10分鐘搞定 pandas (10 MINUTES TO PANDAS) @RWEPA

Title : 10 MINUTES TO PANDAS

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RWEPA : http://rwepa.blogspot.tw/ (http://rwepa.blogspot.tw/)

Source : https://pandas.pydata.org/pandas-docs/stable/getting_started/10min.html (https://pandas.pydata.org/pandas-docs/stable/getting_started/10min.html)

1. Jupyter Notebook 快速鍵

- cell切換: Cell \ Cell Type \ {Code, Markdown}
- 編輯cell, cell 最左側為綠色bar
- 按 [Esc], cell 最左側為藍色bar
- 按 [x]：刪除當前選擇的cell
- 按 [a]：在當前選擇的上方新增一個cell
- 按 [b]：在當前選擇的下方新增一個cell
- 按 [Shift] + [Enter]：執行當前的cell並且選到下一個cell
- 按 [Ctrl] + [Enter]：執行當前cell
- 按 [M]：轉換成 markerdown 模式，可以看到紅色框框內容從code變成markerdown

2. Anaconda 套件管理

- 尋找套件 conda search matplotlib
- 列出已安裝的模組 conda list
- 安裝模組 conda install 模組名稱
- 更新模組 conda update 模組名稱
- 更新所有的模組 conda update –all
- 刪除模組 conda remove 模組名稱

In [1]:

```
# 範例: 更新 Spyder 模組
# conda update anaconda # 先更新 anaconda 模組
# conda update spyder # 再更新 spyder
```

3. 變更工作目錄

In [2]:

```
import os
```

In [3]:

```
os.getcwd()
```

Out[3]:

```
'C:\\00.data\\2.rdata_github_RWEPA'
```

In [4]:

```
os.chdir("C:/pythondata.shp") # 變更工作目錄
```

In [5]:

```
os.getcwd()
```

Out[5]:

```
'C:\\pythondata.shp'
```

In [6]:

```
os.listdir(os.getcwd())
```

Out[6]:

```
['foo.csv',
 'foo.h5',
 'foo.xlsx',
 'mapdata201907050833',
 'mapdata201907050833.zip',
 'mapdata201907311006',
 'mapdata201907311006.zip']
```

4. 載入3大套件 (pandas, numpy, matplotlib)

In [7]:

```
import pandas as pd # Python Data Analysis Library
```

In [8]:

```
import numpy as np # Python Scientific Computing Library
```

In [9]:

```
import matplotlib.pyplot as plt # Python 2D Plotting Library
```

5. pandas 物件簡介

5.1 Object Creation 建立物件

In [10]:

```
# 使用串列(List)建立 序列(Series) 物件, 序列包括指標(Index) 與值(Value), 指標採用預設整數型態指
```

In [11]:

```
s = pd.Series([1,3,5,np.nan,6,8])
s
```

Out[11]:

```
0    1.0
1    3.0
2    5.0
3    NaN
4    6.0
5    8.0
dtype: float64
```

In [12]:

```
type(s)
```

Out[12]:

```
pandas.core.series.Series
```

In [13]:

```
# 使用陣列(Array) 建立資料框(DataFrame)
```

In [14]:

```
dates = pd.date_range('20191101', periods=6) # 日期指標
dates
```

Out[14]:

```
DatetimeIndex(['2019-11-01', '2019-11-02', '2019-11-03', '2019-11-04',
               '2019-11-05', '2019-11-06'],
              dtype='datetime64[ns]', freq='D')
```

In [15]:

```
type(dates)
```

Out[15]:

```
pandas.core.indexes.datetimes.DatetimeIndex
```

In [16]:

```
df = pd.DataFrame(np.random.randn(6,4), index=dates, columns=list('ABCD')) # 文字欄位名稱
df
```

Out[16]:

	A	B	C	D
2019-11-01	-0.825621	0.781337	0.994062	0.658648
2019-11-02	-1.500434	-0.745991	-0.325255	-0.923237
2019-11-03	-0.359479	0.829483	-1.579049	1.197485
2019-11-04	1.554257	-0.054961	-0.915349	0.762935
2019-11-05	-0.257788	-0.641737	0.999873	-0.257817
2019-11-06	1.343814	0.180672	0.793786	-0.987014

In [17]:

```
# 使用字典建立資料框 DataFrame
```

In [18]:

```
df2 = pd.DataFrame({ 'A' : 1.,
    'B' : pd.Timestamp('20190101'),
    'C' : pd.Series(1,index=list(range(4)),dtype='float32'),
    'D' : np.array([3] * 4,dtype='int32'),
    'E' : pd.Categorical(["test","train","test","train"]),
    'F' : 'foo' })
df2
```

Out[18]:

	A	B	C	D	E	F
0	1.0	2019-01-01	1.0	3	test	foo
1	1.0	2019-01-01	1.0	3	train	foo
2	1.0	2019-01-01	1.0	3	test	foo
3	1.0	2019-01-01	1.0	3	train	foo

```
# dtypes: 表示資料型態
```

In [19]:

```
df2.dtypes # df2. 按 [Tab] 按鈕
```

Out[19]:

```
A           float64
B    datetime64[ns]
C           float32
D             int32
E          category
F            object
dtype: object
```

5.2 Viewing Data 資料檢視

In [20]:

```
df
```

Out[20]:

	A	B	C	D
2019-11-01	-0.825621	0.781337	0.994062	0.658648
2019-11-02	-1.500434	-0.745991	-0.325255	-0.923237
2019-11-03	-0.359479	0.829483	-1.579049	1.197485
2019-11-04	1.554257	-0.054961	-0.915349	0.762935
2019-11-05	-0.257788	-0.641737	0.999873	-0.257817
2019-11-06	1.343814	0.180672	0.793786	-0.987014

In [21]:

```
# 檢視前幾筆資料, 後幾筆資料, head 顯示前 5 筆資料, 此功能與 R 顯示 6 筆不相同.
```

In [22]:

```
df.head()
```

Out[22]:

	A	B	C	D
2019-11-01	-0.825621	0.781337	0.994062	0.658648
2019-11-02	-1.500434	-0.745991	-0.325255	-0.923237
2019-11-03	-0.359479	0.829483	-1.579049	1.197485
2019-11-04	1.554257	-0.054961	-0.915349	0.762935
2019-11-05	-0.257788	-0.641737	0.999873	-0.257817

In [23]:

```
df.tail(3)
```

Out[23]:

	A	B	C	D
2019-11-04	1.554257	-0.054961	-0.915349	0.762935
2019-11-05	-0.257788	-0.641737	0.999873	-0.257817
2019-11-06	1.343814	0.180672	0.793786	-0.987014

In [24]:

```
# 顯示指標(index), 欄名稱(columns), 資料值(values)
```

In [25]:

```
df.index
```

Out[25]:

```
DatetimeIndex(['2019-11-01', '2019-11-02', '2019-11-03', '2019-11-04',
               '2019-11-05', '2019-11-06'],
              dtype='datetime64[ns]', freq='D')
```

In [26]:

```
df.columns
```

Out[26]:

```
Index(['A', 'B', 'C', 'D'], dtype='object')
```

In [27]:

```
df.values
```

Out[27]:

```
array([[-0.82562087,  0.7813369 ,  0.99406174,  0.65864838],
       [-1.50043372, -0.74599055, -0.32525525, -0.92323651],
       [-0.35947859,  0.8294832 , -1.57904918,  1.19748522],
       [ 1.55425713, -0.05496138, -0.91534853,  0.76293525],
       [-0.25778755, -0.64173701,  0.99987261, -0.25781728],
       [ 1.34381414,  0.18067245,  0.79378566, -0.98701413]])
```

In [28]:

```
# describe 統計摘要 statistic summary
# count 個數
# mean 平均值
# std  標準差 standard deviation, 一般希望愈小愈好
# min  最小值
# 25%  25百分位數
# 50%  50百分位數, 中位數 median
# 75%  75百分位數 (quantile)
# max  最大值
```

