Python for Accounting Applications

國立臺北大學
National Taipei University

Data Analytics and Visualization with Python

1121PAA08
ACC2, NTPU (M5265) (Fall 2023)
Wed 6, 7, 8, (14:10-17:00) (9:10-12:00) (B3F10)

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aws certified Solutions Architect Associate

Min-Yuh Day, Ph.D,
Associate Professor

Institute of Information Management, National Taipei University

https://web.ntpu.edu.tw/~myday

2023-11-08

Syllabus

Week	Date	Subject/Topics
1	2023/09/13	Introduction to Python for Accounting Applications
2	2023/09/20	Python Programming and Data Science
3	2023/09/27	Foundations of Python Programming
4	2023/10/04	Data Structures
5	2023/10/11	Control Logic and Loops
6	2023/10/18	Functions and Modules
7	2023/10/25	Files and Exception Handling
8	2023/11/01	Midterm Project Report

Syllabus

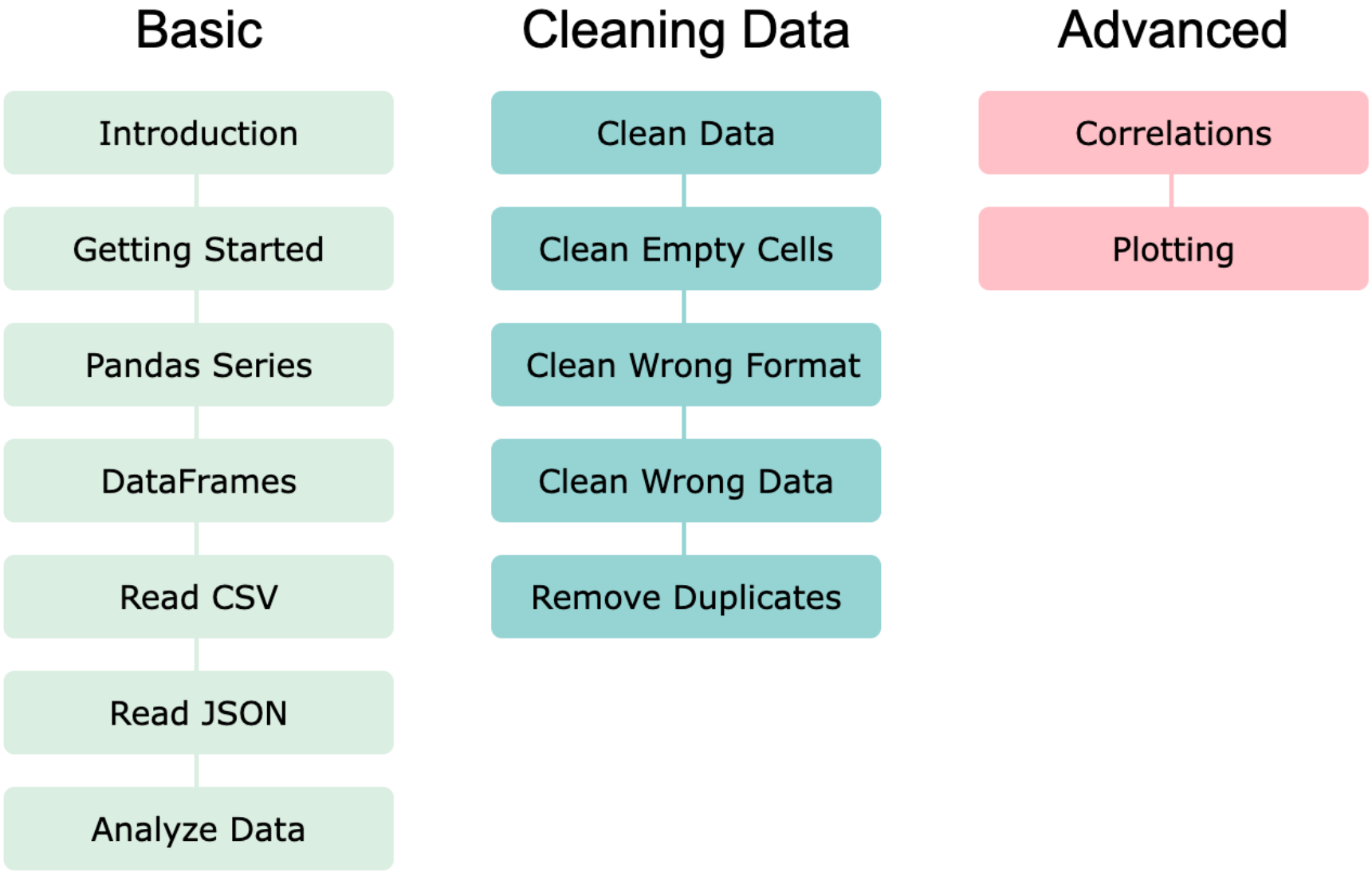
Week	Date	Subject/Topics
9	2023/11/08	Data Analytics and Visualization with Python
10	2023/11/15	Obtaining Data From the Web with Python
11	2023/11/22	Statistical Analysis with Python
12	2023/11/29	Machine Learning with Python
13	2023/12/06	Text Analytics with Python and Large Language Models (LLMs)
14	2023/12/13	Applications of Accounting Data Analytics with Python
15	2023/12/20	Applications of ESG Data Analytics with Python
16	2023/12/27	Final Project Report

