Python Basic Course

Part II

Stefano Alberto Russo

Outline

- Part I: introduction and basics
  - What is Python
  - Tools and “hello world”
  - Basic syntax and data types
    - assignments, types and operators
    - conditional blocks and loops
- Part II: architecture
  - Functions
  - Scope
  - Built-ins
  - Modules
- Part IV: manipulating data
  - List operations
  - String operations
  - List comprehension
  - Reading and writing files
- Part VI: Pandas
  - Series and Dataframes
  - Common operations
  - How to read documentation

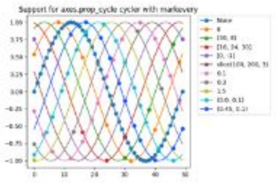
Pandas

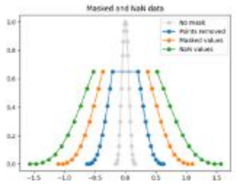
→ *What is Pandas?*

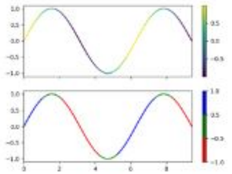
- Pandas is a “fast, powerful, flexible and easy to use open source data analysis and manipulation tool, built on top of the Python programming language”
- Offers data structures and operations for manipulating numerical tables in form of arrays and matrices, and time series to some extent.
- Pandas *does not* marry entirely the Python philosophy: often requires working with indexes to iterate over data structures and adopting an “old-fashioned” mindset.
- The name is derived from the term "panel data", an econometrics term for data sets that include observations over multiple time periods for the same individuals.

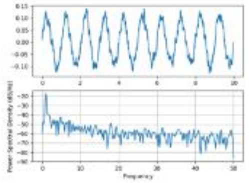
Pandas

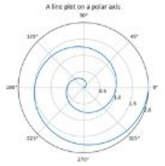
➔ *What is Pandas?*

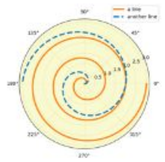


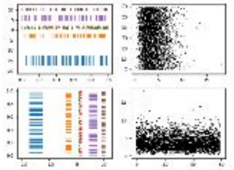


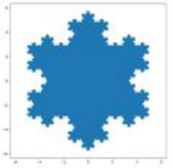


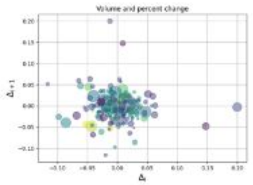


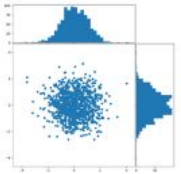


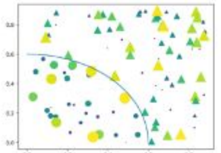












Pandas

→ *How to install Pandas?*

- Being an extra Python library, it needs to be installed.
- The Python Package Manager can be used for this in nearly all environments:

```
$ pip install pandas
```

- In Repl.it, it is automatically installed, so you don't have to worry about it.

Pandas

→ *How to use Pandas?*

- As any other library, Pandas needs to be imported before you can use it
- You import libraries exactly as you import modules:

```
import pandas
```

- You will usually see it imported in a renamed way, for brevity when using it

```
import pandas as pd
```

Pandas

→ *Other libraries involved*

- Numpy (Numerical Python) is another very common library used together with Pandas:

```
import pandas as pd
import numpy as np
```

- Matplotlib is instead a library for plotting, and in particular the pyplot module is very commonly used:

