell=="n.a.":
        return 'Sam Walton'
    return cell

def convert_price_cell(cell):
    if cell=="n.a.":
        return 50
    return cell

df = pd.read_excel("stock_data.xlsx","Sheet1", converters= {
        'people': convert_people_cell,
        'price': convert_price_cell
    })
df
```

## JSON

JSON（JavaScript Object Notation，JavaScript 对象表示法），是存储和交换文本信息的语法，类似 XML。

## Dictionary

```
import pandas as pd
weather_data = {
    'day': ['1/1/2017','1/2/2017','1/3/2017'],
    'event': ['Rain', 'Sunny', 'Snow'],
    'temperature': [32,35,28],
    'windspeed': [6,7,2],

}
df = pd.DataFrame(weather_data)
df

# return
day     event   temperature     windspeed
0       1/1/2017        Rain    32      6
1       1/2/2017        Sunny   35      7
2       1/3/2017        Snow    28      2


weather_data = [
    {'day': '1/1/2017', 'temperature': 32, 'windspeed': 6, 'event': 'Rain'},
    {'day': '1/2/2017', 'temperature': 35, 'windspeed': 7, 'event': 'Sunny'},
    {'day': '1/3/2017', 'temperature': 28, 'windspeed': 2, 'event': 'Snow'},

]
df = pd.DataFrame(data=weather_data, columns=['day','temperature','windspeed','event'])
df

# return
        day     temperature     windspeed       event
0       1/1/2017        32      6       Rain
1       1/2/2017        35      7       Sunny
2       1/3/2017        28      2       Snow
```

## Tuples list

```
weather_data = [
    ('1/1/2017',32,6,'Rain'),
    ('1/2/2017',35,7,'Sunny'),
    ('1/3/2017',28,2,'Snow')
]
df = pd.DataFrame(data=weather_data, columns=['day','temperature','windspeed','event'])
df

# return
day     temperature     windspeed       event
0       1/1/2017        32      6       Rain
1       1/2/2017        35      7       Sunny
2       1/3/2017        28      2       Snow
```

# 数据清洗

很多数据集存在数据缺失、数据格式错误、错误数据或重复数据的情况，如果要对使数据分析更加准确，就需要对这些没有用的数据进行处理。

## dropna()

> axis：默认为 0，表示逢空值剔除整行，如果设置参数 axis＝1 表示逢空值去掉整列。
> how：默认为 'any' 如果一行（或一列）里任何一个数据有出现 NA 就去掉整行，如果设置 how='all' 一行（或列）都是 NA 才去掉这整行。
> thresh：设置需要多少非空值的数据才可以保留下来的。
> subset：设置想要检查的列。如果是多个列，可以使用列名的 list 作为参数。
> inplace：如果设置 True，将计算得到的值直接覆盖之前的值并返回 None，修改的是源数据。

```
DataFrame.dropna(axis=0, how='any', thresh=None, subset=None, inplace=False)
```

```
import pandas as pd

df = pd.read_csv('property-data.csv')

new_df = df.dropna()

print(new_df.to_string())
```

设置需要多少非空值的数据才可以保留下来：

```
new_df = df.dropna(thresh=2) # 有两个或以上的value就留
new_df

# return
            temperature     windspeed       event
day
2017-01-01      32.0    6.0     Rain
2017-01-04      NaN     9.0     Sunny
2017-01-05      28.0    NaN     Snow
2017-01-07      32.0    NaN     Rain
2017-01-10      34.0    8.0     Cloudy
2017-01-11      40.0    12.0    Sunny
```

移除指定列有空值的行：

```
import pandas as pd

df = pd.read_csv('property-data.csv')

df.dropna(subset=['ST_NUM'], inplace = True)

print(df.to_string())
```

## isnull()

可以通过 isnull() 判断各个单元格是否为空

```
import pandas as pd

df = pd.read_csv('property-data.csv')

print (df['NUM_BEDROOMS'])
print (df['NUM_BEDROOMS'].isnull())
```

指定空数据类型：

```
import pandas as pd

missing_values = ["n/a", "na", "--"]
df = pd.read_csv('property-data.csv', na_values = missing_values)

print (df['NUM_BEDROOMS'])
print (df['NUM_BEDROOMS'].isnull())
```

## fillna()

fillna() 方法替换一些空字段：

- fillna()

```
import pandas as pd

df = pd.read_csv('property-data.csv')

df.fillna(12345, inplace = True) # 使用 12345 替换空字段

print(df.to_string())
```

```
import pandas as pd
df = pd.read_csv("weather_data.csv", parse_dates=["day"])
df.set_index('day',inplace=True)
df

new_df = df.fillna(0)
new_df

# return
            temperature     windspeed       event
day
2017-01-01      32.0    6.0     Rain
2017-01-04      0.0     9.0     Sunny
2017-01-05      28.0    0.0     Snow
2017-01-06      0.0     7.0     0
2017-01-07      32.0    0.0     Rain
2017-01-08      0.0     0.0     Sunny
2017-01-09      0.0     0.0     0
2017-01-10      34.0    8.0     Cloudy
2017-01-11      40.0    12.0    Sunny
```

指定某一个列来替换数据：

```
import pandas as pd

df = pd.read_csv('property-data.csv')

df['PID'].fillna(12345, inplace = True) # 使用 12345 替换 PID 为空数据

print(df.to_string())
```

```
new_df = df.fillna({
        'temperature': 0,
        'windspeed': 0,
        'event': 'no event'
    })
new_df

# return
        temperature     windspeed       event
day
2017-01-01      32.0    6.0     Rain
2017-01-04      0.0     9.0     Sunny
2017-01-05      28.0    0.0     Snow
2017-01-06      0.0     7.0     no event
2017-01-07      32.0    0.0     Rain
2017-01-08      0.0     0.0     Sunny
2017-01-09      0.0     0.0     no event
2017-01-10      34.0    8.0     Cloudy
2017-01-11      40.0    12.0    Sunny
```

复制前或后数据 ffill / bfill：

- 加上limit = 1 只可copy一次
- 加上 axis = 'columns' 垂直 copy / 'index' 水平 copy