Data Analytics and Visualization with Python

Outline

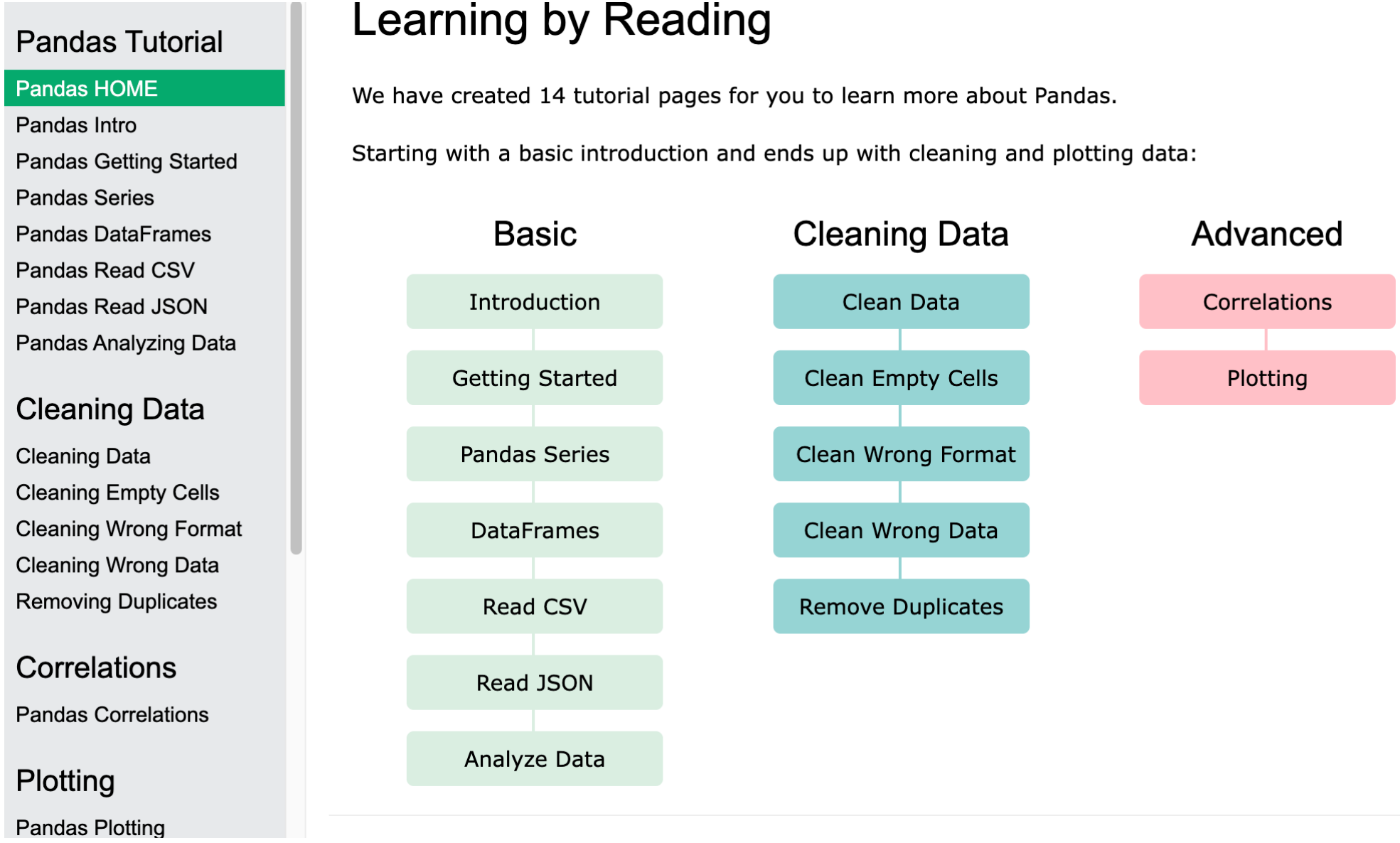
- NumPy
  - Numerical Python N-dimensional array
- Pandas
  - Data Analytics
- Matplotlib
  - Basic Data Visualization
- Seaborn
  - Advanced Visualization