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

Pandas

→ *The Jupyter Notebooks*

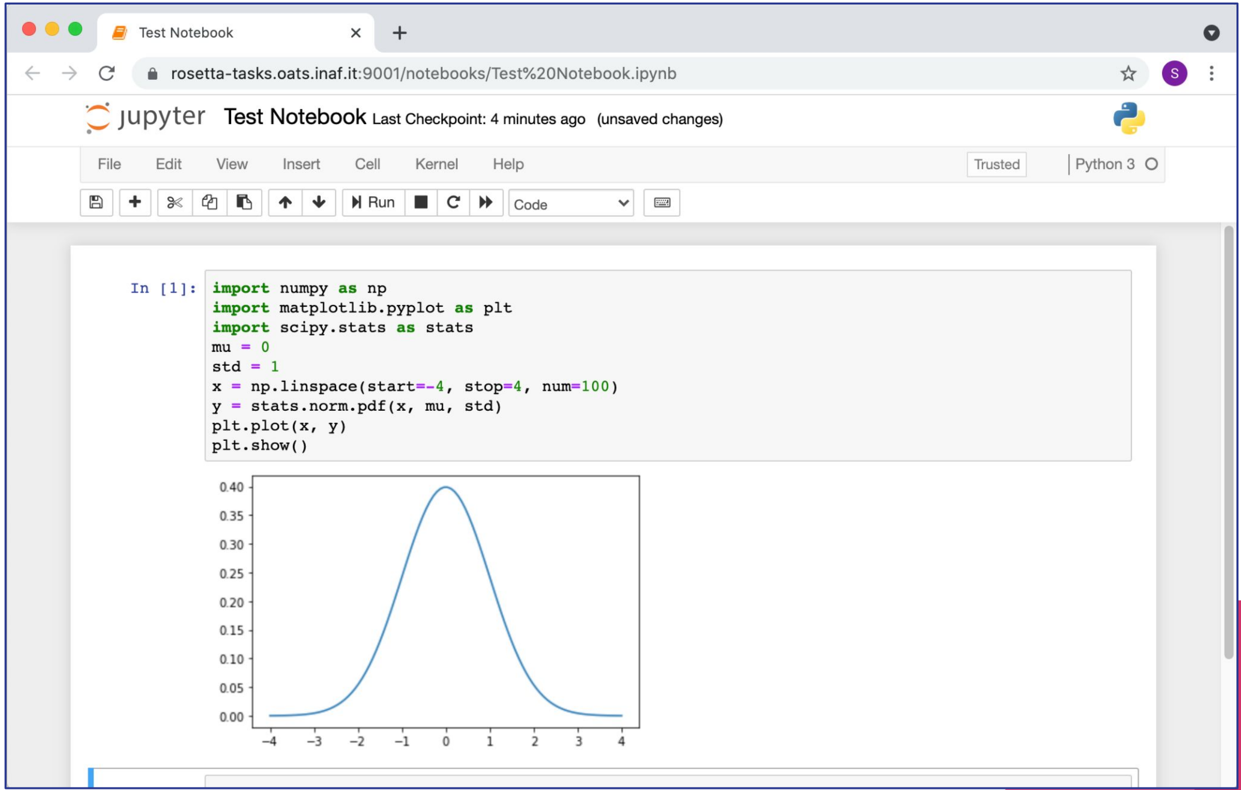
- Pandas has a strong interactive component and for interactive analysis gives it best when used with the Jupyter Notebooks
- These are computational graphical environments which wrap a Python interpreter
- Several services derived from this approach, as Google Colab or Kaggle Notebooks.
- Installing and using the Jupyter engine in your environment it is not covered here, but just for reference:

```
$ pip install notebook
$ jupyter notebook
```

..and then open your browser on localhost:8888

Pandas

→ *The Jupyter Notebooks*


Test Notebook
rosetta-tasks.oats.inaf.it:9001/notebooks/Test%20Notebook.ipynb
jupyter
Test Notebook Last Checkpoint: 4 minutes ago (unsaved changes)
File
Edit
View
Insert
Cell
Kernel
Help
Trusted
Python 3
Run
Code
In [1]:

```
import numpy as np
import matplotlib.pyplot as plt
import scipy.stats as stats
mu = 0
std = 1
x = np.linspace(start=-4, stop=4, num=100)
y = stats.norm.pdf(x, mu, std)
plt.plot(x, y)
plt.show()
```

