

程式設計概論

Programming 101

—matplotlib module

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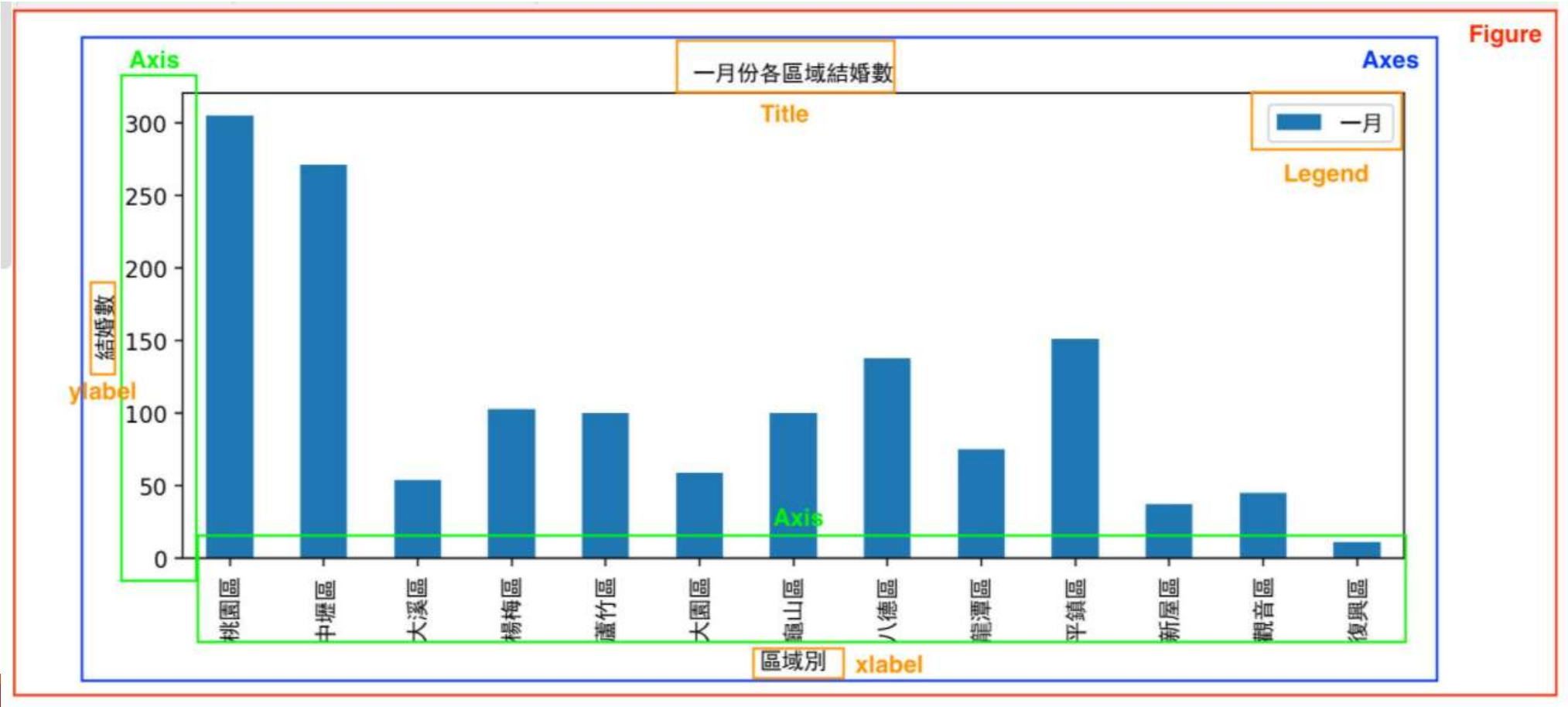
Matplotlib

- Matplotlib (<https://matplotlib.org/>): it is similar to Matlab about drawing functions
- pyplot is the most popular submodule in Matplotlib module
- Matplotlib figure
- Workflow

Drawing functions

- line plot(折線圖): `plt.plot(x,y)`
- bar plot(長條圖): `plt.bar(x,y)`
- pie chart(圓形圖): `plt.pie(hours...)`
- histogram(直方圖): `plt.hist(scores, bins, ...)`
- scatter plot(散佈圖): `plt.scatter(x,y)`
- boxplot(箱形圖): `dataframe.boxplot()`

Figure



Workflow

Create a figure:

1. Step1: Prepare data
2. Step2: Create plot
3. Step3: Plot
4. Step4: Customize plot
5. Step5: Save plot
6. Step6: Show plot