```
new_df = df.fillna(method="ffill")
new_df

# return

temperature     windspeed       event
day
2017-01-01      32.0    6.0     Rain
2017-01-04      32.0    9.0     Sunny
2017-01-05      28.0    9.0     Snow
2017-01-06      28.0    7.0     Snow
2017-01-07      32.0    7.0     Rain
2017-01-08      32.0    7.0     Sunny
2017-01-09      32.0    NaN     Sunny
2017-01-10      34.0    8.0     Cloudy
2017-01-11      40.0    12.0    Sunny
```

# mean() for single column

```
import numpy as np
import pandas as pd

# A dictionary with list as values
GFG_dict = { 'G1': [10, 20,30,40],
                'G2': [25, np.NaN, np.NaN, 29],
                'G3': [15, 14, 17, 11],
                'G4': [21, 22, 23, 25]}

# Create a DataFrame from dictionary
gfg = pd.DataFrame(GFG_dict)

#Finding the mean of the column having NaN
mean_value=gfg['G2'].mean()

# Replace NaNs in column S2 with the
# mean of values in the same column
gfg['G2'].fillna(value=mean_value, inplace=True)
print('Updated Dataframe:')
print(gfg)
```

## mean() for multiple columns

@ Day1 ML Challenge

```
#  from sklearn.preprocessing import Imputer
<p class="mume-header " id="from-sklearnpreprocessing-import-imputer"></p>

from sklearn.impute import SimpleImputer as Imputer
#  old version: class sklearn.preprocessing.Imputer(missing_values='NaN', strategy='mea
<p class="mume-header " id="old-version-class-sklearnpreprocessingimputermissing_values


imputer = Imputer(missing_values=np.nan,strategy="mean")
imputer = imputer.fit(X[:, 1:3])
X[:, 1:3] = imputer.transform(X[:, 1:3])
X
```

## interpolate() 中和数值

```
new_df = df.interpolate(method="time")
new_df
```

```
            temperature     windspeed       event
day
2017-01-01      32.0    6.0     Rain
2017-01-04      NaN     9.0     Sunny
2017-01-05      28.0    NaN     Snow
2017-01-06      NaN     7.0     NaN
2017-01-07      32.0    NaN     Rain
2017-01-08      NaN     NaN     Sunny
2017-01-09      NaN     NaN     NaN
2017-01-10      34.0    8.0     Cloudy
2017-01-11      40.0    12.0    Sunny

# return
            temperature     windspeed       event
day
2017-01-01      32.000000       6.00    Rain
2017-01-04      29.000000       9.00    Sunny
2017-01-05      28.000000       8.00    Snow
2017-01-06      30.000000       7.00    NaN
2017-01-07      32.000000       7.25    Rain
2017-01-08      32.666667       7.50    Sunny
2017-01-09      33.333333       7.75    NaN
2017-01-10      34.000000       8.00    Cloudy
2017-01-11      40.000000       12.00   Sunny
```

# replace()

```
        day     temperature     windspeed       event
0       1/1/2017        32      6       Rain
1       1/2/2017        -99999  7       Sunny
2       1/3/2017        28      -99999  Snow
3       1/4/2017        -99999  7       0
4       1/5/2017        32      -99999  Rain
5       1/6/2017        31      2       Sunny
6       1/6/2017        34      5       0
```

用NaN代替-99999：

```
new_df = df.replace(-99999, value=np.NaN)
new_df

# return
day     temperature     windspeed       event
0       1/1/2017        32.0    6.0     Rain
1       1/2/2017        NaN     7.0     Sunny
2       1/3/2017        28.0    NaN     Snow
3       1/4/2017        NaN     7.0     0
4       1/5/2017        32.0    NaN     Rain
5       1/6/2017        31.0    2.0     Sunny
6       1/6/2017        34.0    5.0     0
```

代替两个数值-99999, -88888：

```
new_df = df.replace(to_replace=[-99999,-88888], value=0)
new_df

# return
day     temperature     windspeed       event
0       1/1/2017        32      6       Rain
1       1/2/2017        0       7       Sunny
2       1/3/2017        28      0       Snow
3       1/4/2017        0       7       0
4       1/5/2017        32      0       Rain
5       1/6/2017        31      2       Sunny
6       1/6/2017        34      5       0
```

代替一行的数值：

```
new_df = df.replace({
        'temperature': -99999,
        'windspeed': -99999,
        'event': '0'
    }, np.nan)
new_df

# return
        day     temperature     windspeed       event
0       1/1/2017        32.0    6.0     Rain
1       1/2/2017        NaN     7.0     Sunny
2       1/3/2017        28.0    NaN     Snow
3       1/4/2017        NaN     7.0     NaN
4       1/5/2017        32.0    NaN     Rain
5       1/6/2017        31.0    2.0     Sunny
6       1/6/2017        34.0    5.0     NaN
```

用mapping代替：

```
new_df = df.replace({
        -99999: np.nan,
        'no event': 'Sunny',
    })
new_df

# return

day     temperature     windspeed       event
0       1/1/2017        32.0    6.0     Rain
1       1/2/2017        NaN     7.0     Sunny
2       1/3/2017        28.0    NaN     Snow
3       1/4/2017        NaN     7.0     0
4       1/5/2017        32.0    NaN     Rain
5       1/6/2017        31.0    2.0     Sunny
6       1/6/2017        34.0    5.0     0
```

代替整个列表：

```
df = pd.DataFrame({
    'score': ['exceptional','average', 'good', 'poor', 'average', 'exceptional'],
    'student': ['rob', 'maya', 'parthiv', 'tom', 'julian', 'erica']
})
df