In [29]:

```
df.describe()
```

Out[29]:

	A	B	C	D
count	6.000000	6.000000	6.000000	6.000000
mean	-0.007542	0.058134	-0.005322	0.075167
std	1.212422	0.675610	1.100444	0.928331
min	-1.500434	-0.745991	-1.579049	-0.987014
25%	-0.709085	-0.495043	-0.767825	-0.756882
50%	-0.308633	0.062856	0.234265	0.200416
75%	0.943414	0.631171	0.943993	0.736864
max	1.554257	0.829483	0.999873	1.197485

In [30]:

```
# T 資料轉置, 類似將原本長資料 (Long data), 轉換為寬資料 (Wide data)
# 資料轉置
# | 1 2 3 4|
# | 5 6 7 8|
# 轉換為
# | 1 5|
# | 2 6|
# | 3 7|
# | 4 8|
```

In [31]:

```
df.T
```

Out[31]:

	2019-11-01 00:00:00	2019-11-02 00:00:00	2019-11-03 00:00:00	2019-11-04 00:00:00	2019-11-05 00:00:00	2019-11-06 00:00:00
A	-0.825621	-1.500434	-0.359479	1.554257	-0.257788	1.343814
B	0.781337	-0.745991	0.829483	-0.054961	-0.641737	0.180672
C	0.994062	-0.325255	-1.579049	-0.915349	0.999873	0.793786
D	0.658648	-0.923237	1.197485	0.762935	-0.257817	-0.987014

In [32]:

```
# axis為排序的軸，0表示 rows index(列指標)，1表示columns index(行指標)，
# 當對數據 "列" 進行排序時，axis必須設置為0.
# df.sort(["A"]) 新版不支援 sort, 改用 sort_values 或 sort_index
```

In [33]:

```
df.sort_index(axis=1, ascending=False) # ascending =FALSE, 即遞增是FALSE, 表示遞減是TRUE
```

Out[33]:

	D	C	B	A
2019-11-01	0.658648	0.994062	0.781337	-0.825621
2019-11-02	-0.923237	-0.325255	-0.745991	-1.500434
2019-11-03	1.197485	-1.579049	0.829483	-0.359479
2019-11-04	0.762935	-0.915349	-0.054961	1.554257
2019-11-05	-0.257817	0.999873	-0.641737	-0.257788
2019-11-06	-0.987014	0.793786	0.180672	1.343814

In [34]:

```
# 依照 B 欄大小, 由小至大排序
```

In [35]:

```
df.sort_values(by='B')
```

Out[35]:

	A	B	C	D
2019-11-02	-1.500434	-0.745991	-0.325255	-0.923237
2019-11-05	-0.257788	-0.641737	0.999873	-0.257817
2019-11-04	1.554257	-0.054961	-0.915349	0.762935
2019-11-06	1.343814	0.180672	0.793786	-0.987014
2019-11-01	-0.825621	0.781337	0.994062	0.658648
2019-11-03	-0.359479	0.829483	-1.579049	1.197485

5.3 Selection 資料選取 .at, .iat, .loc, .iloc, .ix

In [36]:

```
# 5.3.1 Getting 選取行,列
```

In [37]:

```
# 選取行
df['A']
```

Out[37]:

```
2019-11-01   -0.825621
2019-11-02   -1.500434
2019-11-03   -0.359479
2019-11-04    1.554257
2019-11-05   -0.257788
2019-11-06    1.343814
Freq: D, Name: A, dtype: float64
```

In [38]:

```
df.A # 與 df['A'] 相同
```

Out[38]:

```
2019-11-01   -0.825621
2019-11-02   -1.500434
2019-11-03   -0.359479
2019-11-04    1.554257
2019-11-05   -0.257788
2019-11-06    1.343814
Freq: D, Name: A, dtype: float64
```

In [39]:

```
# 選取列
```

In [40]:

```
df[0:4]
```

Out[40]:

	A	B	C	D
2019-11-01	-0.825621	0.781337	0.994062	0.658648
2019-11-02	-1.500434	-0.745991	-0.325255	-0.923237
2019-11-03	-0.359479	0.829483	-1.579049	1.197485
2019-11-04	1.554257	-0.054961	-0.915349	0.762935

In [41]:

```
df['2013-01-02':'2013-01-04']
```

Out[41]:

A	B	C	D

In [42]:

```
# 5.3.2 Selection by Label 選取標籤
df
```

Out[42]:

	A	B	C	D
2019-11-01	-0.825621	0.781337	0.994062	0.658648
2019-11-02	-1.500434	-0.745991	-0.325255	-0.923237
2019-11-03	-0.359479	0.829483	-1.579049	1.197485
2019-11-04	1.554257	-0.054961	-0.915349	0.762935
2019-11-05	-0.257788	-0.641737	0.999873	-0.257817
2019-11-06	1.343814	0.180672	0.793786	-0.987014

In [43]:

```
df.loc[dates[0]]
```

Out[43]:

```
A   -0.825621
B    0.781337
C    0.994062
D    0.658648
Name: 2019-11-01 00:00:00, dtype: float64
```

In [44]:

```
# Selecting on a multi-axis by label 選取多軸(列,行), 如果列的位置是空白, 表示所有列皆選取.
```

In [45]:

```
df.loc[:, ['A','B']]
```

Out[45]:

	A	B
2019-11-01	-0.825621	0.781337
2019-11-02	-1.500434	-0.745991
2019-11-03	-0.359479	0.829483
2019-11-04	1.554257	-0.054961
2019-11-05	-0.257788	-0.641737
2019-11-06	1.343814	0.180672

In [46]:

```
df.loc['20191102':'20191104',['A','B']]
```

Out[46]:

	A	B
2019-11-02	-1.500434	-0.745991
2019-11-03	-0.359479	0.829483
2019-11-04	1.554257	-0.054961

In [47]:

```
df.loc['20191102',['A','B']] # 回傳值已降為1維
```

Out[47]:

```
A   -1.500434
B   -0.745991
Name: 2019-11-02 00:00:00, dtype: float64
```

In [48]:

```
df.loc[dates[0],'A']
```

Out[48]:

```
-0.8256208679582036
```

In [49]:

```
df.at[dates[0],'A'] # .at 與 .loc 如果相同
```

Out[49]:

```
-0.8256208679582036
```

In [50]:

```
# 5.3.3 Selection by Position 依位置選取資料
```

In [51]:

```
df
```

Out[51]:

	A	B	C	D
2019-11-01	-0.825621	0.781337	0.994062	0.658648
2019-11-02	-1.500434	-0.745991	-0.325255	-0.923237
2019-11-03	-0.359479	0.829483	-1.579049	1.197485
2019-11-04	1.554257	-0.054961	-0.915349	0.762935
2019-11-05	-0.257788	-0.641737	0.999873	-0.257817
2019-11-06	1.343814	0.180672	0.793786	-0.987014

In [52]:

```
df.iloc[3] # [3] 表示選取指標為3的列, 實際為第4列.
```

Out[52]:

```
A    1.554257
B   -0.054961
C   -0.915349
D    0.762935
Name: 2019-11-04 00:00:00, dtype: float64
```

In [53]:

```
df.iloc[3:5,0:2] # [第3列:第4列, 第0行:第1行] , 結束位置須減1, 例:5-1=4, 即選取列指標第 3, 4列,
```

Out[53]:

	A	B
2019-11-04	1.554257	-0.054961
2019-11-05	-0.257788	-0.641737

In [54]:

```
df.iloc[[1,2,4],[0,2]] # "," 表示不連續範圍
```

Out[54]:

	A	C
2019-11-02	-1.500434	-0.325255
2019-11-03	-0.359479	-1.579049
2019-11-05	-0.257788	0.999873

In [55]:

```
df.iloc[1:3,:]
```

Out[55]:

	A	B	C	D
2019-11-02	-1.500434	-0.745991	-0.325255	-0.923237
2019-11-03	-0.359479	0.829483	-1.579049	1.197485

In [56]:

```
df.iloc[:,1:3]
```

Out[56]:

	B	C
2019-11-01	0.781337	0.994062
2019-11-02	-0.745991	-0.325255
2019-11-03	0.829483	-1.579049
2019-11-04	-0.054961	-0.915349
2019-11-05	-0.641737	0.999873
2019-11-06	0.180672	0.793786

In [57]:

```
df.iloc[1,1]
```

Out[57]:

```
-0.745990549008202
```

In [58]:

```
df.iat[1,1]
```

Out[58]:

```
-0.745990549008202
```

In [59]:

```
# 5.3.4 Boolean Indexing 邏輯值(條件式)資料選取
```

In [60]:

```
df[df.A > 0]
```

Out[60]:

	A	B	C	D
2019-11-04	1.554257	-0.054961	-0.915349	0.762935
2019-11-06	1.343814	0.180672	0.793786	-0.987014

In [61]:

```
df[df > 0]
```

Out[61]:

	A	B	C	D
2019-11-01	NaN	0.781337	0.994062	0.658648
2019-11-02	NaN	NaN	NaN	NaN
2019-11-03	NaN	0.829483	NaN	1.197485
2019-11-04	1.554257	NaN	NaN	0.762935
2019-11-05	NaN	NaN	0.999873	NaN
2019-11-06	1.343814	0.180672	0.793786	NaN

In [62]:

```
# 使用 .isin
df[df.index.isin(['2013-01-02', '2013-01-06'])]
```

Out[62]:

A	B	C	D

In [63]:

```
df.A
```

Out[63]:

```
2019-11-01   -0.825621
2019-11-02   -1.500434
2019-11-03   -0.359479
2019-11-04    1.554257
2019-11-05   -0.257788
2019-11-06    1.343814
Freq: D, Name: A, dtype: float64
```

In [64]:

```
df2 = df.copy()
df2['E'] = ['one', 'one','two','three','four','three']
df2
```

Out[64]:

	A	B	C	D	E
2019-11-01	-0.825621	0.781337	0.994062	0.658648	one
2019-11-02	-1.500434	-0.745991	-0.325255	-0.923237	one
2019-11-03	-0.359479	0.829483	-1.579049	1.197485	two
2019-11-04	1.554257	-0.054961	-0.915349	0.762935	three
2019-11-05	-0.257788	-0.641737	0.999873	-0.257817	four
2019-11-06	1.343814	0.180672	0.793786	-0.987014	three

In [65]:

```
df2[df2['E'].isin(['two','four'])]
```

Out[65]:

	A	B	C	D	E
2019-11-03	-0.359479	0.829483	-1.579049	1.197485	two
2019-11-05	-0.257788	-0.641737	0.999873	-0.257817	four

In [66]:

```
# 5.3.5 Setting 設定值
```

In [67]:

```
s1 = pd.Series([1,2,3,4,5,6], index=pd.date_range('20130102', periods=6))
s1
```

Out[67]:

```
2013-01-02    1
2013-01-03    2
2013-01-04    3
2013-01-05    4
2013-01-06    5
2013-01-07    6
Freq: D, dtype: int64
```

In [68]:

```
df.at[dates[0],'A'] = 0
df
```

Out[68]:

	A	B	C	D
2019-11-01	0.000000	0.781337	0.994062	0.658648
2019-11-02	-1.500434	-0.745991	-0.325255	-0.923237
2019-11-03	-0.359479	0.829483	-1.579049	1.197485
2019-11-04	1.554257	-0.054961	-0.915349	0.762935
2019-11-05	-0.257788	-0.641737	0.999873	-0.257817
2019-11-06	1.343814	0.180672	0.793786	-0.987014

In [69]:

```
df.iat[0,3] = 0
df
```

Out[69]:

	A	B	C	D
2019-11-01	0.000000	0.781337	0.994062	0.000000
2019-11-02	-1.500434	-0.745991	-0.325255	-0.923237
2019-11-03	-0.359479	0.829483	-1.579049	1.197485
2019-11-04	1.554257	-0.054961	-0.915349	0.762935
2019-11-05	-0.257788	-0.641737	0.999873	-0.257817
2019-11-06	1.343814	0.180672	0.793786	-0.987014

In [70]:

```
df.loc[:,'D'] = np.array([5] * len(df)) # 將D欄改成5
```

In [71]:

```
df
```

Out[71]:

	A	B	C	D
2019-11-01	0.000000	0.781337	0.994062	5
2019-11-02	-1.500434	-0.745991	-0.325255	5
2019-11-03	-0.359479	0.829483	-1.579049	5
2019-11-04	1.554257	-0.054961	-0.915349	5
2019-11-05	-0.257788	-0.641737	0.999873	5
2019-11-06	1.343814	0.180672	0.793786	5

In [72]:

```
df2 = df.copy()
df2[df2 > 0] = -df2
df2
```

Out[72]:

	A	B	C	D
2019-11-01	0.000000	-0.781337	-0.994062	-5
2019-11-02	-1.500434	-0.745991	-0.325255	-5
2019-11-03	-0.359479	-0.829483	-1.579049	-5
2019-11-04	-1.554257	-0.054961	-0.915349	-5
2019-11-05	-0.257788	-0.641737	-0.999873	-5
2019-11-06	-1.343814	-0.180672	-0.793786	-5

5.4 Missing Data 遺漏值

In [73]:

```
# [0:4] 表示index為 0,1,2,3
df1 = df.reindex(index=dates[0:4], columns=list(df.columns) + ['E'])
df1
```

Out[73]:

	A	B	C	D	E
2019-11-01	0.000000	0.781337	0.994062	5	NaN
2019-11-02	-1.500434	-0.745991	-0.325255	5	NaN
2019-11-03	-0.359479	0.829483	-1.579049	5	NaN
2019-11-04	1.554257	-0.054961	-0.915349	5	NaN

In [74]:

```
df1.loc[dates[0]:dates[1],'E'] = 1
df1
```

Out[74]:

	A	B	C	D	E
2019-11-01	0.000000	0.781337	0.994062	5	1.0
2019-11-02	-1.500434	-0.745991	-0.325255	5	1.0
2019-11-03	-0.359479	0.829483	-1.579049	5	NaN
2019-11-04	1.554257	-0.054961	-0.915349	5	NaN

In [75]:

```
# 刪除列中包括 NaN
df1.dropna(how='any')
```

Out[75]:

	A	B	C	D	E
2019-11-01	0.000000	0.781337	0.994062	5	1.0
2019-11-02	-1.500434	-0.745991	-0.325255	5	1.0

In [76]:

```
# 將遺漏值填入值
df1.fillna(value=5)
```

Out[76]:

	A	B	C	D	E
2019-11-01	0.000000	0.781337	0.994062	5	1.0
2019-11-02	-1.500434	-0.745991	-0.325255	5	1.0
2019-11-03	-0.359479	0.829483	-1.579049	5	5.0
2019-11-04	1.554257	-0.054961	-0.915349	5	5.0

In [77]:

```
# 判斷何者為NaN
pd.isnull(df1)
```

Out[77]:

	A	B	C	D	E
2019-11-01	False	False	False	False	False
2019-11-02	False	False	False	False	False
2019-11-03	False	False	False	False	True
2019-11-04	False	False	False	False	True

5.5 Operations 資料操作

In [78]:

```
# 5.5.1 Stats 統計分析
```

In [79]:

```
df
```

Out[79]:

	A	B	C	D
2019-11-01	0.000000	0.781337	0.994062	5
2019-11-02	-1.500434	-0.745991	-0.325255	5
2019-11-03	-0.359479	0.829483	-1.579049	5
2019-11-04	1.554257	-0.054961	-0.915349	5
2019-11-05	-0.257788	-0.641737	0.999873	5
2019-11-06	1.343814	0.180672	0.793786	5

In [80]:

```
df.mean()
```

Out[80]:

```
A    0.130062
B    0.058134
C   -0.005322
D    5.000000
dtype: float64
```