Pandas

→ *Series*

- Pandas Series are one of the most basic data types. You can think of them as Python lists, but provide much more features.

```
series = pd.Series([4,5,6])
print(series[0])
```

```
4
```

Pandas

→ *Series*

- Series have an index to speed up data access. By defaults, it is just composed by the positions of the elements

```
series = pd.Series([4,5,6])
print(series)
```

```
0    4
1    5
2    6
dtype: int64
```

Pandas

➜ *Series*

- Series have an index to speed up data access. By defaults, it is just composed by the positions of the elements

```
series = pd.Series([4,5,6])
print(series)
```

Index

```
0    4
1    5
2    6
dtype: int64
```

Pandas

→ *Series*

- However, other types of indexes are possible, for example based on letters, or dates and time. They are more complex to deal with.

```
series = pd.Series([4,5,6])
series.index = ['a','b','c']
```

```
a    4
b    5
c    6
dtype: int64
```

Pandas

→ *Series*

- However, other types of indexes are possible, for example based on letters, or dates and time. They are more complex to deal with.

```
series = pd.Series([4,5,6])
series.index = ['a','b','c']
print(series[0])
```

```
4
```

Pandas

→ *Series*

- However, other types of indexes are possible, for example based on letters, or dates and time. They are more complex to deal with.

```
series = pd.Series([4,5,6])
series.index = ['a','b','c']
print(series['a'])
```

```
4
```

Pandas

→ *Series*

- However, other types of indexes are possible, for example based on letters, or dates and time. They are more complex to deal with.

```
series = pd.Series([4,5,6])
series.index = ['a','b','c']
print(series.iloc[0])
```

```
4
```

Pandas

→ *Series*

- However, other types of indexes are possible, for example based on letters, or dates and time. They are more complex to deal with.

```
series = pd.Series([4,5,6])
series.index = ['a','b','c']
print(series.loc['a'])
```

```
4
```

Pandas

→ *Series*

- However, other types of indexes are possible, for example based on letters, or dates and time. They are more complex to deal with.

```
series = pd.Series([4,5,6])
series.index = ['a','b','c']
print(series.loc['a'])
```

```
4
```

Pandas

➜ *Series*

- Both Series and their indexes supports being iterated on, and allow to be more pythonic in some contexts:

```
series = pd.Series([4,5,6])
for item in series:
    print(item)
```

```
4
5
6
```

Pandas

→ *Series*

- Both Series and their indexes supports being iterated on, and allow to be more pythonic in some contexts:

```
series = pd.Series([4,5,6])
for index_item in series.index:
    print(index_item)
```

```
0
1
2
```

Pandas

→ *Series*

- Several functions are ready to be applied to the series, unlike the Python lists. Mean, min, max etc. are just some examples of them.

```
series = pd.Series([4,5,6])
print(series.mean())
```

```
5.0
```

Pandas

→ *Series*

- Several functions are ready to be applied to the series, unlike the Python lists. Mean, min, max etc. are just some examples of them.

```
series = pd.Series([4,5,6])
print(series.max())
```

```
6.0
```

Pandas

→ *DataFrames*

- DataFrames are basically matices. They support multiple axes, indexes, and labels for columns.

```
df = pd.DataFrame([[4,40],[5,50],[6,60]])
print(df)
```

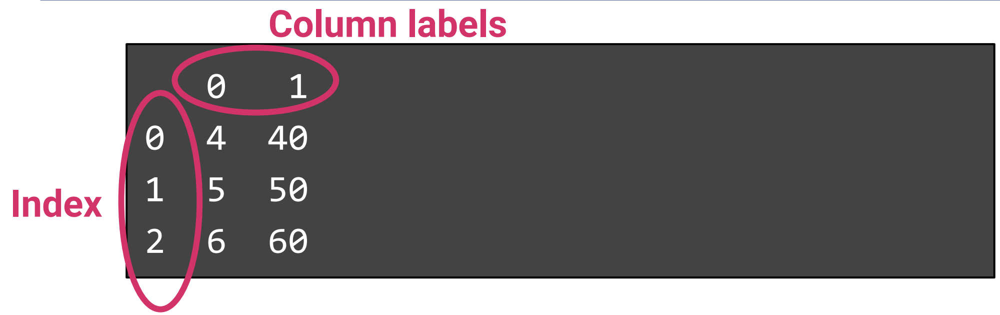
```
   0   1
0  4  40
1  5  50
2  6  60
```