# return
        score   student
0       exceptional     rob
1       average maya
2       good    parthiv
3       poor    tom
4       average julian
5       exceptional     erica
```

## split()

练习1：数据科学 with Flask 的例子：

1. split ' '

```
array(['2 BHK', '4 Bedroom', '3 BHK', '4 BHK', '6 Bedroom', '3 Bedroom',
       '1 BHK', '1 RK', '1 Bedroom', '8 Bedroom', '2 Bedroom',
       '7 Bedroom', '5 BHK', '7 BHK', '6 BHK', '5 Bedroom', '11 BHK',
       '9 BHK', '9 Bedroom', '27 BHK', '10 Bedroom', '11 Bedroom',
       '10 BHK', '19 BHK', '16 BHK', '43 Bedroom', '14 BHK', '8 BHK',
       '12 Bedroom', '13 BHK', '18 Bedroom'], dtype=object)

# Add new feature(integer) for bhk (Bedrooms Hall Kitchen)
df3['bhk'] = df3['size'].apply(lambda x: int(x.split(' ')[0])) # 拆解' '，取第一个元素

# return 即为 2, 4....

df3['bhk'].unique()

# return
array([ 2,  4,  3,  6,  1,  8,  7,  5, 11,  9, 27, 10, 19, 16, 43, 14, 12,
       13, 18])
```

2. split ' - '

```
array(['1056', '2600', '1440', ..., '1133 - 1384', '774', '4689'],
      dtype=object)

def is_float(x):
        try:
                float(x)
                return True
        except ValueError:
                return False

df3[df3['total_sqft'].apply(is_float)].head(10) # 没有反应，因为有' - '

def convert_sqft_to_num(x):
        token = x.split('-')
        if len(token) == 2:
                return (float(token[0]) + float(token[1])) / 2
        try:
            return float(x)
        except:
            return np.nan


convert_sqft_to_num('1000-1200') # token[0] = 1000 token[1] = 1200
# return
1100.0
```

# 利用数据的均值、中位数值或众数

mean()、median() 和 mode() 方法计算列的均值（所有值加起来的平均值）、中位数值（排序后排在中间的数）和众数（出现频率最高的数）：

mean()：

```
import pandas as pd

df = pd.read_csv('property-data.csv')

x = df["ST_NUM"].mean()

df["ST_NUM"].fillna(x, inplace = True)

print(df.to_string())
```

median()：

```
import pandas as pd

df = pd.read_csv('property-data.csv')

x = df["ST_NUM"].median()

df["ST_NUM"].fillna(x, inplace = True)

print(df.to_string())
```

mode()：

```
import pandas as pd

df = pd.read_csv('property-data.csv')

x = df["ST_NUM"].mode()

df["ST_NUM"].fillna(x, inplace = True)

print(df.to_string())
```

## 清洗格式错误数据

过包含空单元格的行，或者将列中的所有单元格转换为相同格式的数据

```
import pandas as pd

# 第三个日期格式错误
data = {
  "Date": ['2020/12/01', '2020/12/02' , '20201226'],
  "duration": [50, 40, 45]
}

df = pd.DataFrame(data, index = ["day1", "day2", "day3"])

df['Date'] = pd.to_datetime(df['Date'])

print(df.to_string())

# return
           Date  duration
day1 2020-12-01        50
day2 2020-12-02        40
day3 2020-12-26        45
```

## 清洗错误数据

对错误的数据进行替换或移除：

```
import pandas as pd

person = {
  "name": ['Google', 'Runoob' , 'Taobao'],
  "age": [50, 40, 12345]    # 12345 年龄数据是错误的
}

df = pd.DataFrame(person)

df.loc[2, 'age'] = 30 # 修改数据

print(df.to_string())

# return
     name  age
0  Google   50
1  Runoob   40
2  Taobao   30
```

设置条件语句：

```
import pandas as pd

person = {
  "name": ['Google', 'Runoob' , 'Taobao'],
  "age": [50, 200, 12345]
}

df = pd.DataFrame(person)

for x in df.index:
  if df.loc[x, "age"] > 120:
    df.loc[x, "age"] = 120

print(df.to_string())

# return
     name  age
0  Google   50
1  Runoob  120
2  Taobao  120
```

## 清洗重复数据

如果我们要清洗重复数据，可以使用 duplicated() 和 drop_duplicates() 方法。
如果对应的数据是重复的，duplicated() 会返回 True，否则返回 False。

```
import pandas as pd

person = {
  "name": ['Google', 'Runoob', 'Runoob', 'Taobao'],
  "age": [50, 40, 40, 23]
}
df = pd.DataFrame(person)

print(df.duplicated())

# return
0    False
1    False
2     True
3    False
dtype: bool
```

删除重复数据，可以直接使用drop_duplicates() 方法：

```
import pandas as pd

persons = {
  "name": ['Google', 'Runoob', 'Runoob', 'Taobao'],
  "age": [50, 40, 40, 23]
}

df = pd.DataFrame(persons)

df.drop_duplicates(inplace = True)
print(df)

# return
     name  age
0  Google   50
1  Runoob   40
3  Taobao   23
```

# 数据处理columns 列

## df.columns

返回index：

```
import pandas as pd
weather_data = {
    'day': ['1/1/2017','1/2/2017','1/3/2017','1/4/2017','1/5/2017','1/6/2017'],
    'temperature': [32,35,28,24,32,31],
    'windspeed': [6,7,2,7,4,2],
    'event': ['Rain', 'Sunny', 'Snow','Snow','Rain', 'Sunny']
}
df = pd.DataFrame(weather_data)
df


df.columns

# return
Index(['day', 'temperature', 'windspeed', 'event'], dtype='object')
```

## df[' ']

即为df.day，返回day列的数据，不带dataframe，因为这是一个pandas.core.series.Series