Workflow

line plot

1. Step1: Prepare Data
2. Step2: Create Plot
3. Step3: Plot
4. Step4: Customize Plot
5. Step5: Save Plot
6. Step6: Show Plot



```
import matplotlib.pyplot as plt
x = [1, 2, 3, 4, 5] # Step 1
y = [5, 10, 20, 35, 45] # Step 1
plt.figure(figsize=(4,6)) # Step 2
plt.plot(x, y, color='blue', linewidth=2, marker='o') # Step 3
plt.xlabel("x value") # Step 4
plt.savefig('wk1.png') # Step 5
plt.show() # Step 6
```

line plot

```
import matplotlib.pyplot as plt
```

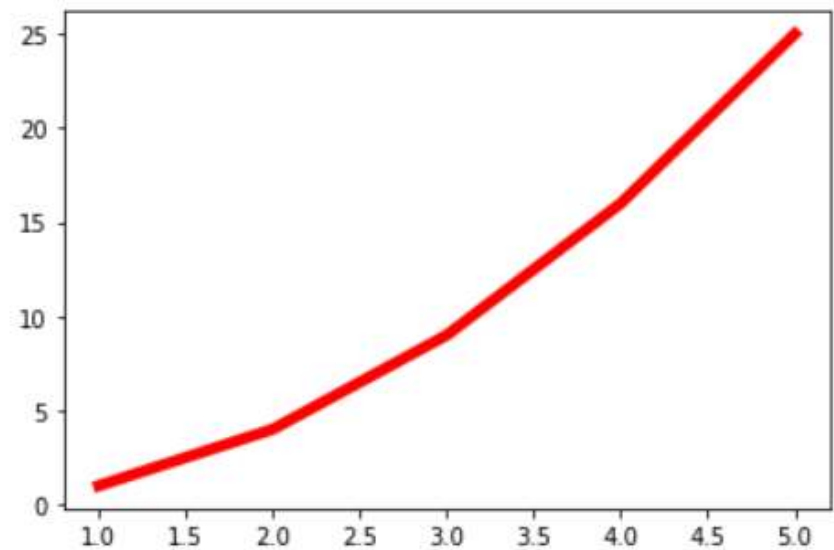
```
x=[1,2,3,4,5]
```

```
y=[1,4,9,16,25]
```

```
plt.plot(x,y, color="red",linewidth=5.0)
```

```
plt.show()
```

```
▶ plt.plot(x,y, color="red", linewidth=5.0)  
plt.show()
```

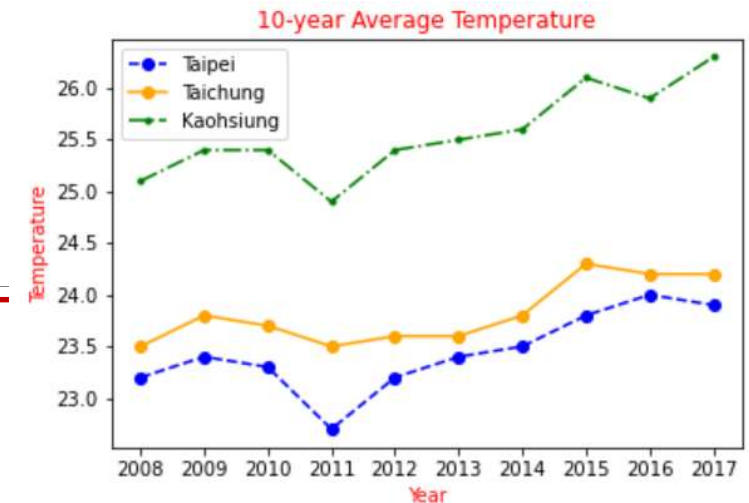


Multiple lines

```
import matplotlib.pyplot as plt
Taipei_HTemp = [16.1, 16.5, 18.5, 21.9, 25.2, 27.7, 29.6, 29.2, 27.4, 24.5, 21.5, 17.9]
Taipei_LTemp = [13.9, 14.2, 15.8, 19.0, 22.3, 24.6, 26.3, 26.1, 24.8, 22.3, 19.3, 15.6]
month = list(range(1, 13))
plt.plot(month, Taipei_HTemp, 'red')
# 讀出month及Taipei_HTemp的資料，產生紅色線
plt.plot(month, Taipei_LTemp, 'blue')
# 讀出month及Taipei_LTemp的資料，產生藍色線
plt.xlabel('Month') # x軸的Label
plt.title('Taipei High and Low Temperature') # 此圖的title
plt.show()
```