Pandas

→ *DataFrames*

- DataFrames are basically matices. They support multiple axes, indexes, and labels for columns.

```
df = pd.DataFrame([[4,40],[5,50],[6,60]])
print(df)
```



```
   0   1
0  4  40
1  5  50
2  6  60
```

Pandas

➜ *DataFrames*

- If accessing them by “position”, they return a column which is returned as as Series which “inherits” the index

```
df = pd.DataFrame([[4,40],[5,50],[6,60]])
print(df[1])
```

```
0    40
1    50
2    60
Name: 1, dtype: int64
```

Pandas

➔ *DataFrames*

- If accessing them by “position”, they return a column which is returned as as Series which “inherits” the index

```
df = pd.DataFrame([[4,40],[5,50],[6,60]])
type(df[1])
```

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

Pandas

→ *DataFrames*

- Data frames supports changing not only the index but also the column labels:

```
df = pd.DataFrame([[4,40],[5,50],[6,60]])
df.index = ['a','b','c']
df.columns = ['Rome', 'Venice']
print(df)
```

```
   Rome  Venice
a     4      40
b     5      50
c     6      60
```

Pandas

➜ *DataFrames*

- DataFrames can also be created directly from Python dictionaries, but remember that you will not have any order guaranteed in the columns!

```
df = pd.DataFrame({'Rome': [4,5,6],
                   'Venice':[40,50,60]})
print(df)
```

```
   Rome  Venice
0     4      40
1     5      50
2     6      60
```

Pandas

→ *DataFrames*

- DataFrames can also be created directly from Python dictionaries, but remember that you will not have any order guaranteed in the columns!

```
df = pd.DataFrame({'Rome': [4,5,6],
                   'Venice':[40,50,60]})
print(df)
```

```
   Rome  Venice
0     4      40
1     5      50
2     6      60
```

```
   Rome  Venice
0     4      40
1     5      50
2     6      60
```

Pandas

➜ *DataFrames*

- DataFrames can also be created directly from Python dictionaries, but remember that you will not have any order guaranteed in the columns!

```
df = pd.DataFrame({'Rome': [4,5,6],
                   'Venice':[40,50,60]})
print(df)
```

```
   Rome  Venice
0     4      40
1     5      50
2     6      60
```

Pandas

→ *DataFrames*

- At this point you can access the columns using their label in the square brackets notation. Keep in mind that for the Series, this was instead accessing the “rows”.

```
df = pd.DataFrame({'Rome': [4,5,6],
                   'Venice':[40,50,60]})
print(df['Venice'])
```

```
   Rome  Venice
0     4      40
1     5      50
2     6      60
```

```
0    40
1    50
2    60
Name: Venice, dtype: int64
```

Pandas

→ *DataFrames*

- This mode still gives you a Series:

```
df = pd.DataFrame({'Rome': [4,5,6],
                   'Venice':[40,50,60]})
type(df['Venice'])
```

```
   Rome  Venice
0     4      40
1     5      50
2     6      60
```

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

Pandas

→ *DataFrames*

- In order to instead get another DataFrame for a specific column (or more), you can use the filter() function, or a bi-dimensional iloc() not covered here.

```
df = pd.DataFrame({'Rome': [4,5,6],
                   'Venice':[40,50,60]})
print(df.filter(['Venice']))
```

```
   Rome  Venice
0     4      40
1     5      50
2     6      60
```

```
   Venice
0      40
1      50
2      60
```