```
df["day"]

# return
0    1/1/2017
1    1/2/2017
2    1/3/2017
3    1/4/2017
4    1/5/2017
5    1/6/2017
Name: day, dtype: object
```

## df[[]]

返回dataframe格式的数据，且有两个数据列或以上，不然单个[]会报错：

```
df[['day','temperature']]

# return
day     temperature
0       1/1/2017        32
1       1/2/2017        35
2       1/3/2017        28
3       1/4/2017        24
4       1/5/2017        32
5       1/6/2017        31
```

## set_index

设置某个column为index：

```
df.set_index('day')
# df.set_index('day', inplace=True)

#return
temperature     windspeed       event
day
1/1/2017        32      6       Rain
1/2/2017        35      7       Sunny
1/3/2017        28      2       Snow
1/4/2017        24      7       Snow
1/5/2017        32      4       Rain
1/6/2017        31      2       Sunny


df.index

# return
Index(['1/1/2017', '1/2/2017', '1/3/2017', '1/4/2017', '1/5/2017', '1/6/2017'], dtype='
```

## reset_index

```
df.reset_index(inplace=True)
df.head()

# return
        day     temperature     windspeed       event
0       1/1/2017        32      6       Rain
1       1/2/2017        35      7       Sunny
2       1/3/2017        28      2       Snow
3       1/4/2017        24      7       Snow
4       1/5/2017        32      4       Rain

df.set_index('event',inplace=True)
df

# return
        day     temperature     windspeed
event
Rain    1/1/2017        32      6
Sunny   1/2/2017        35      7
Snow    1/3/2017        28      2
Snow    1/4/2017        24      7
Rain    1/5/2017        32      4
Sunny   1/6/2017        31      2
```

## loc() by label

Pandas 可以使用 loc 属性返回指定行里面的数据

1. 第一行索引为 0，第二行索引为 1，以此类推：

```
import pandas as pd

data = {
  "calories": [420, 380, 390],
  "duration": [50, 40, 45]
}

# 数据载入到 DataFrame 对象
df = pd.DataFrame(data)

# 返回第一行
print(df.loc[0])
# 返回第二行
print(df.loc[1])

# return
calories    420
duration     50
Name: 0, dtype: int64
calories    380
duration     40
Name: 1, dtype: int64
```

2. 设置索引，即[" "]

```
df = pd.DataFrame(data, index = ["day1", "day2", "day3"])

# 指定索引
print(df.loc["day2"])

# return
calories    380
duration     40
Name: day2, dtype: int64
```

3. 可以返回多行数据，使用 ... 格式，... 为各行的索引，以逗号隔开：

```
# 数据载入到 DataFrame 对象
df = pd.DataFrame(data)

# 返回第一行和第二行
print(df.loc[[0, 1]])

# return
   calories  duration
0       420        50
1       380        40
```

## iloc() by position

与loc一样，第一行索引为 0，第二行索引为 1，以此类推：

```
# 返回第一行
print(df.iloc[0])
# 返回第二行
print(df.iloc[1])

# return
calories    420
duration     50
Name: 0, dtype: int64
calories    380
duration     40
Name: 1, dtype: int64
```

## .columns

练习1：数据科学 with Flask

获取所有数组的index [ ][ ]

```
X.columns
Index(['total_sqft', 'bath', 'bhk', '1st Block Jayanagar',
       '1st Phase JP Nagar', '2nd Phase Judicial Layout',
       '2nd Stage Nagarbhavi', '5th Block Hbr Layout', '5th Phase JP Nagar',
       '6th Phase JP Nagar',
       ...
       'Vijayanagar', 'Vishveshwarya Layout', 'Vishwapriya Layout',
       'Vittasandra', 'Whitefield', 'Yelachenahalli', 'Yelahanka',
       'Yelahanka New Town', 'Yelenahalli', 'Yeshwanthpur'],
      dtype='object', length=244)

np.where(X.columns == '2nd Phase Judicial Layout')[0][0] # index of 2nd Phase Judicial L
# if one [0] only, return array([5])

# return
5
```

# 数据处理rows 行

## head()

> head( n ) 方法用于读取前面的 n 行，如果不填参数 n ，默认返回 5 行。

```
import pandas as pd

df = pd.read_csv('nba.csv')

print(df.head())
```

## tail()

> tail( n ) 方法用于读取尾部的 n 行，如果不填参数 n ，默认返回 5 行，空行各个字段的值返回 NaN。

```
import pandas as pd

df = pd.read_csv('nba.csv')

print(df.tail())
```

## info()

> info() 方法返回表格的一些基本信息

```
import pandas as pd

df = pd.read_csv('nba.csv')

print(df.info())

# return
<class 'pandas.core.frame.DataFrame'>
RangeIndex: 458 entries, 0 to 457          # 行数，458 行，第一行编号为 0
Data columns (total 9 columns):            # 列数，9列
 #   Column    Non-Null Count  Dtype       # 各列的数据类型
---  ------    --------------  -----
 0   Name      457 non-null    object
 1   Team      457 non-null    object
 2   Number    457 non-null    float64
 3   Position  457 non-null    object
 4   Age       457 non-null    float64
 5   Height    457 non-null    object
 6   Weight    457 non-null    float64
 7   College   373 non-null    object         # non-null，意思为非空的数据
 8   Salary    446 non-null    float64
dtypes: float64(4), object(5)                 # 类型
```

# describe()

生成描述的数据：

```
df.describe()

# return
        temperature     windspeed
count   6.000000        6.000000
mean    30.333333       4.666667
std     3.829708        2.338090
min     24.000000       2.000000
25%     28.750000       2.500000
50%     31.500000       5.000000
75%     32.000000       6.750000
max     35.000000       7.000000
```

# feature engineering 特征工程

# replace

