程式設計概論
Programming 101
—matplotlib module

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Matplotlib

- Matplotlib (https://matplotlib.org/): it is similar to Matlib 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

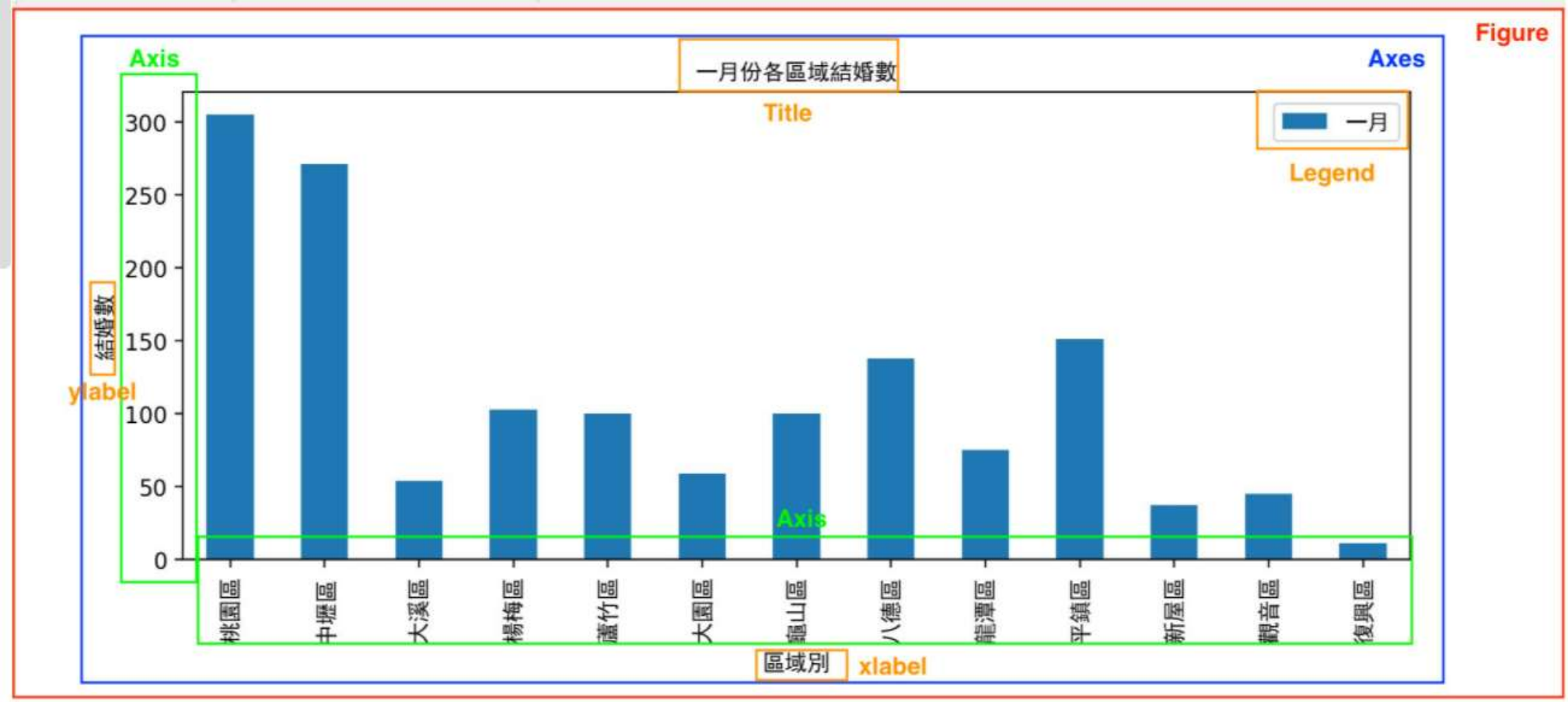


Figure
Axes
Axis
一月份各區域結婚數
Title
一月
Legend
結婚數
ylabel
300
250
200
150
100
50
0
Axis
桃園區
中壢區
大溪區
楊梅區
蘆竹區
大園區
龜山區
八德區
龍潭區
平鎮區
新屋區
觀音區
復興區
區域別
xlabel