Pandas: Data Analytics and Visualization



https://www.w3schools.com/python/pandas/default.asp

Pandas



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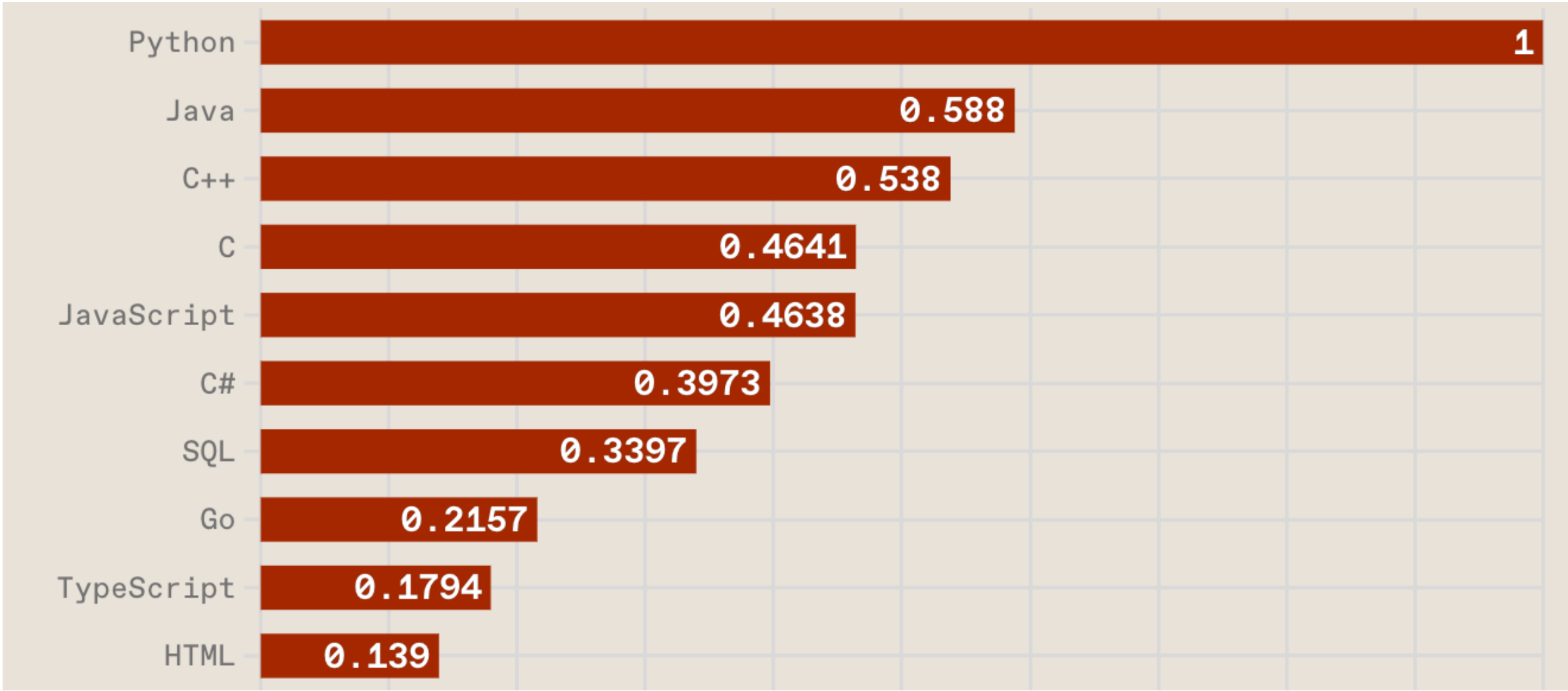
Python