```
        score   student
0       exceptional     rob
1       average maya
2       good    parthiv
3       poor    tom
4       average julian
5       exceptional     erica

df.replace(['poor', 'average', 'good', 'exceptional'], [1,2,3,4])

# return
        score   student
0       4       rob
1       2       maya
2       3       parthiv
3       1       tom
4       2       julian
5       4       erica
```

# mapping

map是针对单列，apply是针对多列/一列也可，applymap是针对全部元素

```
import numpy as np
import  pandas as pd
boolean=[True,False]
gender=["male","female"]
color=["white","black","yellow"]
data=pd.DataFrame({
    "height":np.random.randint(150,190,100),
    "weight":np.random.randint(40,90,100),
    "smoker":[boolean[x] for x in np.random.randint(0,2,100)],
    "gender":[gender[x] for x in np.random.randint(0,2,100)],
    "age":np.random.randint(15,90,100),
    "color":[color[x] for x in np.random.randint(0,len(color),100) ]
}
)
data

# return
        height  weight  smoker  gender  age     color
0       188     43      True    male    65      black
1       177     82      False   male    39      white
2       186     86      False   male    30      white
3       159     79      False   female  80      black
4       175     80      True    female  88      black
...     ...     ...     ...     ...     ...     ...
95      170     48      True    male    21      yellow
96      187     79      True    male    64      black
97      170     61      True    male    39      black
98      172     63      True    female  69      black
99      169     48      True    female  60      white
)



data["gender"] = data["gender"].map({"male":1, "female":0})
data.head(10)

# return

height  weight  smoker  gender  age     color
0       187     85      True    1       17      white
1       186     88      False   0       31      black
2       170     82      True    1       55      white
3       178     72      True    0       34      white
4       158     65      False   1       24      yellow
5       155     69      False   0       48      yellow
6       154     51      False   0       76      yellow
7       162     86      False   0       75      white
8       157     44      False   1       15      white
9       159     54      True    0       46      white
```

Another example:

```
        Survived        Pclass  Sex     Age     Fare
0       0       3       male    22.0    7.2500
1       1       1       female  38.0    71.2833
2       1       3       female  26.0    7.9250
3       1       1       female  35.0    53.1000
4       0       3       male    35.0    8.0500

df.Sex = df.Sex.map({'female':1, 'male':0})
df.Sex

0      0
1      1
2      1
3      1
4      0
      ..
886    0
887    1
888    1
889    0
890    0
Name: Sex, Length: 891, dtype: int64

# return
        Survived        Pclass  Sex     Age     Fare
0       0       3       0       22.000000       7.2500
1       1       1       1       38.000000       71.2833
2       1       3       1       26.000000       7.9250
3       1       1       1       35.000000       53.1000
4       0       3       0       35.000000       8.0500
...     ...     ...     ...     ...     ...
886     0       2       0       27.000000       13.0000
887     1       1       1       19.000000       30.0000
888     0       3       1       29.699118       23.4500
889     1       1       0       26.000000       30.0000
890     0       3       0       32.000000       7.7500
```

## apply

apply方法的作用原理和map方法类似，区别在于apply能够传入功能更为复杂的函数：

可以看到age列都减了3

```
def apply_age(x,bias):
    return x+bias
#以元组的方式传入额外的参数
data["age"] = data["age"].apply(apply_age,args=(-3,))
data

# return

height  weight  smoker  gender  age     color
0       162     61      True    1       58      white
1       177     89      True    1       17      black
2       168     88      False   1       79      white
3       152     74      True    1       68      yellow
4       170     66      False   1       70      black
...     ...     ...     ...     ...     ...     ...
95      163     63      False   1       59      white
96      177     42      False   0       18      white
97      168     65      True    0       74      white
98      169     78      False   0       16      white
99      189     54      False   1       44      white
```

练习1：数据科学 with Flask 的例子：

1. 全部split' '，获取第一个element

```
array(['2 BHK', '4 Bedroom', '3 BHK', '4 BHK', '6 Bedroom', '3 Bedroom',
       '1 BHK', '1 RK', '1 Bedroom', '8 Bedroom', '2 Bedroom',
       '7 Bedroom', '5 BHK', '7 BHK', '6 BHK', '5 Bedroom', '11 BHK',
       '9 BHK', '9 Bedroom', '27 BHK', '10 Bedroom', '11 Bedroom',
       '10 BHK', '19 BHK', '16 BHK', '43 Bedroom', '14 BHK', '8 BHK',
       '12 Bedroom', '13 BHK', '18 Bedroom'], dtype=object)

# Add new feature(integer) for bhk (Bedrooms Hall Kitchen)
df3['bhk'] = df3['size'].apply(lambda x: int(x.split(' ')[0])) # 拆解' '，取第一个元素

# return 即为 2, 4....
```

2. 变浮数点

```
df3[df3['total_sqft'].apply(is_float)].head(10)


df4 = df3.copy()
df4['total_sqft'] = df4['total_sqft'].apply(convert_sqft_to_num)
df4.head()

# return

location        size    total_sqft      bath    price   bhk
0       Electronic City Phase II        2 BHK   1056.0  2.0     39.07   2
1       Chikka Tirupathi        4 Bedroom       2600.0  5.0     120.00  4
2       Uttarahalli     3 BHK   1440.0  2.0     62.00   3
3       Lingadheeranahalli      3 BHK   1521.0  3.0     95.00   3
4       Kothanur        2 BHK   1200.0  2.0     51.00   2
```

## applymap

applymap会对DataFrame中的每个单元格执行指定函数的操作

```
df = pd.DataFrame(
    {
        "A":np.random.randn(5),
        "B":np.random.randn(5),
        "C":np.random.randn(5),
        "D":np.random.randn(5),
        "E":np.random.randn(5),
    }
)
df

df.applymap(lambda x:"%.2f" % x)

# return
A       B       C       D       E
0       -0.70   -1.04   -0.14   -0.57   0.58
1       -0.43   0.55    0.06    -1.61   -0.57
2       -0.96   0.43    0.19    0.63    0.03
3       0.45    -0.28   0.95    -0.72   -1.35
4       -0.65   0.86    -1.60   -1.28   -0.07
```

## get_dummies 1010

Using get_dummies while using pandas to convert categorical variable into dummy/indicator variables.

For example, if there is female and male columns, and using get_dummies will generate two new

columns for them. Usually it is used when there is a need to drop one of the column for prediction, like Naive Bayes.