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

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

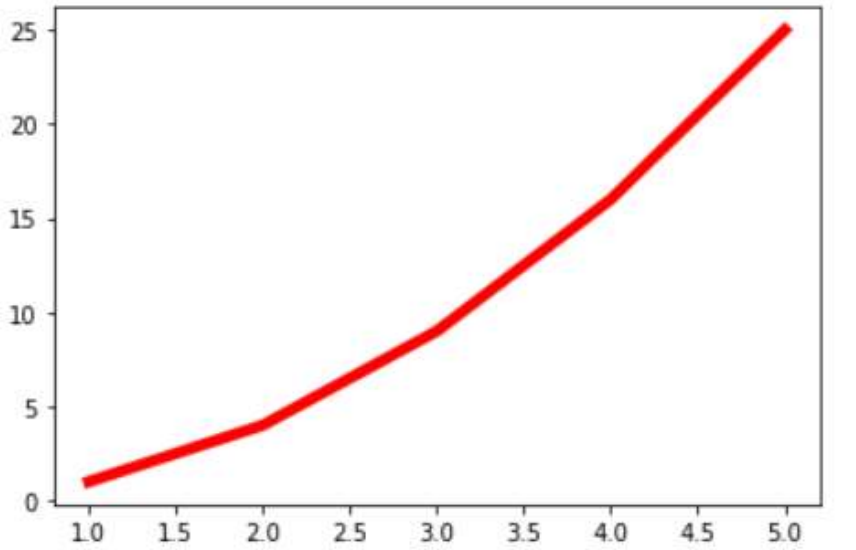
line plot

```
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()
```

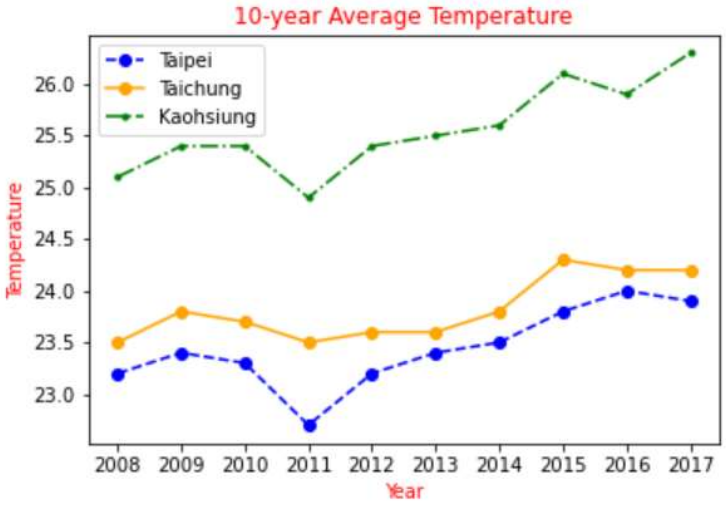
```
plt.plot(x,y, color="red", linewidth=5.0)
plt.show()
```



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()
```

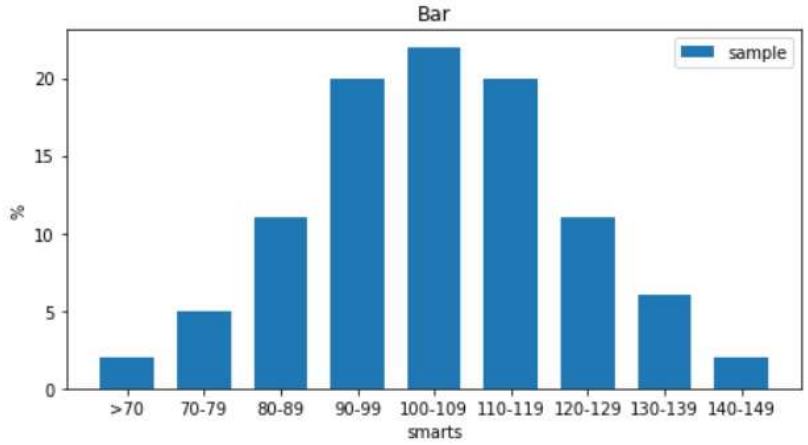
Add legend and save graph