Programming

Top Programming Languages



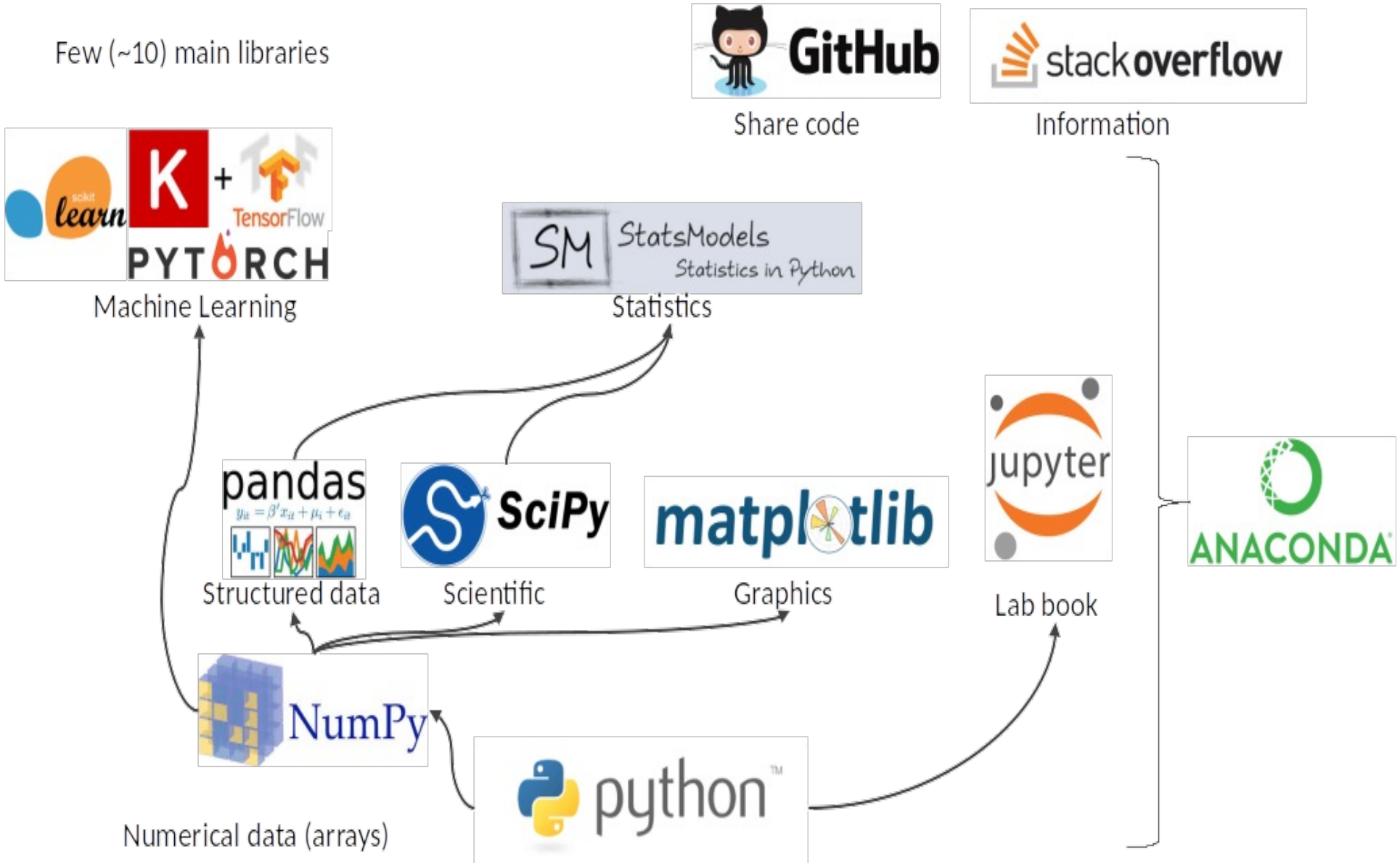
https://spectrum.ieee.org/the-top-programming-languages-2023

python™

Python is an interpreted, object-oriented, high-level programming language with dynamic semantics.