```
data_df = pd.get_dummies(data.gender)
data_df.head(10)
merged = pd.concat([data, data_df], axis = 1) # left, right, columns
merged

# return
```

| | height | weight | smoker | gender | age | color | female | male |
|---|---|---|---|---|---|---|---|---|
| 0 | 155 | 74 | True | female | 28 | white | 1 | 0 |
| 1 | 173 | 75 | True | male | 47 | yellow | 0 | 1 |
| 2 | 172 | 61 | True | female | 51 | yellow | 1 | 0 |
| 3 | 171 | 88 | True | male | 67 | yellow | 0 | 1 |
| 4 | 163 | 40 | False | male | 15 | white | 0 | 1 |
| ... | ... | ... | ... | ... | ... | ... | ... | ... |
| 95 | 177 | 70 | False | male | 88 | white | 0 | 1 |
| 96 | 172 | 52 | False | male | 79 | black | 0 | 1 |
| 97 | 158 | 77 | True | male | 82 | yellow | 0 | 1 |
| 98 | 159 | 55 | False | male | 57 | yellow | 0 | 1 |
| 99 | 182 | 74 | False | female | 53 | white | 1 | 0 |

## LabelEncoder 1010 and OneHotEnoder

Label Encoder is for 10101010

while Onecoder is for the array ([1,0,1,0...0,1,0,1])

```
from sklearn.preprocessing import LabelEncoder, OneHotEncoder
labelencoder_X = LabelEncoder()
X[ : , 0] = labelencoder_X.fit_transform(X[ : , 0])

# onehotencoder = OneHotEncoder(categorical_features = [0])
# X = onehotencoder.fit_transform(X).toarray()
# labelencoder_Y = LabelEncoder()
# Y =  labelencoder_Y.fit_transform(Y)

# onehotencoder = OneHotEncoder(categorical_features = [0])
onehotencoder = OneHotEncoder()
X = onehotencoder.fit_transform(X).toarray()

labelencoder_Y = LabelEncoder()
Y =  labelencoder_Y.fit_transform(y)
```

## split()

移除字符串头尾指定的字符

```
df5.location

# return
0        Electronic City Phase II
1                Chikka Tirupathi
2                     Uttarahalli
3              Lingadheeranahalli
4                        Kothanur
                   ...
13315                   Whitefield
13316                Richards Town
13317       Raja Rajeshwari Nagar
13318              Padmanabhanagar
13319                 Doddathoguru
Name: location, Length: 13246, dtype: object

# Examine locations which is a categorical variable. We need to apply dimensionality red
df5.location = df5.location.apply(lambda x: x.strip()) # strip()用于移除字符串头尾指定的字符

location_stats = df5.groupby('location')['location'].count()  # how many types does it h
location_stats

# return
location
1 Annasandrapalya                                    1
1 Giri Nagar                                         1
1 Immadihalli                                        1
1 Ramamurthy Nagar                                   1
12th cross srinivas nagar banshankari 3rd stage      1
                                                   ..
t.c palya                                            1
tc.palya                                             4
vinayakanagar                                        1
white field,kadugodi                                 1
whitefiled                                           1
Name: location, Length: 1293, dtype: int64
```

## operator: ~

The bitwise operator ~ (tilde) is a complement operator. So ~i on an integer value i is ~i=-i-1

```
df6 = df5[~(df5.total_sqft/df5.bhk<300)]
# negate on the criteria if you want to filter the rows
df6.shape


'''
In[1]：s = pd.Series(range(-3, 4))
Out[1]: s
0   -3
1   -2
2   -1
3    0
4    1
5    2
6    3

In[2]:s[~(s < 0)] -> -(s < 0)-1 -> s > -1
Out[2]:
3    0
4    1
5    2
6    3
dtype: int64
'''
```

# Groupby

筛选某个组别名：

```
g.get_group('mumbai')

# return
day     city    temperature     windspeed       event
4       1/1/2017        mumbai  90      5       Sunny
5       1/2/2017        mumbai  85      12      Fog
6       1/3/2017        mumbai  87      15      Fog
7       1/4/2017        mumbai  92      5       Rain
```

自定义组别：

```
def grouper(df, idx, col):
    if 80 <= df[col].loc[idx] <= 90:
        return '80-90'
    elif 50 <= df[col].loc[idx] <= 60:
        return '50-60'
    else:
        return 'others'

g = df.groupby(lambda x: grouper(df, x, 'temperature'))
g

for key, d in g:
    print("Group by Key: {}\n".format(key))
    print(d)

# return
Group by Key: 50-60

         day   city  temperature  windspeed   event
9   1/2/2017  paris           50         13  Cloudy
10  1/3/2017  paris           54          8  Cloudy
Group by Key: 80-90

        day    city  temperature  windspeed  event
4  1/1/2017  mumbai           90          5  Sunny
5  1/2/2017  mumbai           85         12    Fog
6  1/3/2017  mumbai           87         15    Fog
Group by Key: others

         day      city  temperature  windspeed   event
0   1/1/2017  new york           32          6    Rain
1   1/2/2017  new york           36          7   Sunny
2   1/3/2017  new york           28         12    Snow
3   1/4/2017  new york           33          7   Sunny
7   1/4/2017    mumbai           92          5    Rain
8   1/1/2017     paris           45         20   Sunny
11  1/4/2017     paris           42         10  Cloudy
```

# Concatenation 串联