```
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()
```

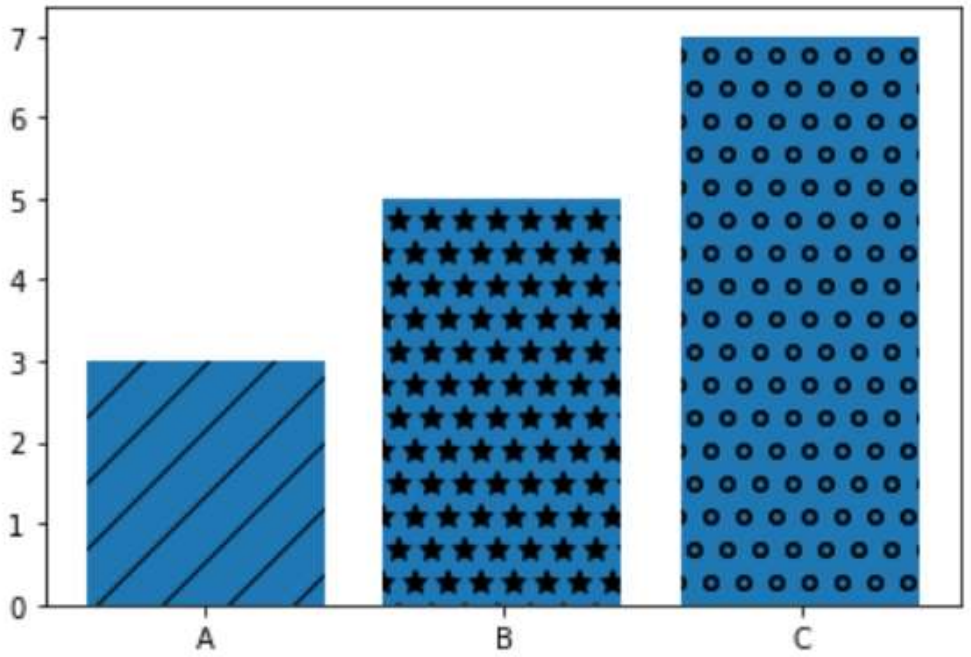
Bar plot

```
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()
```



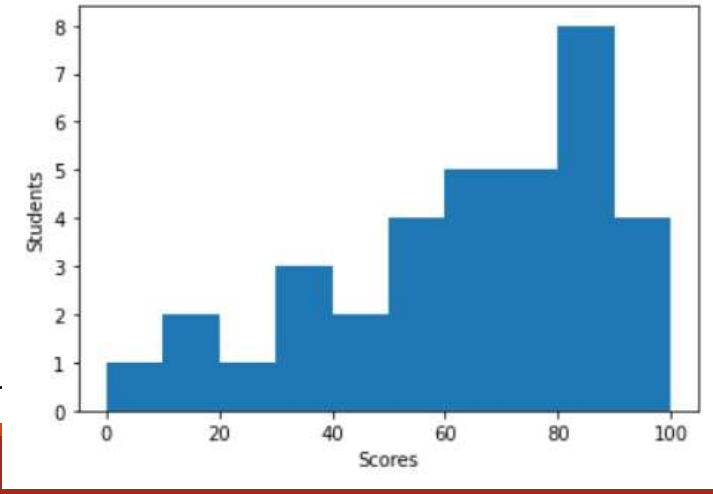
Bar plot: change pattern