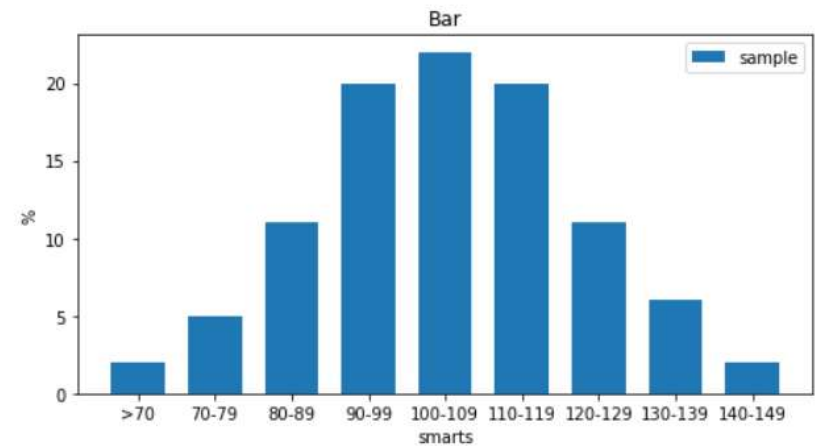
Add legend and save graph

```
from matplotlib import pyplot as plt
Taipei_temp = [23.2, 23.4, 23.3, 22.7, 23.2, 23.4, 23.5, 23.8, 24, 23.9]
Taichung_temp = [23.5, 23.8, 23.7, 23.5, 23.6, 23.6, 23.8, 24.3, 24.2, 24.2]
Kaohsiung_temp = [25.1, 25.4, 25.4, 24.9, 25.4, 25.5, 25.6, 26.1, 25.9, 26.3]
year = range(2008, 2018)
plt.plot(year, Taipei_temp, color = 'blue', marker='o', linestyle = '--', label='Taipei')
plt.plot(year, Taichung_temp, color = 'orange', marker='o', linestyle = '-', label='Taichung')
plt.plot(year, Kaohsiung_temp, color = 'green', marker='.', linestyle = '-.', label='Kaohsiung')
plt.legend(loc = 'upper left')
plt.xlabel('Year', color = 'red')
plt.ylabel('Temperature', color = 'red')
plt.title('10-year Average Temperature', color = 'red')
plt.xticks([2008, 2009, 2010, 2011, 2012, 2013, 2014, 2015, 2016, 2017])
plt.savefig('wn2.png')
plt.show()
```



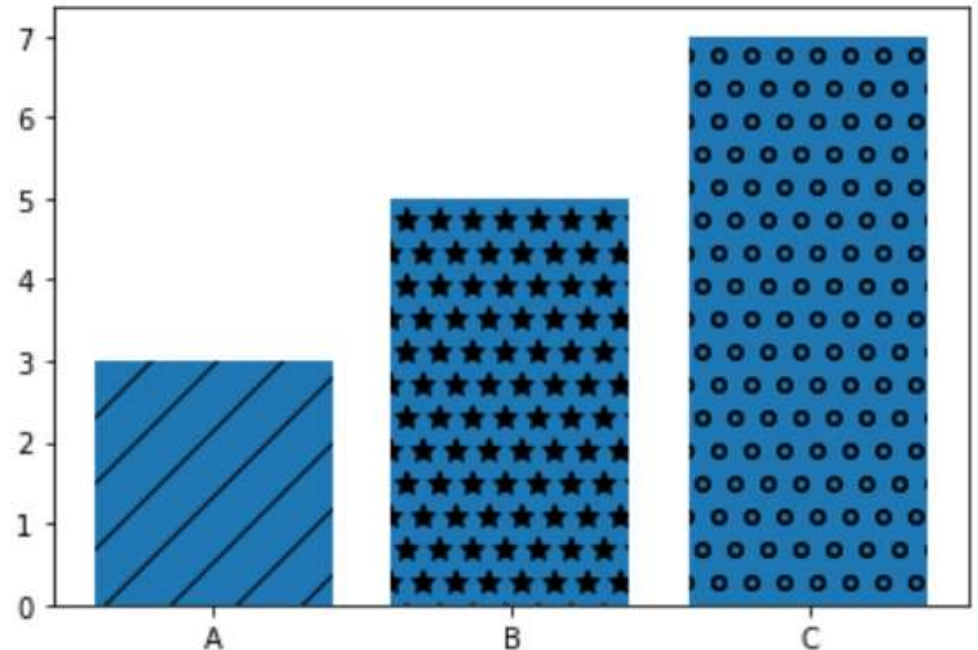
Bar plot

```
import matplotlib.pyplot as plt
x=[70,80,90,100,110,120,130,140,150]
y=[2,5,11,20,22,20,11,6,2]
tit=['>70','70-79','80-89','90-99','100-109','110-119','120-129','130-139','140-149']
plt.figure(figsize=(8,4)) #8 inch, 4 inch
plt.bar(x,y, width=7, tick_label=tit,label='sample')
plt.legend() # 放置圖例
plt.xlabel('smarts')
plt.ylabel('%') # set label of y asix
plt.title('Bar') # set title
plt.show()
```