```
import pandas as pd

india_weather = pd.DataFrame({
    "city": ["mumbai","delhi","banglore"],
    "temperature": [32,45,30],
    "humidity": [80, 60, 78]
})
india_weather

# return
        city    temperature     humidity
0       mumbai  32      80
1       delhi   45      60
2       banglore        30      78

us_weather = pd.DataFrame({
    "city": ["new york","chicago","orlando"],
    "temperature": [21,14,35],
    "humidity": [68, 65, 75]
})
us_weather

# return
city    temperature     humidity
0       new york        21      68
1       chicago 14      65
2       orlando 35      75


df = pd.concat([india_weather, us_weather], ignore_index=True) # it ignores that origina
df

city    temperature     humidity
0       mumbai  32      80
1       delhi   45      60
2       banglore        30      78
3       new york        21      68
4       chicago 14      65
5       orlando 35      75
```

## Concatenation And Keys

```
df = pd.concat([india_weather, us_weather], keys=["india", "us"])
df

# return
city    temperature     humidity
india
0       mumbai  32      80
1       delhi   45      60
2       banglore 30     78
us
0       new york 21     68
1       chicago 14      65
2       orlando 35      75
```

## Concatenation Using Index

```
temperature_df = pd.DataFrame({
    "city": ["mumbai","delhi","banglore"],
    "temperature": [32,45,30],
}, index=[0,1,2])
temperature_df

# return
city    temperature
0       mumbai  32
1       delhi   45
2       banglore        30

windspeed_df = pd.DataFrame({
    "city": ["delhi","mumbai"],
    "windspeed": [7,12],
}, index=[1,0])
windspeed_df

# return
        city    windspeed
1       delhi   7
0       mumbai  12


df = pd.concat([temperature_df,windspeed_df],axis=1)
df

# return
        city    temperature     city    windspeed
0       mumbai   32             mumbai  12.0
1       delhi    45              delhi  7.0
2       banglore 30              NaN    NaN
```

## Concatenate dataframe with series

```
s = pd.Series(["Humid","Dry","Rain"], name="event")
s

# return
0    Humid
1      Dry
2     Rain
Name: event, dtype: object

df = pd.concat([temperature_df,s],axis=1)
df

# return

city temperature event
0       mumbai  32      Humid
1       delhi   45      Dry
2       banglore 30     Rain
```

# Merge Using a Dataframe Column 使用数据框架列进行合并

根据columns 行合并，on="city"：

```
import pandas as pd
df1 = pd.DataFrame({
    "city": ["new york","chicago","orlando"],
    "temperature": [21,14,35],
})
df1

# return
city    temperature
0       new york        21
1       chicago 14
2       orlando 35


df2 = pd.DataFrame({
    "city": ["chicago","new york","orlando"],
    "humidity": [65,68,75],
})
df2

# return
        city    humidity
0       chicago 65
1       new york        68
2       orlando 75

df3 = pd.merge(df1, df2, on="city")
df3

# return
city    temperature     humidity
0       new york        21      68
1       chicago 14      65
2       orlando 35      75
```

# Joins

```
df1 = pd.DataFrame({
    "city": ["new york","chicago","orlando", "baltimore"],
    "temperature": [21,14,35, 38],
})
df1

df2 = pd.DataFrame({
    "city": ["chicago","new york","san diego"],
    "humidity": [65,68,71],
})
df2
```

## inner

```
df3=pd.merge(df1,df2,on="city",how="inner") #df1 left df2 right
df3

# return
        city    temperature     humidity
0       new york        21      68
1       chicago 14      65
```

## outer

```
df3=pd.merge(df1,df2,on="city",how="outer")
df3

# return
city    temperature     humidity
0       new york        21.0    68.0
1       chicago 14.0    65.0
2       orlando 35.0    NaN
3       baltimore       38.0    NaN
4       san diego       NaN     71.0
```

## left

```
df3=pd.merge(df1,df2,on="city",how="left")
df3

# return

city    temperature     humidity
0       new york        21      68.0
1       chicago 14      65.0
2       orlando 35      NaN
3       baltimore       38      NaN
```

## right

```
df3=pd.merge(df1,df2,on="city",how="right")
df3

# return
city    temperature     humidity
0       new york        21.0    68
1       chicago 14.0    65
2       san diego       NaN     71
```

## indicator flags

```
df3=pd.merge(df1,df2,on="city",how="outer",indicator=True)
df3

# return

city    temperature     humidity        _merge
0       new york        21.0 68.0       both
1       chicago   14.0  65.0    both
2       orlando   35.0   NaN    left_only
3       baltimore       38.0 NaN        left_only
4       san diego       NaN     71.0    right_only
```

## suffix

前缀名字：

```
df3= pd.merge(df1,df2,on="city",how="outer", suffixes=('_first','_second'))
df3

# return
city    humidity_first  temperature_first       humidity_second temperature_second
0       new york        65.0    21.0    68.0    14.0
1       chicago 68.0    14.0    65.0    21.0
2       orlando 71.0    35.0    NaN     NaN
3       baltimore       75.0    38.0    NaN     NaN
4       san diego       NaN     NaN     71.0    35.0
```

# Pivot Table 改造和重塑

```
df.pivot(index='city',columns='date')

# return
temperature     humidity
date    5/1/2017        5/2/2017        5/3/2017        5/1/2017        5/2/2017
city
beijing 80      77      79      26      30      35
mumbai  75      78      82      80      83      85
new york        65      66      68      56      58      60
```

只获取某个数值，但是保留框架：

```
df.pivot(index='city',columns='date',values="humidity") # only get value humidity