```
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()
```

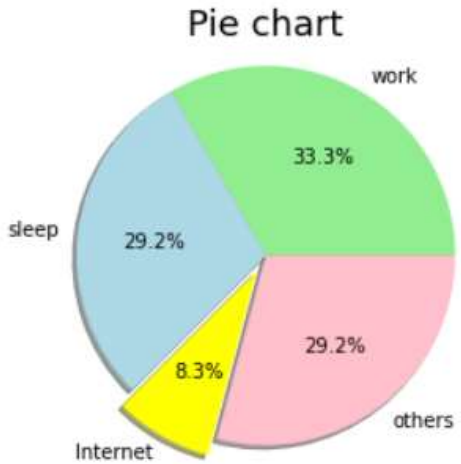


Histogram

```
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()
```



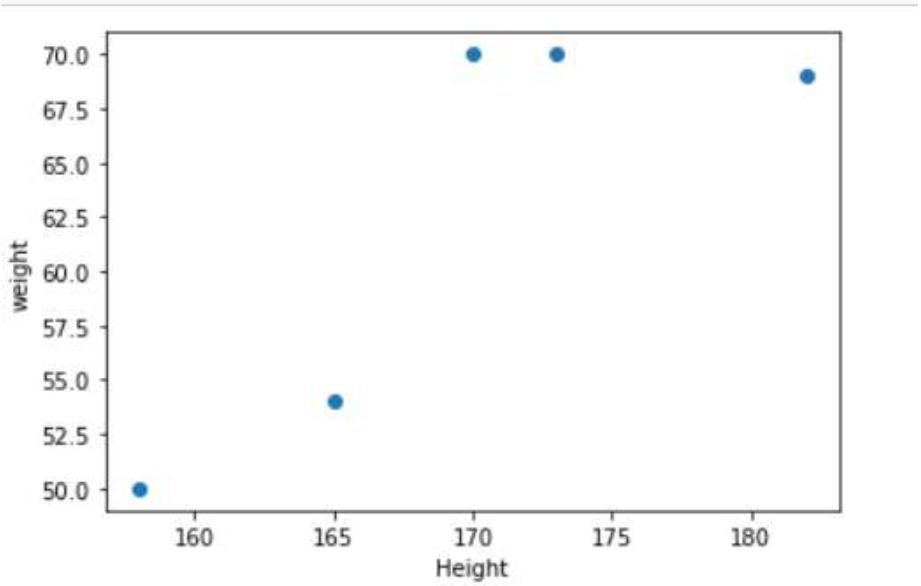
Pie chart




```
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

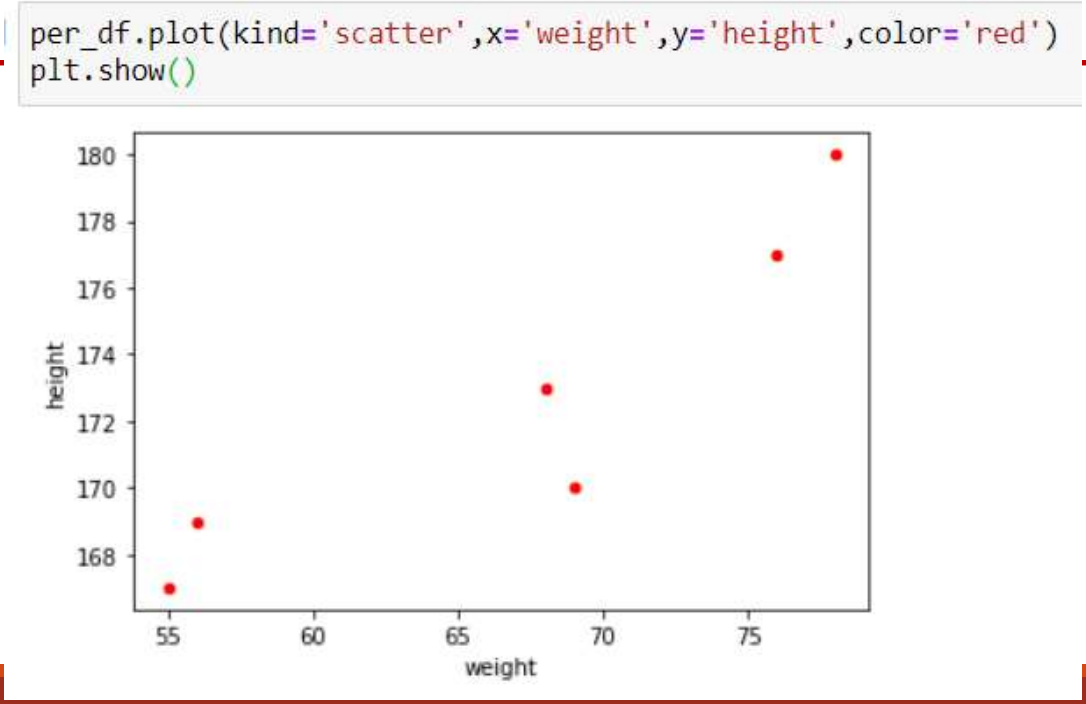
Create DataFrame

```
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)
```