Pandas

→ *DataFrames*

- In order to instead get another DataFrame for a specific column (or more), you can use the filter() function, or a bi-dimensional iloc() not covered here.

```
df = pd.DataFrame({'Rome': [4,5,6],
                   'Venice':[40,50,60]})
type(df.filter(['Venice']))
```

```
   Rome  Venice
0     4      40
1     5      50
2     6      60
```

```
pandas.core.frame.DataFrame
```

Pandas

→ *DataFrames*

- To access a row of a DataFrame, you can use the loc and/or iloc functions, which access “by row”, exactly as for the Series… and returns a Series, in “horizontal”.

```
df = pd.DataFrame({'Rome': [4,5,6],
                   'Venice':[40,50,60]})
print(df.loc[0])
```

```
   Rome  Venice
0     4      40
1     5      50
2     6      60
```

```
Rome       4
Venice    40
Name: 0, dtype: int64
```

Pandas

→ *DataFrames*

- To access a row of a DataFrame, you can use the loc and/or iloc functions, which access “by row”, exactly as for the Series... and returns a Series, in “horizontal”.

```
df = pd.DataFrame({'Rome': [4,5,6],
                   'Venice':[40,50,60]})
type(df.loc[0])
```

```
   Rome  Venice
0     4      40
1     5      50
2     6      60
```

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

Pandas

→ *DataFrames*

- You can also “elect” a data frame column as its index:

```
df = pd.DataFrame({'Quarter': ['q1','q2','q3'],
                   'Rome': [4,5,6],
                   'Venice': [40,50,60]})
df.set_index('Quarter', inplace=True)
print(df)
```

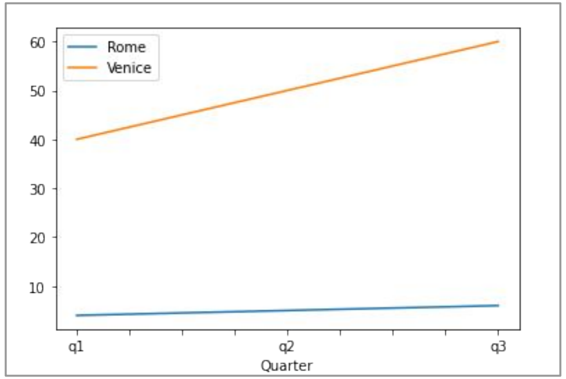
```
         Rome  Venice
Quarter
q1          4      40
q2          5      50
q3          6      60
```

Pandas

→ *DataFrames*

- ..and you can plot DataFrames, as the Series and other Pandas data structures.

```
df = pd.DataFrame({'Quarter': ['q1','q2','q3'],
                   'Rome': [4,5,6],
                   'Venice': [40,50,60]})
df.set_index('Quarter', inplace=True)
plt.plot(df)
plt.show()
```