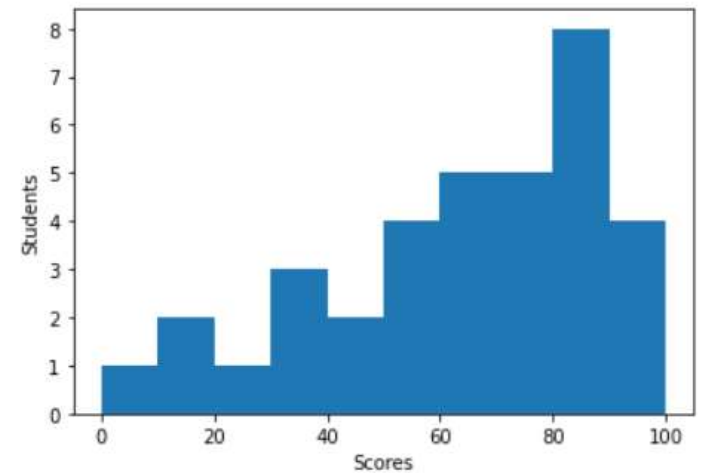
Bar plot: change pattern

```
x1=['A','B','C']  
y1=[3,5,7]  
bar1 = plt.bar(x1,y1)  
patterns=['/','*','o']  
for bar in bar1:  
    bar.set_hatch(patterns.pop(0))  
#bar1[0].set_hatch('/')  
#bar1[1].set_hatch('*')  
plt.show()
```



Histogram

```
import matplotlib.pyplot as plt
scores = [10, 15, 80, 22, 93, 55, 88, 62, 45, 75, 81, 34, 99, 84, 85, 55,
58, 63, 68, 82, 84, \
77, 69, 90, 100, 75, 65, 54, 34, 38, 48, 88, 71, 72, 5]
bins = [0, 10, 20, 30, 40, 50, 60, 70, 80, 90, 100]
plt.hist(scores, bins, histtype = "bar")
plt.xlabel("Scores")
plt.ylabel("Students")
plt.show()
```



Pie chart



```
import matplotlib.pyplot as plt
```

```
activities = ["work", "sleep", "Internet", "others"]
```

```
hours = [8, 7, 2, 7]
```

```
colors = ["lightgreen", "lightblue", "yellow", "pink"]
```

```
plt.pie(hours, labels = activities, colors = colors, shadow = True, explode = (0, 0, 0.1, 0),  
autopct = "%.1f%%") # 將數值百分比並留到小數點一位; 設定分隔的區塊位置
```

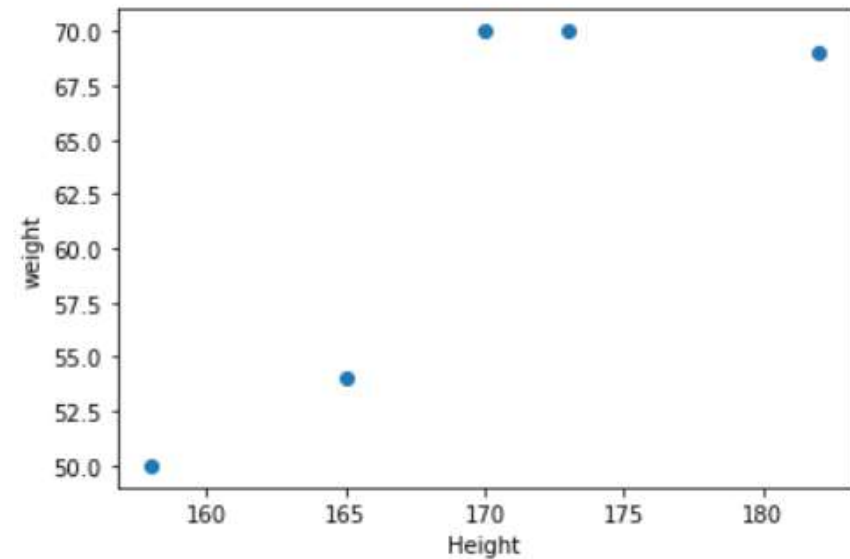
```
plt.axis("equal") # 使圓餅圖比例相等
```

```
plt.title("Pie chart", {"fontsize" : 18})
```

```
plt.show()
```

scatter plot

```
x=[170,165,158,182,173]  
y=[70,54,50,69,70]  
plt.scatter(x,y)  
plt.xlabel("Height")  
plt.ylabel("weight")  
plt.show()
```



