Berlin School of Economics and Law
Prof. Dr. Natalie Packham

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LV-Nr. 425093

Computational Finance and FinTech

File I/O

Contents

5 Input/Output (IO)

Input / Output

- Further reading: **Py4Fi, Chapter 9**
- This chapter is about loading data from and storing data to a persistent data source (e.g. hard drive).
- Often financial data comes as `.csv`-files or `xlsx-` / `xls`-files.
- Before working with the data it must be loaded into Python first.
- Data can be loaded, written and stored using Python's built-in functions or `csv` or `pandas`.
- The book contains additional information on reading from and writing to SQL databases.

Input / Output

- The usual initialisation:

[1]:
```
import numpy as np
import pandas as pd
from pylab import mpl, plt
plt.style.use('seaborn')
%matplotlib inline
```

5.1 Basic IO with Python

CSV files

- A popular data format for working with spreadsheet-like data is **comma-separated values**, abbreviated as `.csv`.
- In a csv file, data entries are stored in rows, with column separated by comma.
- The top row may contain the column names.

CSV files

- Create a dummy data set to demonstrate how to work with csv files:

[2]:
```
rows = 10000
a = np.random.standard_normal((rows, 5)).round(4)
a[:2]
```

[2]:
```
array([[ 1.4625, -0.0305, -1.4143,  0.3824,  0.1528],
       [-0.4249, -0.244 ,  0.5228,  1.1071, -0.3109]])
```

[3]:
```
t = pd.date_range(start='2019/1/1', periods=rows, freq='H') # creates a␣
↪DateTimeIndex
```

[4]:
```
t[:4]
```

[4]:
```
DatetimeIndex(['2019-01-01 00:00:00', '2019-01-01 01:00:00',
               '2019-01-01 02:00:00', '2019-01-01 03:00:00'],
              dtype='datetime64[ns]', freq='H')
```

Note: 'H' is used for an hourly frequency, see here for more information about the `freq` settings.

Creating a .csv-file in Python

- `open()` with the `w` flag creates an empty file.

[5]:
```
import os
path = os.getcwd() + '/' # the current working directory
path
```

[5]:
```
'/Users/nat/Documents/GitHub/compfin_dev/'
```

[6]:
```
csv_file = open(path + 'RandomNumbers.csv', 'w') # opens a file for writing
header = 'date,no1,no2,no3,no4,no5\n'
csv_file.write(header) # defines the header row and writes it as the first line
```

[6]:
```
25
```

Creating a .csv-file in Python

- The data is written to the `.csv`-file using Python's built-in function `write()`:

[7]:
```
for t_, (no1, no2, no3, no4, no5) in zip(t, a): # combines the data row-wise ...
    s = '{},{},{},{},{},{}\n'.format(t_, no1, no2, no3, no4, no5) # ... into string␣
↪objects ...
    csv_file.write(s) # ... and writes it to the file line-by-line
```

- The changes are saved by calling `close()`.

[8]:
```
csv_file.close()
```

[9]:
```
ls -l RandomN* # Here it is!
```

```
-rw-r--r--@ 1 nat  staff  569343 23 Mar 20:48 RandomNumbers.csv
-rw-r--r--  1 nat  staff  445582 25 May  2020 RandomNumbers.xlsx
-rw-r--r--  1 nat  staff  579310 25 May  2020 RandomNumbers_2.csv
-rw-r--r--  1 nat  staff  602833 25 May  2020 RandomNumbers_3.csv
```

Reading a .csv-file in Python

[10]:
```
csv_file = open(path + 'RandomNumbers.csv', 'r') # open file for reading ('r')
RandomNumbers = csv_file.readlines() # read the file contents in one step
RandomNumbers[:5]
```

[10]:
```
['date,no1,no2,no3,no4,no5\n',
 '2019-01-01 00:00:00,1.4625,-0.0305,-1.4143,0.3824,0.1528\n',
 '2019-01-01 01:00:00,-0.4249,-0.244,0.5228,1.1071,-0.3109\n',
 '2019-01-01 02:00:00,0.7776,0.1785,-0.0359,-0.9896,0.7601\n',
 '2019-01-01 03:00:00,0.3889,0.1908,-0.2494,-1.2765,0.2922\n']
```

[11]:
```
csv_file.close() # close the file
```

csv reader

- CSV files are so common that a dedicated package for reading (and writing) CSV files exists.