Pandas

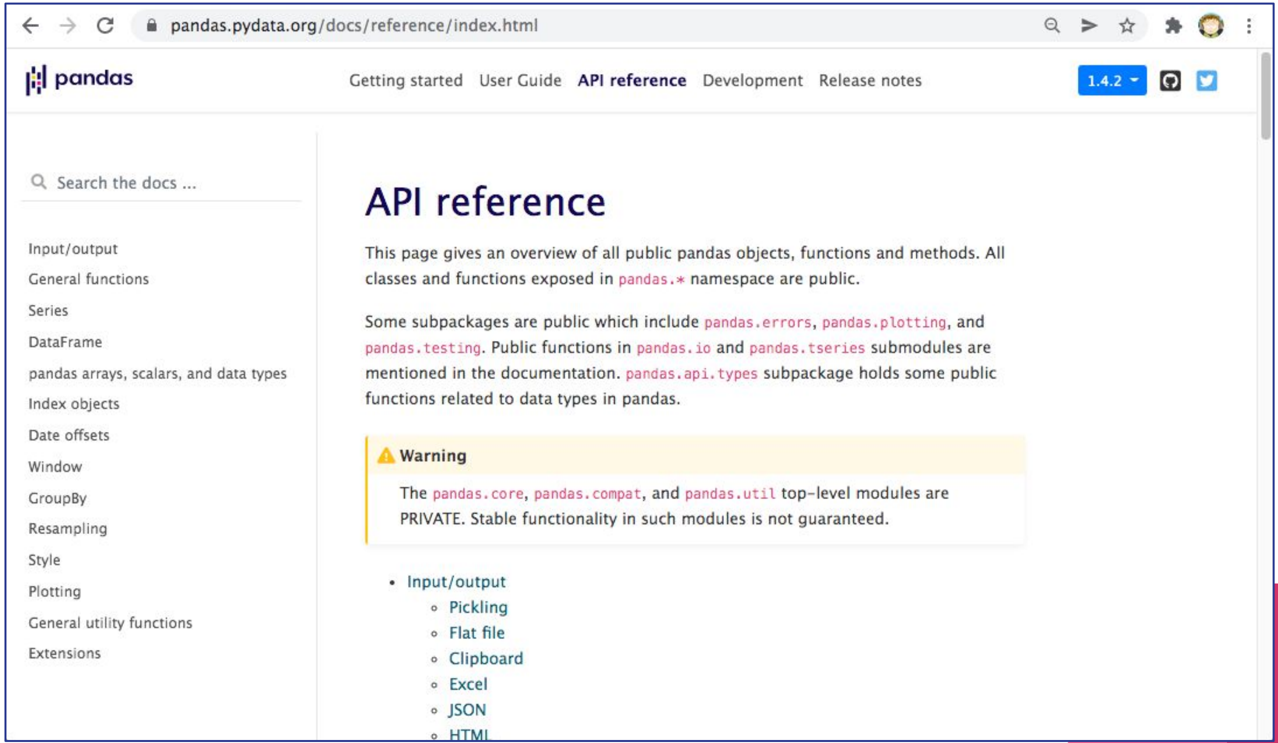
→ *How to read the documentation*

- There are loads of operations which can be done on pandas objects.
- While classic (textbook-like) documentation is always useful, there is another type of documentation that is good to know how to read:

  → the API reference documentation.
- API stands for the Application Programming Interface.
- When you use Pandas, you use its API!

Pandas

→ *How to read the documentation*



Input/output
General functions
Series
DataFrame
pandas arrays, scalars, and data types
Index objects
Date offsets
Window
GroupBy
Resampling
Style
Plotting
General utility functions
Extensions

API reference

This page gives an overview of all public pandas objects, functions and methods. All classes and functions exposed in `pandas.*` namespace are public.

Some subpackages are public which include `pandas.errors`, `pandas.plotting`, and `pandas.testing`. Public functions in `pandas.io` and `pandas.tseries` submodules are mentioned in the documentation. `pandas.api.types` subpackage holds some public functions related to data types in pandas.