# return

date    5/1/2017        5/2/2017        5/3/2017
city
beijing 26      30      35
mumbai  80      83      85
new york        56      58      60
```

# Melt

syntax：

```
pandas.melt(frame, id_vars=None, value_vars=None, var_name=None, value_name='value', co
```

```
import pandas as pd
df = pd.read_csv("weather.csv")
df

# return
day     chicago chennai berlin
0       Monday  32      75      41
1       Tuesday 30      77      43
2       Wednesday       28      75      45
3       Thursday        22      82      38
4       Friday  30      83      30
5       Saturday        20      81      45
6       Sunday  25      77      47


df1=pd.melt(df, id_vars=["day"]) # Column(s) to use as identifier variables
df1

# return
day     variable        value
0       Monday  chicago 32
1       Tuesday chicago 30
2       Wednesday       chicago 28
3       Thursday        chicago 22
...
8       Tuesday chennai 77
9       Wednesday       chennai 75
10      Thursday        chennai 82
11      Friday  chennai 83
12      Saturday        chennai 81
...
17      Thursday        berlin  38
18      Friday  berlin  30
19      Saturday        berlin  45
20      Sunday  berlin  47
```

```
melted = pd.melt(df, id_vars=["day"], var_name='city', value_name='temperature')
# Column(s) to unpivot. If not specified, uses all columns that are not set as id_vars
# Name to use for the ‘value’ column.
melted

# return
        day     city    temperature
0       Monday  chicago 32
1       Tuesday chicago 30
...
6       Sunday  chicago 25
7       Monday  chennai 75
8       Tuesday chennai 77
9       Wednesday       chennai 75
...
15      Tuesday berlin  43
16      Wednesday       berlin  45
17      Thursday        berlin  38
18      Friday  berlin  30
```

# stack

# crosstab

```
        Name    Nationality     Sex     Age     Handedness
0       Kathy   USA     Female  23      Right
1       Linda   USA     Female  18      Right
2       Peter   USA     Male    19      Right
3       John    USA     Male    22      Left
4       Fatima  Bangadesh       Female  31      Left
5       Kadir   Bangadesh       Male    25      Left
6       Dhaval  India   Male    35      Left
7       Sudhir  India   Male    31      Left
8       Parvir  India   Male    37      Right
9       Yan     China   Female  52      Right
10      Juan    China   Female  58      Left
11      Liang   China   Male    43      Left
```

```
pd.crosstab(df.Nationality,df.Handedness)

# return
Handedness      Left    Right
Nationality
Bangadesh       2       0
China   2       1
India   2       1
USA     1       3

pd.crosstab(df.Sex,df.Handedness)

# return
Handedness      Left    Right
Sex
Female  2       3
Male    5       2
```

## margins

返回all：

```
pd.crosstab(df.Sex,df.Handedness, margins=True) # all

# return

Handedness      Left    Right   All
Sex
Female  2       3       5
Male    5       2       7
All     7       5       12
```

## multi index columns and rows

```
pd.crosstab(df.Sex, [df.Handedness,df.Nationality], margins=True)

# return
Handedness      Left    Right   All
Nationality     Bangadesh       China   India   USA     China   India   USA
Sex
Female  1       1       0       0       1       0       2       5
Male    1       1       2       1       0       1       1       7
All     2       2       2       1       1       1       3       12


pd.crosstab([df.Nationality, df.Sex], [df.Handedness], margins=True)

# return
        Handedness      Left    Right   All
Nationality     Sex
Bangadesh       Female  1       0       1
Male    1       0       1
China   Female  1       1       2
Male    1       0       1
India   Male    2       1       3
USA     Female  0       2       2
Male    1       1       2
All             7       5       12
```

## normalize

列出百分比：

```
pd.crosstab(df.Sex, df.Handedness, normalize='index') # percentage

# return

Handedness      Left    Right
Sex
Female  0.400000        0.600000
Male    0.714286        0.285714
```

## aggfunc and values

```
import numpy as np
pd.crosstab(df.Sex, df.Handedness, values=df.Age, aggfunc=np.average)
'''
values : array-like, optional
        Array of values to aggregate according to the factors.
        Requires `aggfunc` be specified.
aggfunc : function, optional
        If specified, requires  `values` be specified as well.
'''
# return
Handedness      Left    Right
Sex
Female  44.5    31.0
Male    31.2    28.0
```

# 数据操作

## 内置函数 max(), min(), std()

查找某个数值：

```
import pandas as pd
weather_data = {
    'day': ['1/1/2017','1/2/2017','1/3/2017','1/4/2017','1/5/2017','1/6/2017'],
    'temperature': [32,35,28,24,32,31],
    'windspeed': [6,7,2,7,4,2],
    'event': ['Rain', 'Sunny', 'Snow','Snow','Rain', 'Sunny']
}
df = pd.DataFrame(weather_data)
df

df['temperature'].max()
# return
35


df['temperature'].std()

# return
3.8297084310253524
```

查找某个数值对应的index：

```
df['day'][df['temperature'] == df['temperature'].max()]

# return
1    1/2/2017
Name: day, dtype: object
```

查找某个数值对应的dataframe：

```
df[df['temperature'] == df['temperature'].max()]

# return
day     temperature     windspeed       event
1       1/2/2017        35      7       Sunny
```

## 操作符 > < =

```
df[df['temperature']>32] # df[df.temperature>32]

# return
        day     temperature     windspeed       event
1       1/2/2017        35      7       Sunny
```

## Summary

1. import data
2. check outliner/ null value
3. preprocessing/ feature engineering
4. split data
5. model
6. hyperparameter
7. AOC/ ROC score
8. Data visualization

# Reference

Runoob: Matplotlib
Runoob: NumPy
Runoob: Pandas

Matplotlib.org
Numpy.org
Pandas.pydata.org

Pandas教程 | 数据处理三板斧——map、apply、applymap详解