In [81]:

```
# 計算每列平均
df.mean(1)
```

Out[81]:

```
2019-11-01    1.693850
2019-11-02    0.607080
2019-11-03    0.972739
2019-11-04    1.395987
2019-11-05    1.275087
2019-11-06    1.829568
Freq: D, dtype: float64
```

In [82]:

```
# 計算每行平均
df.mean(0)
```

Out[82]:

```
A    0.130062
B    0.058134
C   -0.005322
D    5.000000
dtype: float64
```

In [83]:

```
s = pd.Series([1,3,5,np.nan,6,8], index=dates)
s
```

Out[83]:

```
2019-11-01    1.0
2019-11-02    3.0
2019-11-03    5.0
2019-11-04    NaN
2019-11-05    6.0
2019-11-06    8.0
Freq: D, dtype: float64
```

In [84]:

```
# 移動2個位置
s = pd.Series([1,3,5,np.nan,6,8], index=dates).shift(2)
s
```

Out[84]:

```
2019-11-01    NaN
2019-11-02    NaN
2019-11-03    1.0
2019-11-04    3.0
2019-11-05    5.0
2019-11-06    NaN
Freq: D, dtype: float64
```

In [85]:

```
df
```

Out[85]:

	A	B	C	D
2019-11-01	0.000000	0.781337	0.994062	5
2019-11-02	-1.500434	-0.745991	-0.325255	5
2019-11-03	-0.359479	0.829483	-1.579049	5
2019-11-04	1.554257	-0.054961	-0.915349	5
2019-11-05	-0.257788	-0.641737	0.999873	5
2019-11-06	1.343814	0.180672	0.793786	5

In [86]:

```
# 每行數值 減1
df.sub(s, axis='index')
#  0.750356  -1 = -0.249644
# -0.335855 - 3 = -3.335855
#  0.901004 - 5 = -4.098996
```

Out[86]:

	A	B	C	D
2019-11-01	NaN	NaN	NaN	NaN
2019-11-02	NaN	NaN	NaN	NaN
2019-11-03	-1.359479	-0.170517	-2.579049	4.0
2019-11-04	-1.445743	-3.054961	-3.915349	2.0
2019-11-05	-5.257788	-5.641737	-4.000127	0.0
2019-11-06	NaN	NaN	NaN	NaN

In [87]:

```
# 5.5.2 Apply 將資料套用至函數
```

In [88]:

```
df.apply(np.cumsum)
```

Out[88]:

	A	B	C	D
2019-11-01	0.000000	0.781337	0.994062	5
2019-11-02	-1.500434	0.035346	0.668806	10
2019-11-03	-1.859912	0.864830	-0.910243	15
2019-11-04	-0.305655	0.809868	-1.825591	20
2019-11-05	-0.563443	0.168131	-0.825719	25
2019-11-06	0.780371	0.348804	-0.031933	30

5.6 Merge 合併

In [89]:

```
df = pd.DataFrame(np.random.randn(10, 4))
df
```

Out[89]:

	0	1	2	3
0	-0.960953	-0.671441	-1.018001	-0.365062
1	1.512377	-0.375024	-1.195049	-0.209362
2	1.437184	0.756504	0.244469	0.457802
3	0.416008	-0.377330	-0.075784	0.236123
4	-0.567648	0.574109	-0.182277	-1.332585
5	0.640146	1.461211	-1.684183	-0.789332
6	0.024130	0.512198	-0.437310	-0.274802
7	-0.283277	0.252416	-0.547451	2.075400
8	-0.364530	-0.318077	-0.624497	1.309957
9	0.283302	0.715928	-0.169675	1.222712

In [90]:

```
pieces = [df[:3], df[4:7], df[8:]]
pieces
```

Out[90]:

```
[          0         1         2         3
 0 -0.960953 -0.671441 -1.018001 -0.365062
 1  1.512377 -0.375024 -1.195049 -0.209362
 2  1.437184  0.756504  0.244469  0.457802,
           0         1         2         3
 4 -0.567648  0.574109 -0.182277 -1.332585
 5  0.640146  1.461211 -1.684183 -0.789332
 6  0.024130  0.512198 -0.437310 -0.274802,
           0         1         2         3
 8 -0.364530 -0.318077 -0.624497  1.309957
 9  0.283302  0.715928 -0.169675  1.222712]
```

In [91]:

```
# 列合併, 類似R的 rbind
pd.concat(pieces)
```

Out[91]:

	0	1	2	3
0	-0.960953	-0.671441	-1.018001	-0.365062
1	1.512377	-0.375024	-1.195049	-0.209362
2	1.437184	0.756504	0.244469	0.457802
4	-0.567648	0.574109	-0.182277	-1.332585
5	0.640146	1.461211	-1.684183	-0.789332
6	0.024130	0.512198	-0.437310	-0.274802
8	-0.364530	-0.318077	-0.624497	1.309957
9	0.283302	0.715928	-0.169675	1.222712

In [92]:

```
# 5.6.2 Join, 執行 SQL join
```

In [93]:

```
# 範例 1
left = pd.DataFrame({'key': ['foo', 'foo'], 'lval': [1, 2]})
right = pd.DataFrame({'key': ['foo', 'foo'], 'rval': [4, 5]})
```

In [94]:

```
left
```

Out[94]:

	key	lval
0	foo	1
1	foo	2

In [95]:

```
right
```

Out[95]:

	key	rval
0	foo	4
1	foo	5

In [96]:

```
pd.merge(left, right, on='key')
```

Out[96]:

	key	lval	rval
0	foo	1	4
1	foo	1	5
2	foo	2	4
3	foo	2	5

In [97]:

```
# 範例 2
left = pd.DataFrame({'key': ['foo', 'bar'], 'lval': [1, 2]})
right = pd.DataFrame({'key': ['foo', 'bar'], 'rval': [4, 5]})
```

In [98]:

```
left
```

Out[98]:

	key	lval
0	foo	1
1	bar	2

In [99]:

```
right
```

Out[99]:

	key	rval
0	foo	4
1	bar	5

In [100]:

```
pd.merge(left, right, on='key')
```

Out[100]:

	key	lval	rval
0	foo	1	4
1	bar	2	5

In [101]:

```
# 5.6.3 Append 附加
```

In [102]:

```
df = pd.DataFrame(np.random.randn(8, 4), columns=['A','B','C','D'])
df
```

Out[102]:

	A	B	C	D
0	1.986506	-0.197843	0.362917	-0.897121
1	-0.550426	-1.242338	0.817869	-0.317295
2	-0.556084	-1.983968	-0.280628	-1.146358
3	0.660068	-1.860863	1.020574	-0.160337
4	0.625518	-0.006584	-0.968440	0.968336
5	-0.405946	-0.019134	1.645841	0.246077
6	1.196225	0.345763	1.140376	-0.143422
7	0.649234	0.290237	1.397745	2.297697

In [103]:

```
s = df.iloc[3]
s
```

Out[103]:

```
A    0.660068
B   -1.860863
C    1.020574
D   -0.160337
Name: 3, dtype: float64
```

In [104]:

```
df.append(s, ignore_index=True)
```

Out[104]:

	A	B	C	D
0	1.986506	-0.197843	0.362917	-0.897121
1	-0.550426	-1.242338	0.817869	-0.317295
2	-0.556084	-1.983968	-0.280628	-1.146358
3	0.660068	-1.860863	1.020574	-0.160337
4	0.625518	-0.006584	-0.968440	0.968336
5	-0.405946	-0.019134	1.645841	0.246077
6	1.196225	0.345763	1.140376	-0.143422
7	0.649234	0.290237	1.397745	2.297697
8	0.660068	-1.860863	1.020574	-0.160337