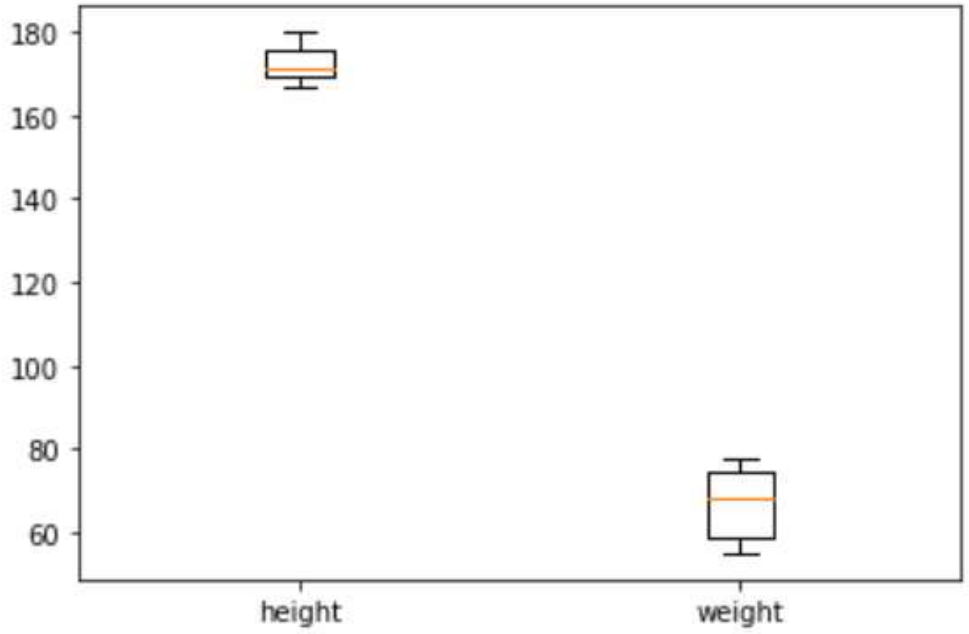
Scatter plot

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



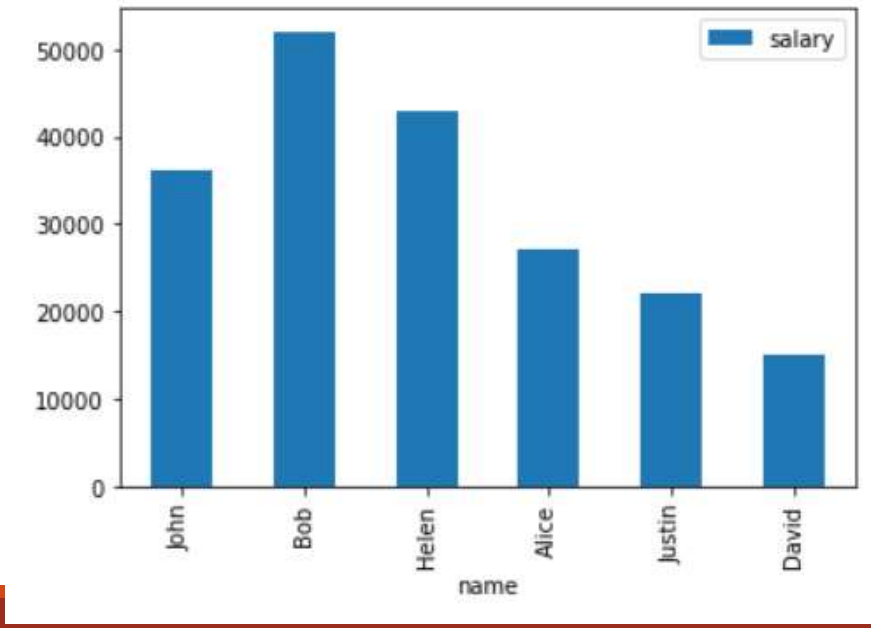
Boxplot

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



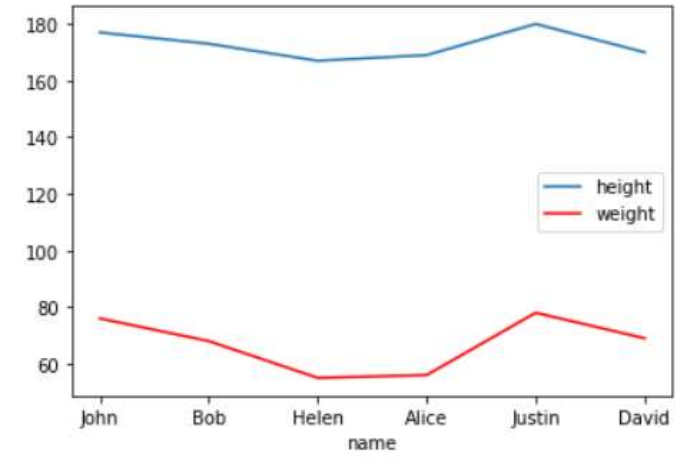
Bar plot

```
# 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()
```