Method 2:
use drawing functions in dataframe

Create DataFrame

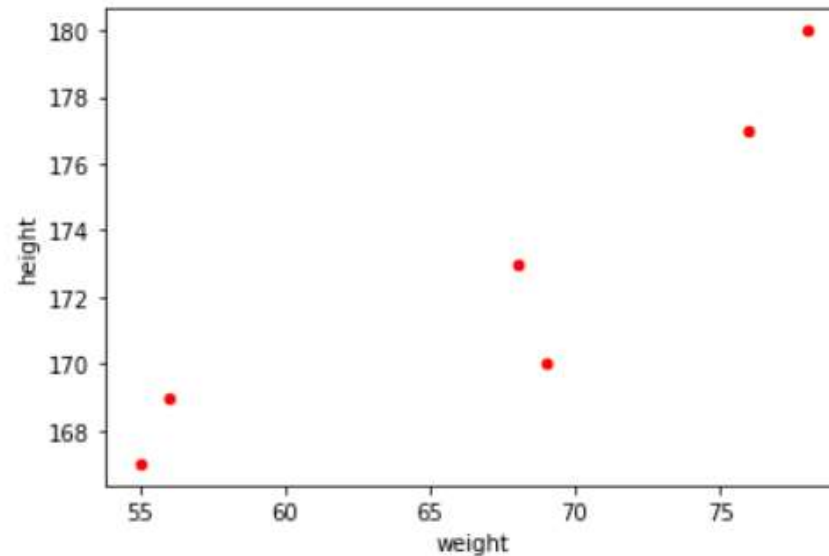
```
import matplotlib.pyplot as plt  
import pandas as pd
```

```
per_df = pd.DataFrame() # 產生一個空的dataframe  
col = ['class','name','Birthdate','salary','height','weight']  
data = [['class0', 'John', '1993-10-01',36000, 177, 76], ['class0', 'Bob', '1992-10-02',52000, 173, 68], ['class1', 'Helen', '1990-10-01',43000, 167, 55], ['class2', 'Alice', '1983-10-03', 27000, 169, 56], ['class1', 'Justin', '1991-10-02',22000, 180, 78], ['class0', 'David', '2001-10-03', 15000, 170, 69]]  
per_df = pd.DataFrame(data,columns=col, index=['1','2','3','4','5','6'])  
print(per_df)
```

Scatter plot

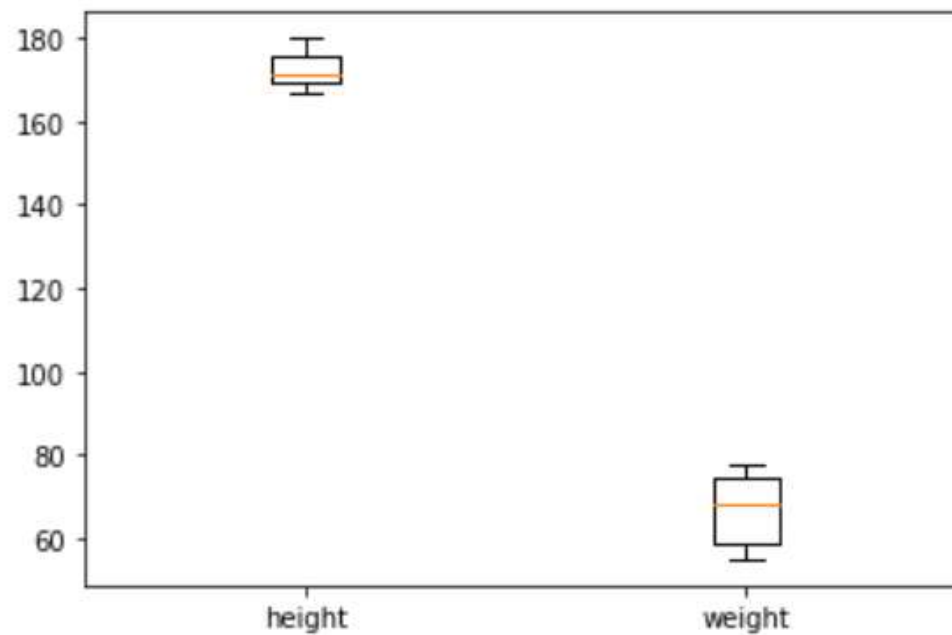
```
per_df.plot(kind='scatter',x='weight',y='height',color='red')  
plt.show()
```

```
per_df.plot(kind='scatter',x='weight',y='height',color='red')  
plt.show()
```