5.7 Grouping 群組計算

In [105]:

```
df = pd.DataFrame({
    'A' : ['foo', 'bar', 'foo', 'bar', 'foo', 'bar', 'foo', 'foo'],
    'B' : ['one', 'one', 'two', 'three', 'two', 'two', 'one', 'three'],
    'C' : np.random.randn(8),
    'D' : np.random.randn(8)})
```

In [106]:

```
df
```

Out[106]:

	A	B	C	D
0	foo	one	-0.859642	-0.972764
1	bar	one	-1.504795	-0.527323
2	foo	two	-0.890070	1.007099
3	bar	three	-2.005281	-0.331801
4	foo	two	0.957768	-1.865947
5	bar	two	-1.217132	0.733990
6	foo	one	0.382726	-0.622104
7	foo	three	-0.038551	1.588017

In [107]:

```
df.groupby('A').sum() # 類似 R- aggregate
```

Out[107]:

	C	D
A		
bar	-4.727208	-0.125135
foo	-0.447769	-0.865699

In [108]:

```
df.groupby(['A','B']).sum()
```

Out[108]:

		C	D
A	**B**		
bar	**one**	-1.504795	-0.527323
	three	-2.005281	-0.331801
	two	-1.217132	0.733990
foo	**one**	-0.476916	-1.594868
	three	-0.038551	1.588017
	two	0.067697	-0.858848

5.8 Reshaping 改變形狀(維度)

In [109]:

```
# 5.8.1 Stack
```

In [110]:

```
tuples = list(zip(*[['bar', 'bar', 'baz', 'baz', 'foo', 'foo', 'qux', 'qux'],
                    ['one', 'two', 'one', 'two', 'one', 'two', 'one', 'two']]))
tuples
```

Out[110]:

```
[('bar', 'one'),
 ('bar', 'two'),
 ('baz', 'one'),
 ('baz', 'two'),
 ('foo', 'one'),
 ('foo', 'two'),
 ('qux', 'one'),
 ('qux', 'two')]
```

In [111]:

```
index = pd.MultiIndex.from_tuples(tuples, names=['first', 'second'])
index
```

Out[111]:

```
MultiIndex(levels=[['bar', 'baz', 'foo', 'qux'], ['one', 'two']],
           codes=[[0, 0, 1, 1, 2, 2, 3, 3], [0, 1, 0, 1, 0, 1, 0, 1]],
           names=['first', 'second'])
```

In [112]:

```
df = pd.DataFrame(np.random.randn(8, 2), index=index, columns=['A', 'B'])
df
```

Out[112]:

		A	B
first	**second**		
bar	**one**	-1.130456	-0.678118
	two	1.289839	-1.376732
baz	**one**	0.372925	1.446147
	two	-0.459043	0.616563
foo	**one**	-0.748907	0.202167
	two	0.566093	1.405192
qux	**one**	1.066089	-0.564319
	two	-0.122939	-0.089435

In [113]:

```
df2 = df[:4]
df2
```

Out[113]:

		A	B
first	second		
bar	one	-1.130456	-0.678118
	two	1.289839	-1.376732
baz	one	0.372925	1.446147
	two	-0.459043	0.616563

In [114]:

```
# 類似 R - reshape2 套件
stacked = df2.stack()
stacked
```

Out[114]:

```
first  second
bar    one     A   -1.130456
               B   -0.678118
       two     A    1.289839
               B   -1.376732
baz    one     A    0.372925
               B    1.446147
       two     A   -0.459043
               B    0.616563
dtype: float64
```

In [115]:

```
stacked.unstack()
```

Out[115]:

		A	B
first	second		
bar	one	-1.130456	-0.678118
	two	1.289839	-1.376732
baz	one	0.372925	1.446147
	two	-0.459043	0.616563

In [116]:

```
stacked.unstack(1)
```

Out[116]:

	second	**one**	**two**
first			
bar	**A**	-1.130456	1.289839
	B	-0.678118	-1.376732
baz	**A**	0.372925	-0.459043
	B	1.446147	0.616563

In [117]:

```
stacked.unstack(0)
```

Out[117]:

	first	**bar**	**baz**
second			
one	**A**	-1.130456	0.372925
	B	-0.678118	1.446147
two	**A**	1.289839	-0.459043
	B	-1.376732	0.616563

In [118]:

```
# 5.8.2 Pivot Tables
```

In [119]:

```
df = pd.DataFrame({'A' : ['one', 'one', 'two', 'three'] * 3,
 'B' : ['A', 'B', 'C'] * 4,
 'C' : ['foo', 'foo', 'foo', 'bar', 'bar', 'bar'] * 2,
 'D' : np.random.randn(12),
 'E' : np.random.randn(12)})
```

In [120]:

```
df
```

Out[120]:

	A	B	C	D	E
0	one	A	foo	-1.558003	1.773625
1	one	B	foo	-0.094296	0.563927
2	two	C	foo	0.334020	-0.677899
3	three	A	bar	-1.050374	-1.114131
4	one	B	bar	1.002836	-0.128907
5	one	C	bar	0.916780	2.145353
6	two	A	foo	-2.052363	0.856735
7	three	B	foo	-0.186344	-0.745535
8	one	C	foo	0.051240	-0.250160
9	one	A	bar	0.156870	-0.473240
10	two	B	bar	-1.471838	0.973769
11	three	C	bar	-0.610691	-0.752378

In [121]:

```
pd.pivot_table(df, values='D', index=['A', 'B'], columns=['C'])
```

Out[121]:

	C	**bar**	**foo**
A	**B**		
one	**A**	0.156870	-1.558003
	B	1.002836	-0.094296
	C	0.916780	0.051240
three	**A**	-1.050374	NaN
	B	NaN	-0.186344
	C	-0.610691	NaN
two	**A**	NaN	-2.052363
	B	-1.471838	NaN
	C	NaN	0.334020

5.9 Time Series 時間序列

In [122]:

```
rng = pd.date_range('1/1/2012', periods=100, freq='S')
rng
```

Out[122]:

```
DatetimeIndex(['2012-01-01 00:00:00', '2012-01-01 00:00:01',
               '2012-01-01 00:00:02', '2012-01-01 00:00:03',
               '2012-01-01 00:00:04', '2012-01-01 00:00:05',
               '2012-01-01 00:00:06', '2012-01-01 00:00:07',
               '2012-01-01 00:00:08', '2012-01-01 00:00:09',
               '2012-01-01 00:00:10', '2012-01-01 00:00:11',
               '2012-01-01 00:00:12', '2012-01-01 00:00:13',
               '2012-01-01 00:00:14', '2012-01-01 00:00:15',
               '2012-01-01 00:00:16', '2012-01-01 00:00:17',
               '2012-01-01 00:00:18', '2012-01-01 00:00:19',
               '2012-01-01 00:00:20', '2012-01-01 00:00:21',
               '2012-01-01 00:00:22', '2012-01-01 00:00:23',
               '2012-01-01 00:00:24', '2012-01-01 00:00:25',
               '2012-01-01 00:00:26', '2012-01-01 00:00:27',
               '2012-01-01 00:00:28', '2012-01-01 00:00:29',
               '2012-01-01 00:00:30', '2012-01-01 00:00:31',
               '2012-01-01 00:00:32', '2012-01-01 00:00:33',
               '2012-01-01 00:00:34', '2012-01-01 00:00:35',
               '2012-01-01 00:00:36', '2012-01-01 00:00:37',
               '2012-01-01 00:00:38', '2012-01-01 00:00:39',
               '2012-01-01 00:00:40', '2012-01-01 00:00:41',
               '2012-01-01 00:00:42', '2012-01-01 00:00:43',
               '2012-01-01 00:00:44', '2012-01-01 00:00:45',
               '2012-01-01 00:00:46', '2012-01-01 00:00:47',
               '2012-01-01 00:00:48', '2012-01-01 00:00:49',
               '2012-01-01 00:00:50', '2012-01-01 00:00:51',
               '2012-01-01 00:00:52', '2012-01-01 00:00:53',
               '2012-01-01 00:00:54', '2012-01-01 00:00:55',
               '2012-01-01 00:00:56', '2012-01-01 00:00:57',
               '2012-01-01 00:00:58', '2012-01-01 00:00:59',
               '2012-01-01 00:01:00', '2012-01-01 00:01:01',
               '2012-01-01 00:01:02', '2012-01-01 00:01:03',
               '2012-01-01 00:01:04', '2012-01-01 00:01:05',
               '2012-01-01 00:01:06', '2012-01-01 00:01:07',
               '2012-01-01 00:01:08', '2012-01-01 00:01:09',
               '2012-01-01 00:01:10', '2012-01-01 00:01:11',
               '2012-01-01 00:01:12', '2012-01-01 00:01:13',
               '2012-01-01 00:01:14', '2012-01-01 00:01:15',
               '2012-01-01 00:01:16', '2012-01-01 00:01:17',
               '2012-01-01 00:01:18', '2012-01-01 00:01:19',
               '2012-01-01 00:01:20', '2012-01-01 00:01:21',
               '2012-01-01 00:01:22', '2012-01-01 00:01:23',
               '2012-01-01 00:01:24', '2012-01-01 00:01:25',
               '2012-01-01 00:01:26', '2012-01-01 00:01:27',
               '2012-01-01 00:01:28', '2012-01-01 00:01:29',
               '2012-01-01 00:01:30', '2012-01-01 00:01:31',
               '2012-01-01 00:01:32', '2012-01-01 00:01:33',
               '2012-01-01 00:01:34', '2012-01-01 00:01:35',
               '2012-01-01 00:01:36', '2012-01-01 00:01:37',
               '2012-01-01 00:01:38', '2012-01-01 00:01:39'],
              dtype='datetime64[ns]', freq='S')
```