[12]:
```
import csv

with open(path + 'RandomNumbers.csv', 'r') as f:
    numbers = csv.reader(f) # returns every line as a list object
    lines = [line for line in numbers]

lines[:5]
```

[12]:
```
[['date', 'no1', 'no2', 'no3', 'no4', 'no5'],
 ['2019-01-01 00:00:00', '1.4625', '-0.0305', '-1.4143', '0.3824', '0.1528'],
 ['2019-01-01 01:00:00', '-0.4249', '-0.244', '0.5228', '1.1071', '-0.3109'],
 ['2019-01-01 02:00:00', '0.7776', '0.1785', '-0.0359', '-0.9896', '0.7601'],
 ['2019-01-01 03:00:00', '0.3889', '0.1908', '-0.2494', '-1.2765', '0.2922']]
```

[13]:
```
type(lines)
```

[13]:
```
list
```

Note: Aside of a `list`, the `csv` module can also return an `OrderedDict`, by using `DictReader()`. To learn more about the object `OrderedDict`, see here.

csv writer

- CSV files are easily written to a file using the `csv` package.
- Write the `.csv`-file, using the functions `writer()` and `writerow()`.

[14]:
```
with open(path + 'RandomNumbers_2.csv', 'w') as f:
    numbers = csv.writer(f, delimiter = ',')
    for line in lines:
        numbers.writerow(line)
```

5.2 CSV files with pandas

- Some of the data formats that **pandas** can read/write:
  - CSV (Comma-separated values)
  - SQL (Structured query language)
  - XLS / XLSX (Microsoft Excel files)
  - JSON (Javascript object notation)
  - HTML (Hyptertext markup language)

CSV files with pandas

- Reading a CSV file with pandas loads the data into a `DataFrame` object.
- The first line of of the file is assumed to be the header.

[15]:
```
df = pd.read_csv('RandomNumbers.csv')
```

[16]:
```
df.head()
```

[16]:

	date	no1	no2	no3	no4	no5
0	2019-01-01 00:00:00	1.4625	-0.0305	-1.4143	0.3824	0.1528
1	2019-01-01 01:00:00	-0.4249	-0.2440	0.5228	1.1071	-0.3109
2	2019-01-01 02:00:00	0.7776	0.1785	-0.0359	-0.9896	0.7601
3	2019-01-01 03:00:00	0.3889	0.1908	-0.2494	-1.2765	0.2922
4	2019-01-01 04:00:00	-0.4529	1.1905	-0.9269	-1.0902	-0.0477

CSV files with pandas

- `pd.read_csv()` adds an index by default.
- To use a different index, add `set_index(columnName)`.

[17]:
```
df.set_index('date', inplace=True)
df.head()
```

[17]:

date	no1	no2	no3	no4	no5
2019-01-01 00:00:00	1.4625	-0.0305	-1.4143	0.3824	0.1528
2019-01-01 01:00:00	-0.4249	-0.2440	0.5228	1.1071	-0.3109
2019-01-01 02:00:00	0.7776	0.1785	-0.0359	-0.9896	0.7601
2019-01-01 03:00:00	0.3889	0.1908	-0.2494	-1.2765	0.2922
2019-01-01 04:00:00	-0.4529	1.1905	-0.9269	-1.0902	-0.0477

Writing a `.csv`-file using pandas

[18]:
```
df['no1'] = df['no1'] + 1000
df.to_csv('RandomNumbers_3.csv') # couldn't be easier...
```

5.3 Excel-files with pandas

- Microsoft Excel files can be read and created easily using `pandas`.
- This is quite similar to reading / writing CSV files.

[19]:
```
df.to_excel('RandomNumbers.xlsx')
```

[20]:
```
ls -l RandomNumbers*
```

```
-rw-r--r--@ 1 nat  staff  569343 23 Mar 20:48 RandomNumbers.csv
-rw-r--r--  1 nat  staff  445096 23 Mar 20:48 RandomNumbers.xlsx
-rw-r--r--  1 nat  staff  579344 23 Mar 20:48 RandomNumbers_2.csv
-rw-r--r--  1 nat  staff  602605 23 Mar 20:48 RandomNumbers_3.csv
```

Reading a `.xlsx`-file using pandas

[21]:
```
df = pd.read_excel('RandomNumbers.xlsx', index_col=0)
```

[22]:
```
df.head()
```

[22]:

date	no1	no2	no3	no4	no5

```
2019-01-01 00:00:00  1001.4625 -0.0305 -1.4143  0.3824  0.1528
2019-01-01 01:00:00   999.5751 -0.2440  0.5228  1.1071 -0.3109
2019-01-01 02:00:00  1000.7776  0.1785 -0.0359 -0.9896  0.7601
2019-01-01 03:00:00  1000.3889  0.1908 -0.2494 -1.2765  0.2922
2019-01-01 04:00:00   999.5471  1.1905 -0.9269 -1.0902 -0.0477
```

5.4 Saving plots

- This section demonstrates how to make plots persistent for further processing.
- The file format is typically detected by the file name extensions.