Boxplot

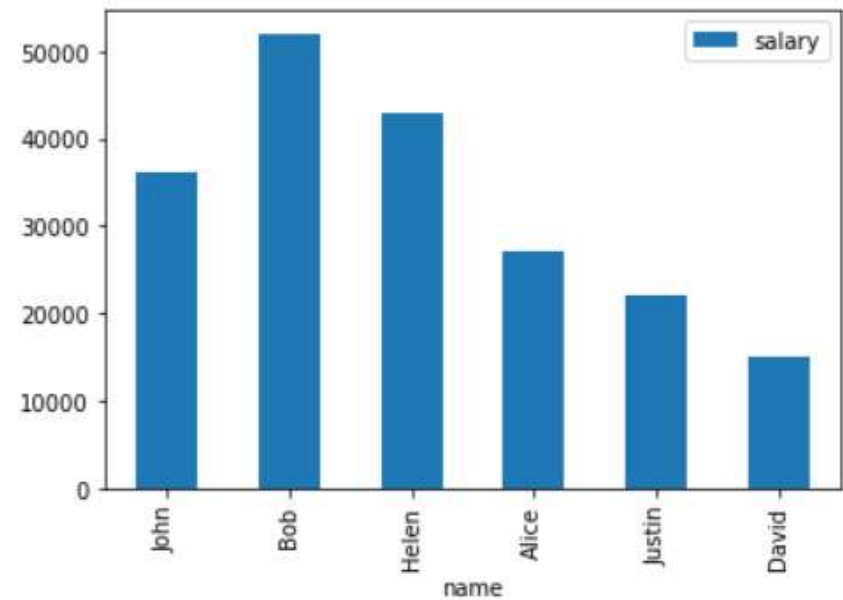
```
plt.boxplot([per_df.height,per_df.weight],labels=['height ','weight'])
```



Bar plot

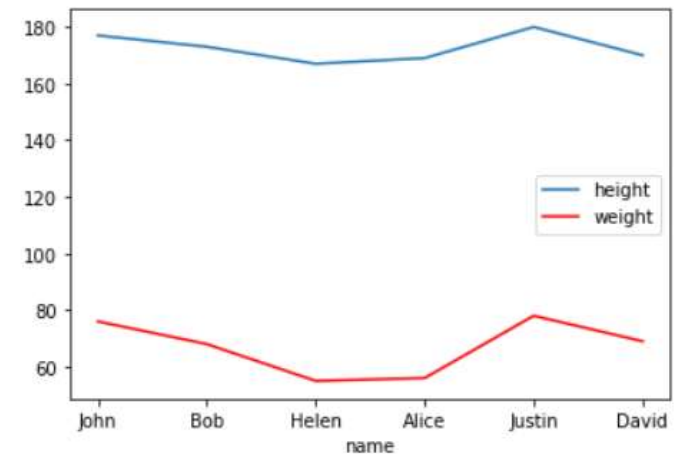
a simple line plot

```
per_df.plot(kind='bar',x='name',y='salary')
```



Line plot, multiple columns

```
# gca stands for 'get current axis'  
ax = plt.gca()  
per_df.plot(kind='line',x='name',y='height',ax=ax)  
per_df.plot(kind='line',x='name',y='weight', color='red', ax=ax)  
plt.show()
```



Save plot to file

```
plt.savefig('outputfile.png')
```

```
per_df.plot(kind='bar',x='name',y='height')  
# the plot gets saved to 'output.png'  
plt.savefig('output.png')  
plt.show()
```

Multiple figures

```
names = ['group_a', 'group_b', 'group_c']  
values = [1, 10, 100]
```

```
plt.figure(figsize=(9, 3))
```

```
plt.subplot(131)
```

```
plt.bar(names, values)
```

```
plt.subplot(132)
```

```
plt.scatter(names, values)
```

```
plt.subplot(133)
```

```
plt.plot(names, values)
```

```
plt.suptitle('Categorical Plotting')
```

```
plt.show()
```

Some functions

X軸上加入自訂標籤

```
x = [1, 2, 3, 4]
```

```
y = [95, 38, 54, 35]
```

```
labels = ['Geeks1', 'Geeks2', 'Geeks3', 'Geeks4']
```

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

```
plt.xticks(x, labels, rotation='vertical')
```