In [123]:

```
ts = pd.Series(np.random.randint(0, 500, len(rng)), index=rng)
```

In [124]:

```
ts
```

Out[124]:

```
2012-01-01 00:00:00      1
2012-01-01 00:00:01    292
2012-01-01 00:00:02    429
2012-01-01 00:00:03     41
2012-01-01 00:00:04    172
2012-01-01 00:00:05    491
2012-01-01 00:00:06    134
2012-01-01 00:00:07    333
2012-01-01 00:00:08    173
2012-01-01 00:00:09    354
2012-01-01 00:00:10    444
2012-01-01 00:00:11    476
2012-01-01 00:00:12    364
2012-01-01 00:00:13    198
2012-01-01 00:00:14    460
2012-01-01 00:00:15    372
2012-01-01 00:00:16    268
2012-01-01 00:00:17    493
2012-01-01 00:00:18    349
2012-01-01 00:00:19    230
2012-01-01 00:00:20     45
2012-01-01 00:00:21    244
2012-01-01 00:00:22    295
2012-01-01 00:00:23    402
2012-01-01 00:00:24    463
2012-01-01 00:00:25    201
2012-01-01 00:00:26    126
2012-01-01 00:00:27    141
2012-01-01 00:00:28    144
2012-01-01 00:00:29    200
                      ... 
2012-01-01 00:01:10    148
2012-01-01 00:01:11    491
2012-01-01 00:01:12    196
2012-01-01 00:01:13    378
2012-01-01 00:01:14    476
2012-01-01 00:01:15    338
2012-01-01 00:01:16    160
2012-01-01 00:01:17    191
2012-01-01 00:01:18    160
2012-01-01 00:01:19    316
2012-01-01 00:01:20    246
2012-01-01 00:01:21    389
2012-01-01 00:01:22    293
2012-01-01 00:01:23    283
2012-01-01 00:01:24     27
2012-01-01 00:01:25    469
2012-01-01 00:01:26     74
2012-01-01 00:01:27    328
2012-01-01 00:01:28    379
2012-01-01 00:01:29    438
2012-01-01 00:01:30      4
2012-01-01 00:01:31    357
2012-01-01 00:01:32    299
2012-01-01 00:01:33    434
```

```
2012-01-01 00:01:34    229
2012-01-01 00:01:35     84
2012-01-01 00:01:36    147
2012-01-01 00:01:37    123
2012-01-01 00:01:38    358
2012-01-01 00:01:39    438
Freq: S, Length: 100, dtype: int32
```

In [125]:

```
ts.resample('5Min').sum()
```

Out[125]:

```
2012-01-01    27038
Freq: 5T, dtype: int32
```

In [126]:

```
rng = pd.date_range('3/6/2012 00:00', periods=5, freq='D')
rng
```

Out[126]:

```
DatetimeIndex(['2012-03-06', '2012-03-07', '2012-03-08', '2012-03-09',
               '2012-03-10'],
              dtype='datetime64[ns]', freq='D')
```

In [127]:

```
ts = pd.Series(np.random.randn(len(rng)), rng)
ts
```

Out[127]:

```
2012-03-06   -0.564270
2012-03-07    1.142990
2012-03-08   -1.530038
2012-03-09    0.323460
2012-03-10    0.699793
Freq: D, dtype: float64
```

In [128]:

```
ts_utc = ts.tz_localize('UTC')
ts_utc
```

Out[128]:

```
2012-03-06 00:00:00+00:00   -0.564270
2012-03-07 00:00:00+00:00    1.142990
2012-03-08 00:00:00+00:00   -1.530038
2012-03-09 00:00:00+00:00    0.323460
2012-03-10 00:00:00+00:00    0.699793
Freq: D, dtype: float64
```

In [129]:

```
# 間隔一個月
rng = pd.date_range('1/1/2012', periods=5, freq='M')
rng
```

Out[129]:

```
DatetimeIndex(['2012-01-31', '2012-02-29', '2012-03-31', '2012-04-30',
               '2012-05-31'],
              dtype='datetime64[ns]', freq='M')
```

In [130]:

```
ts = pd.Series(np.random.randn(len(rng)), index=rng)
ts
```

Out[130]:

```
2012-01-31   -1.546689
2012-02-29   -0.272964
2012-03-31   -0.468497
2012-04-30    1.288806
2012-05-31    0.578089
Freq: M, dtype: float64
```

In [131]:

```
# to_period() 轉換為期間
ps = ts.to_period()
ps
```

Out[131]:

```
2012-01   -1.546689
2012-02   -0.272964
2012-03   -0.468497
2012-04    1.288806
2012-05    0.578089
Freq: M, dtype: float64
```

In [132]:

```
# to_timestamp 轉換為時間戳記
ps.to_timestamp()
```

Out[132]:

```
2012-01-01   -1.546689
2012-02-01   -0.272964
2012-03-01   -0.468497
2012-04-01    1.288806
2012-05-01    0.578089
Freq: MS, dtype: float64
```

5.10 Categoricals 類別資料型別

In [133]:

```
df = pd.DataFrame({"id":[1,2,3,4,5,6], "raw_grade":['a', 'b', 'b', 'a', 'a', 'e']})
```

In [134]:

```
df
```

Out[134]:

	id	raw_grade
0	1	a
1	2	b
2	3	b
3	4	a
4	5	a
5	6	e

In [135]:

```
# category 與 R - factor 類似
df["grade"] = df["raw_grade"].astype("category")
df["grade"]
```

Out[135]:

```
0    a
1    b
2    b
3    a
4    a
5    e
Name: grade, dtype: category
Categories (3, object): [a, b, e]
```

In [136]:

```
# 更改名稱
df["grade"].cat.categories = ["1very good", "2good", "3very bad"]
df
```

Out[136]:

	id	raw_grade	grade
0	1	a	1very good
1	2	b	2good
2	3	b	2good
3	4	a	1very good
4	5	a	1very good
5	6	e	3very bad

In [137]:

```
s = df["grade"]
s
```

Out[137]:

```
0    1very good
1         2good
2         2good
3    1very good
4    1very good
5     3very bad
Name: grade, dtype: category
Categories (3, object): [1very good, 2good, 3very bad]
```