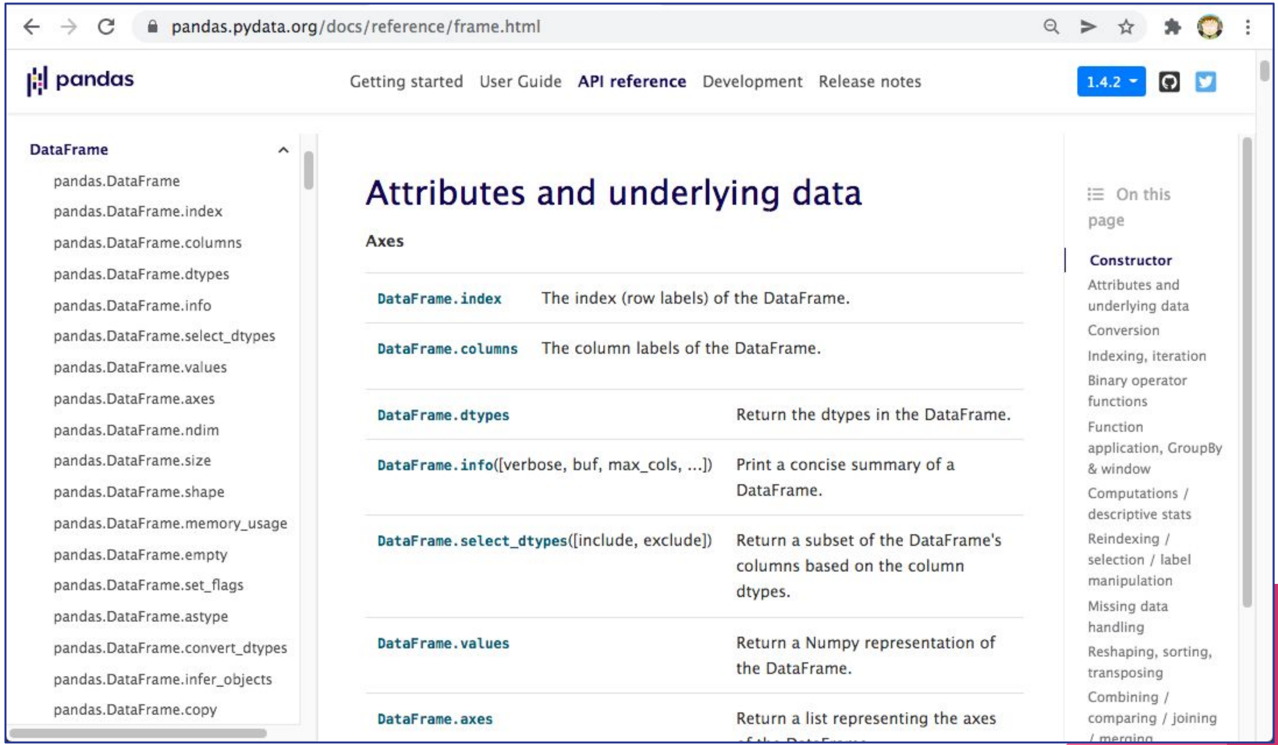
Warning

The `pandas.core`, `pandas.compat`, and `pandas.util` top-level modules are PRIVATE. Stable functionality in such modules is not guaranteed.

- Input/output
  - Pickling
  - Flat file
  - Clipboard
  - Excel
  - JSON
  - HTML