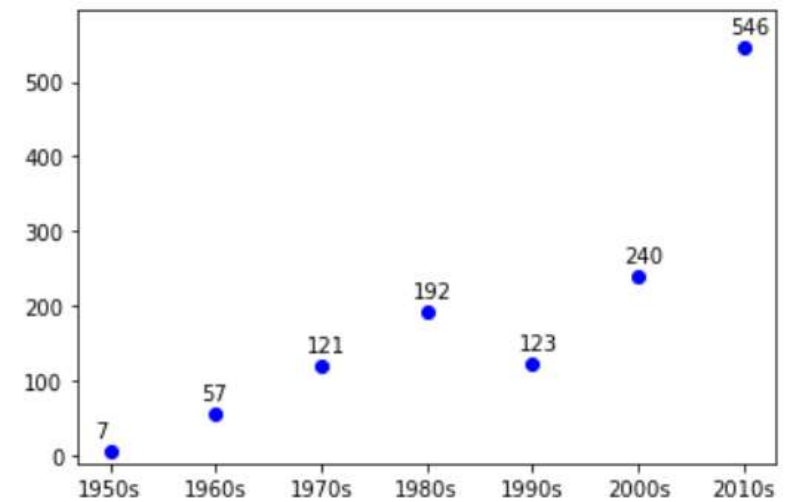
```
plt.show()
```

圖上顯示數值

```
fig = plt.figure()
ax = fig.add_subplot(111)
values = [7, 57, 121, 192, 123, 240, 546]
labels = ['1950s', '1960s', '1970s', '1980s', '1990s', '2000s', '2010s']
```

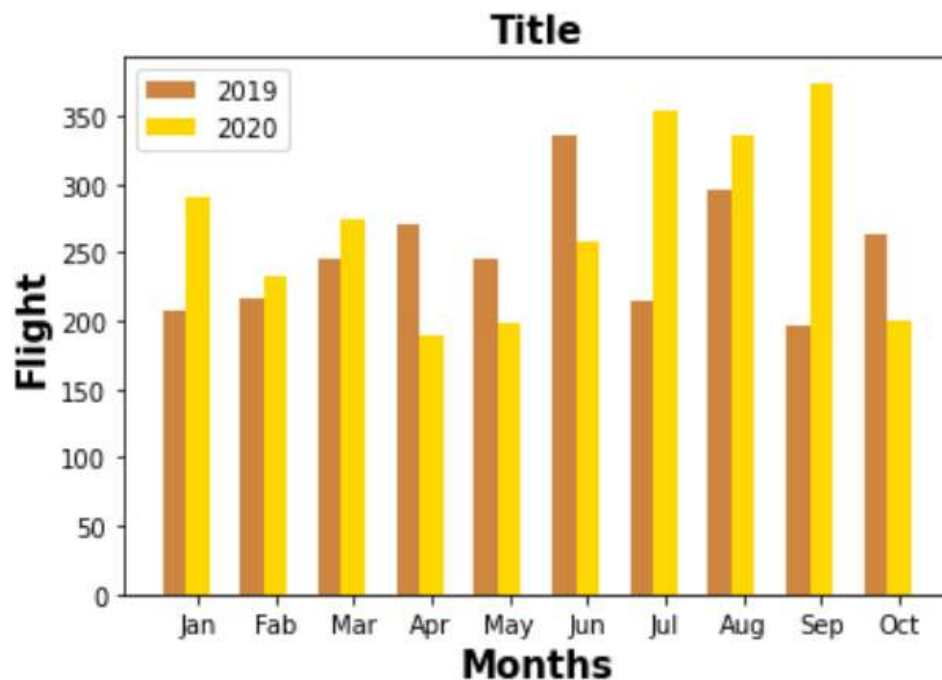
```
plt.plot(range(len(labels)), values, 'bo') # Plotting data
plt.xticks(range(len(labels)), labels) # Redefining x-axis labels
```

```
for i, v in enumerate(values):
    ax.annotate(str(v), xy=(i,v), xytext=(-7,7), textcoords='offset points')
plt.ylim(-10, 595)
plt.show()
```



Grouped barplot

Grouped barplot by column



```
import numpy as np
import matplotlib.pyplot as plt
# set width of bar
barWidth = 0.3
# set height of bar
bars1=[208,216,246,270,246,336,214,296,196,264]
bars2=[290,232,274,190,198,258,354,336,374,200]
# Set position of bar on X axis
r1 = list(range(len(bars1)))
r2 = [x + barWidth for x in r1]
# Make the plot
plt.bar(r1, bars1, color='peru', width=barWidth, label='2019')
plt.bar(r2, bars2, color='gold', width=barWidth, label='2020')
# Add xticks on the middle of the group bars
plt.xlabel('Months',fontweight='bold',fontsize = 15)
plt.ylabel('Flight',fontweight='bold',fontsize = 15)
plt.xticks([r + barWidth for r in range(len(bars1))],
['Jan','Feb','Mar','Apr', 'May','Jun','Jul','Aug','Sep','Oct'])
# Create legend & Show graphic
plt.title(' Title',fontsize = 15,fontweight='bold')
plt.legend()
plt.show()
```