In [138]:

```
s.cat.categories
```

Out[138]:

```
Index(['1very good', '2good', '3very bad'], dtype='object')
```

In [139]:

```
s.cat.ordered
```

Out[139]:

```
False
```

In [140]:

```
# need to verify (原始:3個levels, 修改為5個levels)
# df["grade"] = df["grade"].cat.set_categories(["01very bad", "02bad", "03medium", "04good"
# df["grade"]
```

5.11 Plotting 繪圖

DataFrame.plot 包括常用繪圖方式, 以下列出全部繪圖函數, 依最常使用函數, 優先排序:

參考: https://pandas.pydata.org/pandas-docs/stable/reference/frame.html#plotting (https://pandas.pydata.org/pandas-docs/stable/reference/frame.html#plotting)

1. 繪圖 DataFrame.plot([x, y, kind, ax, ….]) DataFrame plotting accessor and method
2. 長條圖 DataFrame.plot.bar(self[, x, y]) Vertical bar plot.
3. 水平長條圖 DataFrame.plot.barh(self[, x, y]) Make a horizontal bar plot.
4. 盒鬚圖 DataFrame.plot.box(self[, by]) Make a box plot of the DataFrame columns.
5. 盒鬚圖 DataFrame.boxplot(self[, column, by, ax, …]) Make a box plot from DataFrame columns.
6. 直方圖 DataFrame.plot.hist(self[, by, bins]) Draw one histogram of the DataFrame’s columns.
7. 直方圖 DataFrame.hist(data[, column, by, grid, …]) Make a histogram of the DataFrame’s.
8. 區域圖 DataFrame.plot.area(self[, x, y]) Draw a stacked area plot.
9. 密度圖 DataFrame.plot.density(self[, bw_method, ind]) Generate Kernel Density Estimate plot using Gaussian kernels.
10. 六邊箱圖 DataFrame.plot.hexbin(self, x, y[, C, …]) Generate a hexagonal binning plot.

11. 核密度圖 DataFrame.plot.kde(self[, bw_method, ind]) Generate Kernel Density Estimate plot using Gaussian kernels.
12. 線圖 DataFrame.plot.line(self[, x, y]) Plot Series or DataFrame as lines.
13. 圓形圖 DataFrame.plot.pie(self, **kwargs) Generate a pie plot.
14. 散佈圖 DataFrame.plot.scatter(self, x, y[, s, c]) Create a scatter plot with varying marker point size and color.

In [141]:

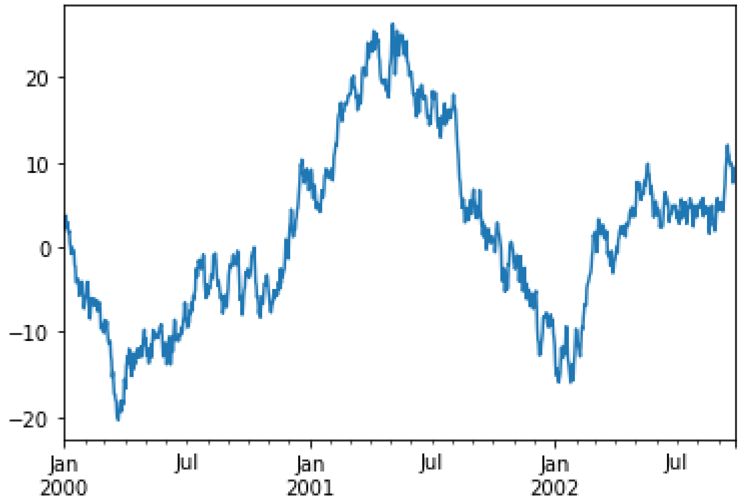
```
ts = pd.Series(np.random.randn(1000), index=pd.date_range('1/1/2000', periods=1000))
```

In [142]:

```
ts = ts.cumsum()
```

In [143]:

```
ts.plot()
plt.show()
```



In [144]:

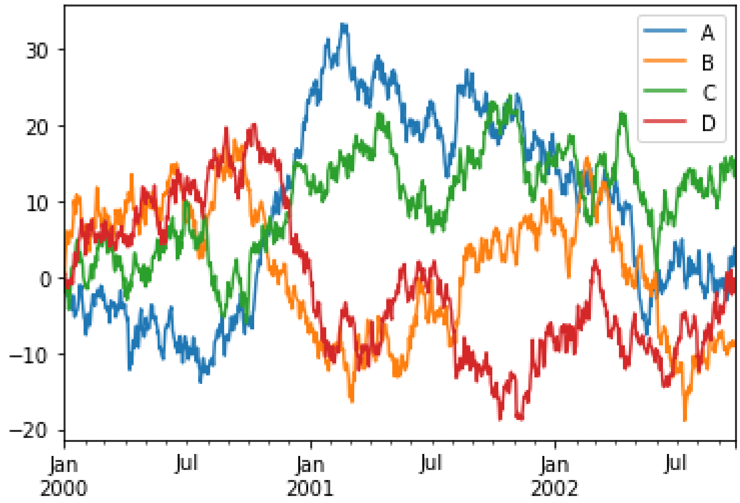
```
df = pd.DataFrame(np.random.randn(1000, 4), index=ts.index, columns=['A', 'B', 'C', 'D'])
```

In [145]:

```
df = df.cumsum()
```

In [146]:

```
df.plot(); plt.legend(loc='best');plt.show() # 使用 ; 區隔, 將3個指令寫在一行
```



5.12 Getting Data In/Out 輸入/輸出資料

In [147]:

```
# 5.12.1 CSV
```

In [148]:

```
df.to_csv('foo.csv')
```

In [149]:

```
pd.read_csv('foo.csv')
```

Out[149]:

	Unnamed: 0	A	B	C	D
0	2000-01-01	-1.515421	1.046894	1.103273	-0.017596
1	2000-01-02	-0.879449	0.179941	-0.525108	0.472839
2	2000-01-03	-0.357084	2.333477	-0.788783	-0.221006
3	2000-01-04	-1.888479	3.726610	-2.157528	-1.063497
4	2000-01-05	-1.505090	5.505807	-1.412244	-0.724003
5	2000-01-06	-2.041952	6.041225	-1.904534	-1.192538
6	2000-01-07	-2.599241	5.097778	-2.848507	-1.532498
7	2000-01-08	-2.104231	4.368956	-4.323252	-1.061803
8	2000-01-09	-3.690357	5.455412	-3.344782	-0.485067
9	2000-01-10	-3.666496	5.436646	-2.689336	-0.342853
10	2000-01-11	-3.300002	5.956283	-1.338430	-0.993244
11	2000-01-12	-4.326059	5.846544	0.798152	-0.164640
12	2000-01-13	-4.139932	5.215530	1.291351	-0.373410
13	2000-01-14	-2.471326	6.592691	1.211470	-0.933474
14	2000-01-15	-2.460295	7.641627	1.196404	0.568512
15	2000-01-16	-4.686822	10.092050	1.139721	2.173693
16	2000-01-17	-5.310315	9.324614	2.138259	3.148100
17	2000-01-18	-4.554471	8.290772	2.748017	1.401523
18	2000-01-19	-4.767771	10.500934	4.014797	1.983516
19	2000-01-20	-4.442251	10.838706	4.666799	2.328542
20	2000-01-21	-4.388924	10.391876	4.916358	2.176266
21	2000-01-22	-3.655122	10.199977	4.497655	3.533653
22	2000-01-23	-2.910483	9.735512	3.724775	4.607368
23	2000-01-24	-1.095846	9.911080	1.851604	4.976893
24	2000-01-25	-1.823465	10.486732	3.223405	5.775840
25	2000-01-26	-1.627052	8.650146	3.029852	6.586670
26	2000-01-27	-1.166801	6.359527	2.157567	6.761470
27	2000-01-28	-2.810053	5.929106	2.161038	7.608134
28	2000-01-29	-3.787554	5.277211	1.536752	6.779525
29	2000-01-30	-4.495474	5.234718	-0.049852	5.301118
...	...	...	...	...	...
970	2002-08-28	-0.454958	-9.498523	10.448580	-3.564366
971	2002-08-29	-0.770390	-8.996964	10.610715	-2.044398
972	2002-08-30	-1.740845	-8.322504	9.018427	-5.440972