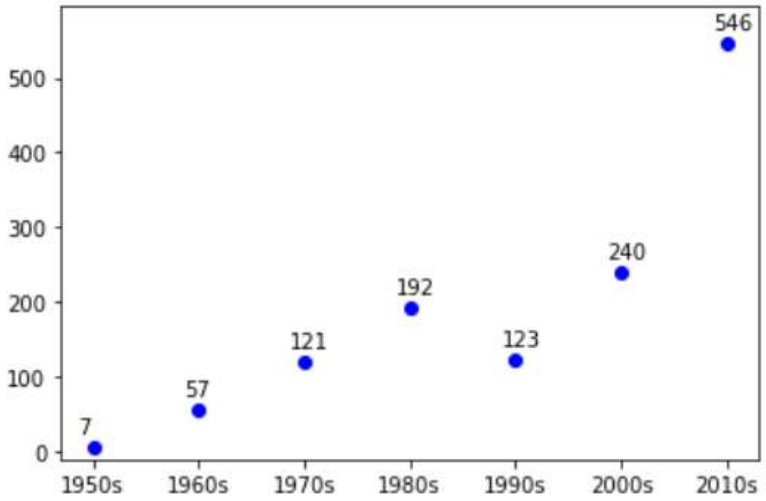
Some functions

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()
```

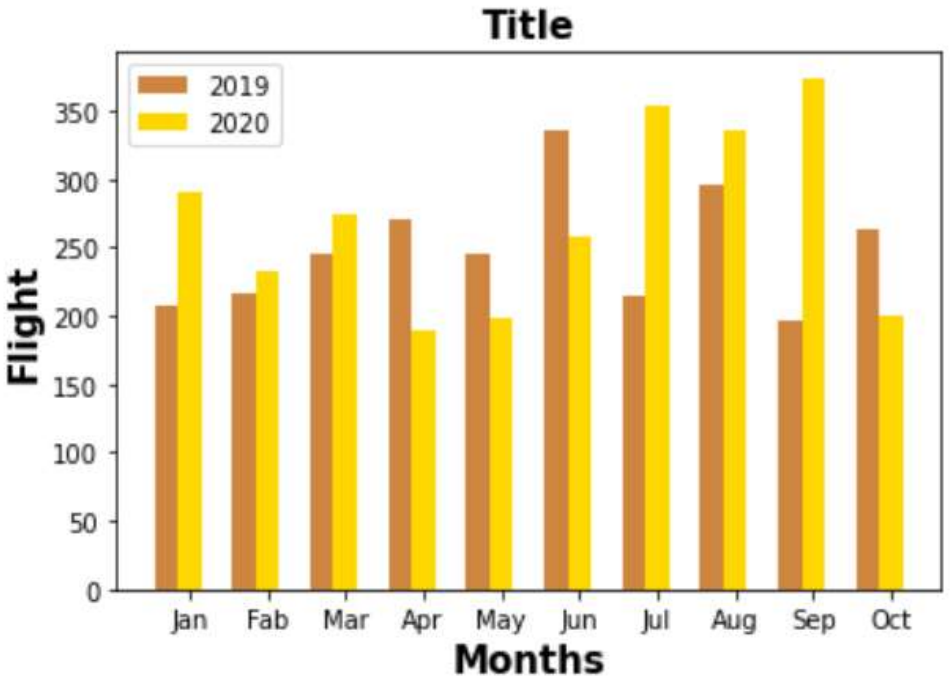
圖上顯示數值

```
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()
```



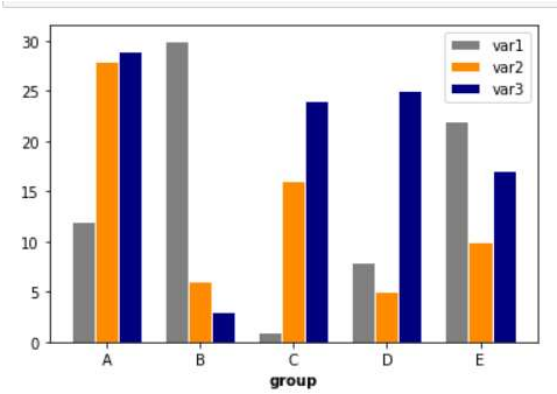
Grouped barplot

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','Fab','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]
```

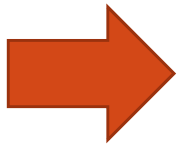
```
 # Make the plot
plt.bar(r1, bars1, color='gray', width=barWidth, edgecolor='white',
label='var1')
plt.bar(r2, bars2, color='darkorange', width=barWidth,
edgecolor='white', label='var2')
plt.bar(r3, bars3, color='navy', width=barWidth, edgecolor='white',
label='var3')

# 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

補充教材

Play mp3 file using pygame

Need pygame module

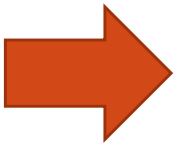


```
import pygame
file = 'XXX.mp3'
pygame.init()
pygame.mixer.init()
pygame.mixer.music.load(file)
pygame.mixer.music.play()
```

Show image as background using Canvas

Need pillow module

PIL (pillow)是 Python 中著名的影像處理套件



```
import tkinter as tk
from PIL import Image, ImageTk

# 保留在全域變數中，這是關鍵！
bg_image = None
root = tk.Tk()
root.geometry("300x350")
# 載入圖片（請確保圖片存在於同一資料夾，或給絕對路徑）
image = Image.open("Snoopy.jpg")
bg_image = ImageTk.PhotoImage(image)  # 這行變數要「活到最後」
# 建立 Canvas 並放背景圖
canvas_1 = tk.Canvas(root, width=300, height=350)
canvas_1.pack(fill="both", expand=True)
canvas_1.create_image(0, 0, image=bg_image, anchor="nw")
# 加上一個按鈕測試
btn = tk.Button(root, text="點我")
btn.place(x=100, y=100)
root.mainloop()
```

Ref: set color

Google search: color picker

颜色可以参考下面：