[23]:
```
from matplotlib import pyplot as plt
import matplotlib.dates as mdates
```

[24]:
```
fig, ax = plt.subplots()
df['no1'][:100].plot()
fig.autofmt_xdate()
plt.savefig('LineChart.png')
```

Generating a `pdf` plot

[25]:
```
fig, ax = plt.subplots()
df['no1'][:100].plot()
fig.autofmt_xdate()
plt.savefig('LineChart.pdf')
```

Generating plots

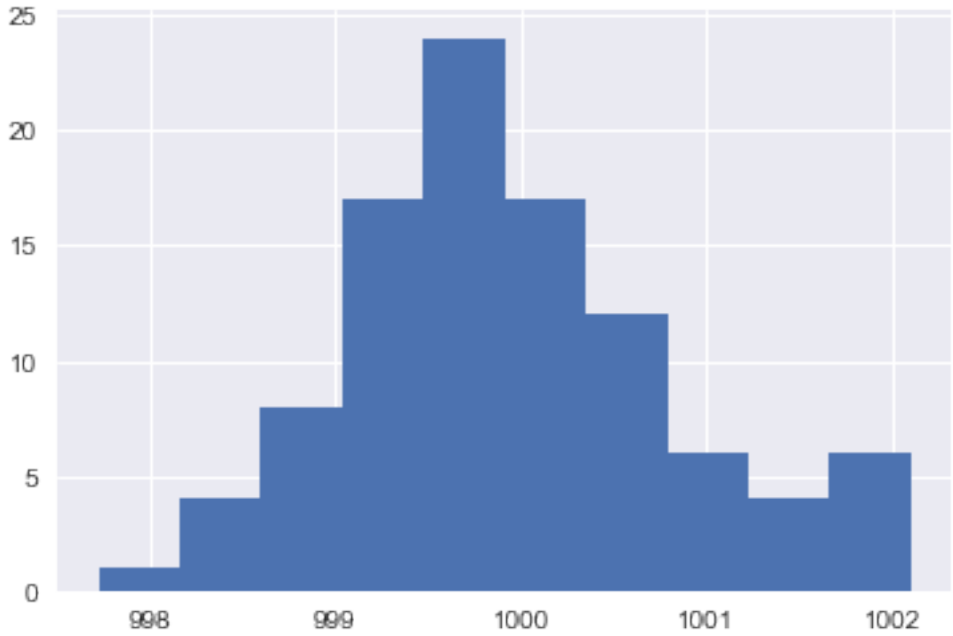
- There are various options for fine-tuning the appearance and quality of the plot.
- Let's check that both plots have been written to the hard disk:

[26]:
```
ls -l LineChart*
```

```
-rw-r--r--  1 nat  staff   9851 23 Mar 20:48 LineChart.pdf
-rw-r--r--@ 1 nat  staff  30985 23 Mar 20:48 LineChart.png
```

Another pdf plot

[27]:
```
df['no1'][1:100].hist()
plt.savefig('Hist.pdf')
```



5.5 Direct download from the internet: `pandas-datareader`

- Many data providers offer direct downloads through an API (application programming interface), an programming interface that controls data access and the data format.
- In other words, instead of manually downloading and subsequently importing a file, the data download can directly be incorporated into the program.
- The package `pandas-datareader` provides a convenient unified way of extracting data from various Internet sources into a pandas `DataFrame`.

Installing `pandas-datareader`

- Installation via anaconda: go to environments in the left menubar, enter `datareader` in `search packages` and install.
- Alternatively, use a terminal programme (command line) and type:
  - `pip install pandas-datareader`

- This is a frequently changing package... I had to use:
  - `pip install git+https://github.com/pydata/pandas-datareader.git`
- For more information, see here and here.

Using `pandas-datareader`

Using TIINGO requires that you create a free account and obtain an API key.

[28]:
```
import os
import pandas_datareader as pdr
```

```
/Users/natalie/anaconda3/lib/python3.7/site-
packages/pandas_datareader/compat/__init__.py:9: FutureWarning:
pandas.util.testing is deprecated. Use the functions in the public API at
pandas.testing instead.
  from pandas.util.testing import assert_frame_equal
```

[29]:
```
df = pdr.get_data_tiingo('GOOG', api_key=os.getenv('TIINGO_API_KEY'))
df.head()
```

[29]:

symbol	date	close	high	low	open	volume	adjClose	adjHigh	adjLow	adjOpen	adjVolume	divCash	splitFactor
GOOG	2016-03-24 00:00:00+00:00	735.30	737.747	731.00	732.01	1594891	735.30	737.747	731.00	732.01	1594891	0.0	1.0
	2016-03-28 00:00:00+00:00	733.53	738.990	732.50	736.79	1301327	733.53	738.990	732.50	736.79	1301327	0.0	1.0
	2016-03-29 00:00:00+00:00	744.77	747.250	728.76	734.59	1903758	744.77	747.250	728.76	734.59	1903758	0.0	1.0
	2016-03-30 00:00:00+00:00	750.53	757.880	748.74	750.10	1782427	750.53	757.880	748.74	750.10	1782427	0.0	1.0
	2016-03-31 00:00:00+00:00	744.95	750.850	740.94	749.25	1718798	744.95	750.850	740.94	749.25	1718798	0.0	1.0