Grouped barplot by column

```
import matplotlib.pyplot as plt
```

```
# set width of bar
```

```
barWidth = 0.25
```

```
# set height of bar
```

```
bars1 = [12, 30, 1, 8, 22]
```

```
bars2 = [28, 6, 16, 5, 10]
```

```
bars3 = [29, 3, 24, 25, 17]
```

```
# Set position of bar on X axis
```

```
r1 = [0,1,2,3,4]
```

```
r2 = [x + barWidth for x in r1]
```

```
r3 = [x + barWidth for x in r2]
```

```
# Make the plot
```

```
plt.bar(r1, bars1, color='gray', width=barWidth, edgecolor='white',  
label='var1')
```

```
plt.bar(r2, bars2, color='darkorange', width=barWidth,  
edgecolor='white', label='var2')
```

```
plt.bar(r3, bars3, color='navy', width=barWidth, edgecolor='white',  
label='var3')
```

```
# Add xticks on the middle of the group bars
```

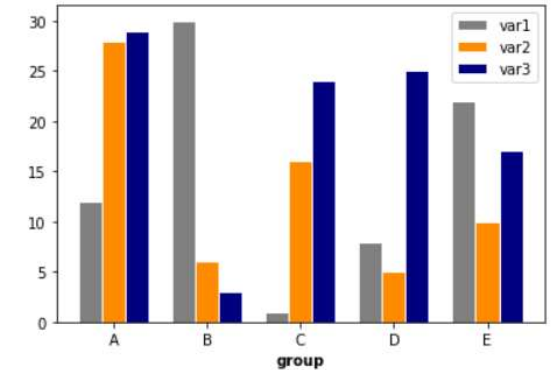
```
plt.xlabel('group', fontweight='bold')
```

```
plt.xticks([r + barWidth for r in range(len(bars1))], ['A', 'B', 'C', 'D', 'E'])
```

```
# Create legend & Show graphic
```

```
plt.legend()
```

```
plt.show()
```



How to show Chinese word in Figures

Ref: set color

Google search: color picker

颜色可以参考下面:

black	bisque	lightgreen	slategrey
k	darkorange	forestgreen	lightsteelblue
dimgray	burlywood	limegreen	cornflowerblue
dimgrey	antiquewhite	darkgreen	royalblue
grey	tan	green	ghostwhite
gray	navajowhite	g	lavender
darkgrey	blanchedalmond	lime	midnightblue
darkgray	papayawhip	mediumseagreen	navy
silver	moccasin	springgreen	darkblue
lightgray	orange	mintcream	mediumblue
lightgrey	wheat	mediumspringgreen	blue
gainsboro	oldlace	mediumaquamarine	b
whitesmoke	floralwhite	aquamarine	slateblue
white	darkgoldenrod	turquoise	darkslateblue
w	goldenrod	lightseagreen	mediumslateblue
snow	cornsilk	mediumturquoise	mediumpurple
rosybrown	gold	azure	blueviolet
lightcoral	lemonchiffon	lightcyan	indigo
indianred	khaki	paleturquoise	darkorchid
brown	palegoldenrod	darkslategray	darkviolet
firebrick	darkkhaki	darkslategrey	mediumorchid
maroon	ivory	teal	thistle
darkred	beige	darkcyan	plum
red	lightyellow	c	violet
r	lightgoldenrodyellow	cyan	purple
mistyrose	olive	aqua	darkmagenta
salmon	y	darkturquoise	m
tomato	olivedrab	cadetblue	fuchsia
darksalmon	yellowgreen	powderblue	magenta
coral	darkolivegreen	lightblue	orchid
orangered	greenyellow	deepskyblue	mediumvioletred
lightsalmon	chartreuse	skyblue	deeppink
sienna	lawngreen	lightskyblue	hotpink
seashell	sage	steelblue	lavenderblush
chocolate	lightsage	aliceblue	palevioletred
saddlebrown	darksage	dodgerblue	crimson
sandybrown	honeydew	lightslategrey	pink
peachpuff	darkseagreen	lightslategray	lightpink
peru	palegreen	slategray	
linen			