	Unnamed: 0	A	B	C	D
973	2002-08-31	-2.522881	-8.387136	10.181419	-4.729880
974	2002-09-01	-1.913962	-8.290372	10.061177	-5.690780
975	2002-09-02	-1.035865	-7.616352	10.402122	-6.177104
976	2002-09-03	-0.326674	-7.306872	11.390000	-5.693970
977	2002-09-04	-0.636447	-8.038326	12.516559	-3.753444
978	2002-09-05	-0.720842	-7.752041	14.667304	-4.264390
979	2002-09-06	-1.372068	-7.318511	14.942900	-4.073682
980	2002-09-07	-0.470838	-7.135204	14.166464	-4.804247
981	2002-09-08	-0.173262	-8.185753	14.487074	-4.040609
982	2002-09-09	-1.077481	-8.800000	14.261505	-4.764320
983	2002-09-10	-1.577217	-9.655900	12.631299	-3.417862
984	2002-09-11	-1.697957	-9.204640	13.770891	-3.240072
985	2002-09-12	-1.459475	-9.513261	15.763124	-1.251192
986	2002-09-13	-2.943844	-9.683493	14.549463	0.012185
987	2002-09-14	-3.110415	-10.319449	14.878091	0.549640
988	2002-09-15	-2.180200	-10.104168	14.417792	-0.017051
989	2002-09-16	-0.389322	-9.758274	13.836178	-0.721796
990	2002-09-17	0.474768	-9.114384	14.717156	-0.834182
991	2002-09-18	2.596129	-8.674412	14.848614	-2.030694
992	2002-09-19	2.488058	-9.183320	15.417202	-0.987737
993	2002-09-20	1.301304	-9.225143	15.358592	0.931544
994	2002-09-21	2.213917	-9.047657	15.850491	-2.369491
995	2002-09-22	2.583581	-8.478367	14.503597	-2.129820
996	2002-09-23	1.451245	-8.410277	15.459656	-0.209586
997	2002-09-24	2.624274	-9.022725	13.609603	-1.893872
998	2002-09-25	3.826023	-9.146473	13.187133	-1.780519
999	2002-09-26	3.546855	-8.732078	13.888444	-1.247862

1000 rows × 5 columns

In [150]:

```
# 5.12.2 HDF5
```

In [151]:

```
df.to_hdf('foo.h5','df')
```

In [152]:

```
pd.read_hdf('foo.h5','df')
```

Out[152]:

```
                    A         B         C         D
2000-01-01  -1.515421  1.046894  1.103273 -0.017596
2000-01-02  -0.879449  0.179941 -0.525108  0.472839
2000-01-03  -0.357084  2.333477 -0.788783 -0.221006
2000-01-04  -1.888479  3.726610 -2.157528 -1.063497
2000-01-05  -1.505090  5.505807 -1.412244 -0.724003
2000-01-06  -2.041952  6.041225 -1.904534 -1.192538
2000-01-07  -2.599241  5.097778 -2.848507 -1.532498
2000-01-08  -2.104231  4.368956 -4.323252 -1.061803
2000-01-09  -3.690357  5.455412 -3.344782 -0.485067
2000-01-10  -3.666496  5.436646 -2.689336 -0.342853
```

In [153]:

```
# 5.12.3 Excel
```

In [154]:

```
df.to_excel('foo.xlsx', sheet_name='Sheet1')
```

In [155]:

```
pd.read_excel('foo.xlsx', 'Sheet1', index_col=None, na_values=['NA'])
```

Out[155]:

	Unnamed: 0	A	B	C	D
0	2000-01-01	-1.515421	1.046894	1.103273	-0.017596
1	2000-01-02	-0.879449	0.179941	-0.525108	0.472839
2	2000-01-03	-0.357084	2.333477	-0.788783	-0.221006
3	2000-01-04	-1.888479	3.726610	-2.157528	-1.063497
4	2000-01-05	-1.505090	5.505807	-1.412244	-0.724003
5	2000-01-06	-2.041952	6.041225	-1.904534	-1.192538
6	2000-01-07	-2.599241	5.097778	-2.848507	-1.532498
7	2000-01-08	-2.104231	4.368956	-4.323252	-1.061803
8	2000-01-09	-3.690357	5.455412	-3.344782	-0.485067
9	2000-01-10	-3.666496	5.436646	-2.689336	-0.342853
10	2000-01-11	-3.300002	5.956283	-1.338430	-0.993244
11	2000-01-12	-4.326059	5.846544	0.798152	-0.164640
12	2000-01-13	-4.139932	5.215530	1.291351	-0.373410
13	2000-01-14	-2.471326	6.592691	1.211470	-0.933474
14	2000-01-15	-2.460295	7.641627	1.196404	0.568512
15	2000-01-16	-4.686822	10.092050	1.139721	2.173693
16	2000-01-17	-5.310315	9.324614	2.138259	3.148100
17	2000-01-18	-4.554471	8.290772	2.748017	1.401523
18	2000-01-19	-4.767771	10.500934	4.014797	1.983516
19	2000-01-20	-4.442251	10.838706	4.666799	2.328542
20	2000-01-21	-4.388924	10.391876	4.916358	2.176266
21	2000-01-22	-3.655122	10.199977	4.497655	3.533653
22	2000-01-23	-2.910483	9.735512	3.724775	4.607368
23	2000-01-24	-1.095846	9.911080	1.851604	4.976893
24	2000-01-25	-1.823465	10.486732	3.223405	5.775840
25	2000-01-26	-1.627052	8.650146	3.029852	6.586670
26	2000-01-27	-1.166801	6.359527	2.157567	6.761470
27	2000-01-28	-2.810053	5.929106	2.161038	7.608134
28	2000-01-29	-3.787554	5.277211	1.536752	6.779525
29	2000-01-30	-4.495474	5.234718	-0.049852	5.301118
...	...	...	...	...	...
970	2002-08-28	-0.454958	-9.498523	10.448580	-3.564366
971	2002-08-29	-0.770390	-8.996964	10.610715	-2.044398
972	2002-08-30	-1.740845	-8.322504	9.018427	-5.440972

	Unnamed: 0	A	B	C	D
973	2002-08-31	-2.522881	-8.387136	10.181419	-4.729880
974	2002-09-01	-1.913962	-8.290372	10.061177	-5.690780
975	2002-09-02	-1.035865	-7.616352	10.402122	-6.177104
976	2002-09-03	-0.326674	-7.306872	11.390000	-5.693970
977	2002-09-04	-0.636447	-8.038326	12.516559	-3.753444
978	2002-09-05	-0.720842	-7.752041	14.667304	-4.264390
979	2002-09-06	-1.372068	-7.318511	14.942900	-4.073682
980	2002-09-07	-0.470838	-7.135204	14.166464	-4.804247
981	2002-09-08	-0.173262	-8.185753	14.487074	-4.040609
982	2002-09-09	-1.077481	-8.800000	14.261505	-4.764320
983	2002-09-10	-1.577217	-9.655900	12.631299	-3.417862
984	2002-09-11	-1.697957	-9.204640	13.770891	-3.240072
985	2002-09-12	-1.459475	-9.513261	15.763124	-1.251192
986	2002-09-13	-2.943844	-9.683493	14.549463	0.012185
987	2002-09-14	-3.110415	-10.319449	14.878091	0.549640
988	2002-09-15	-2.180200	-10.104168	14.417792	-0.017051
989	2002-09-16	-0.389322	-9.758274	13.836178	-0.721796
990	2002-09-17	0.474768	-9.114384	14.717156	-0.834182
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993	2002-09-20	1.301304	-9.225143	15.358592	0.931544
994	2002-09-21	2.213917	-9.047657	15.850491	-2.369491
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