Pandas

→ *How to read the documentation*



pandas.pydata.org/docs/reference/frame.html

Attributes and underlying data

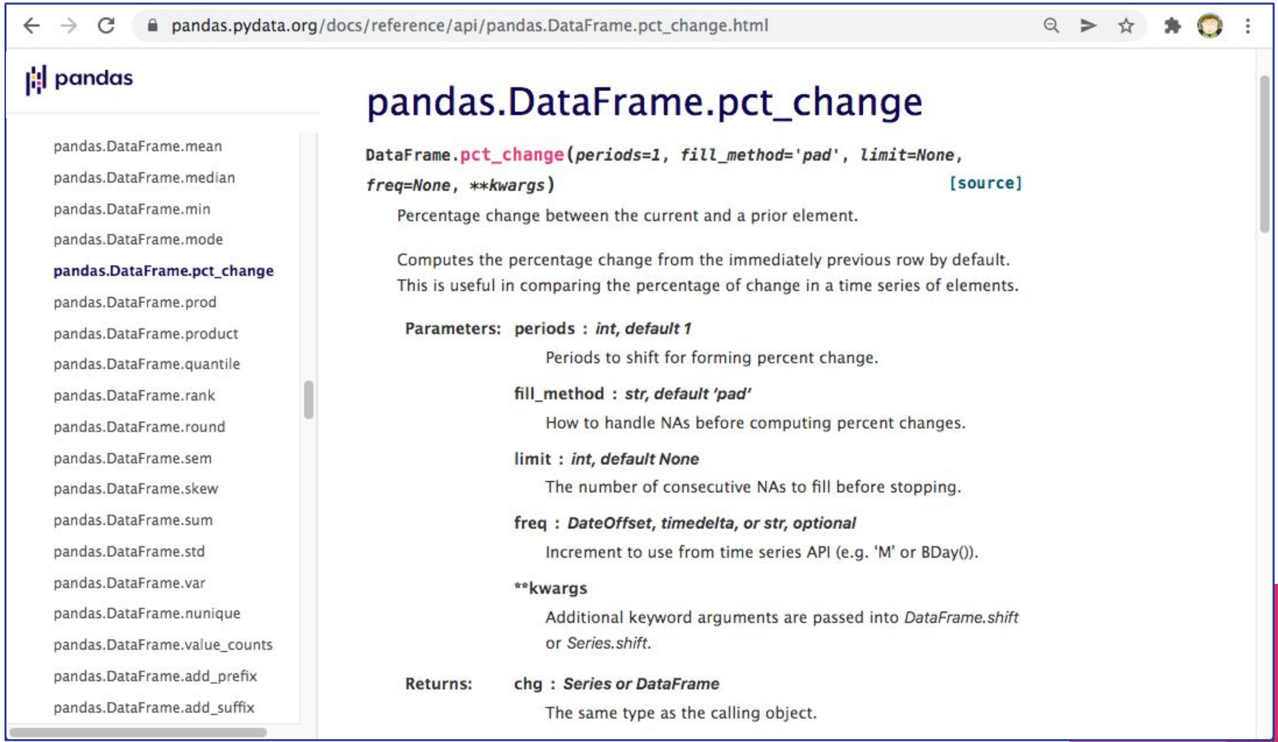
Axes

`DataFrame.index`	The index (row labels) of the DataFrame.
`DataFrame.columns`	The column labels of the DataFrame.

`DataFrame.dtypes`	Return the dtypes in the DataFrame.
`DataFrame.info`([verbose, buf, max_cols, ...])	Print a concise summary of a DataFrame.
`DataFrame.select_dtypes`([include, exclude])	Return a subset of the DataFrame's columns based on the column dtypes.
`DataFrame.values`	Return a Numpy representation of the DataFrame.
`DataFrame.axes`	Return a list representing the axes

Pandas

→ *How to read the documentation*



pandas.pydata.org/docs/reference/api/pandas.DataFrame.pct_change.html

pandas

pandas.DataFrame.mean
pandas.DataFrame.median
pandas.DataFrame.min
pandas.DataFrame.mode
pandas.DataFrame.pct_change
pandas.DataFrame.prod
pandas.DataFrame.product
pandas.DataFrame.quantile
pandas.DataFrame.rank
pandas.DataFrame.round
pandas.DataFrame.sem
pandas.DataFrame.skew
pandas.DataFrame.sum
pandas.DataFrame.std
pandas.DataFrame.var
pandas.DataFrame.nunique
pandas.DataFrame.value_counts
pandas.DataFrame.add_prefix
pandas.DataFrame.add_suffix

pandas.DataFrame.pct_change

```
DataFrame.pct_change(periods=1, fill_method='pad', limit=None,
freq=None, **kwargs)                                    [source]
```

Percentage change between the current and a prior element.

Computes the percentage change from the immediately previous row by default. This is useful in comparing the percentage of change in a time series of elements.

Parameters: **periods : *int, default 1***

Periods to shift for forming percent change.

fill_method : *str, default 'pad'*

How to handle NAs before computing percent changes.

limit : *int, default None*

The number of consecutive NAs to fill before stopping.

freq : *DateOffset, timedelta, or str, optional*

Increment to use from time series API (e.g. 'M' or BDay()).

****kwargs**

Additional keyword arguments are passed into *DataFrame.shift* or *Series.shift*.

Returns: **chg : *Series or DataFrame***

The same type as the calling object.

End of part IV

- *Questions?*

Next: exercise 4

Exercise 4

Let's go through an example together

Try to execute the commands we will see by yourself

First, download the file below and upload it to your Repl.it:
https://sarusso.github.io/python_courses/time_series.csv