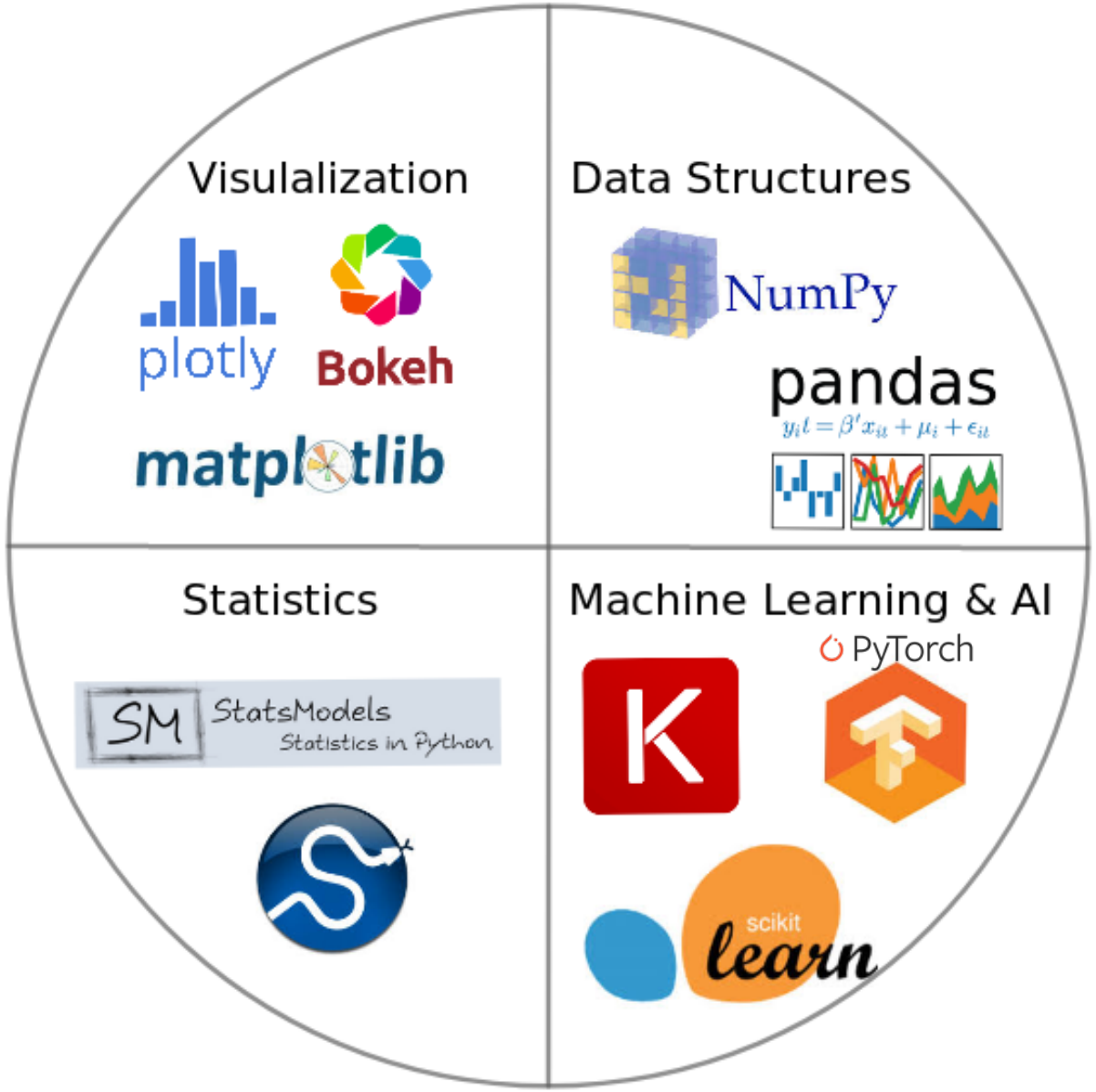
Source: https://www.python.org/doc/essays/blurb/

Python Ecosystem for Data Science



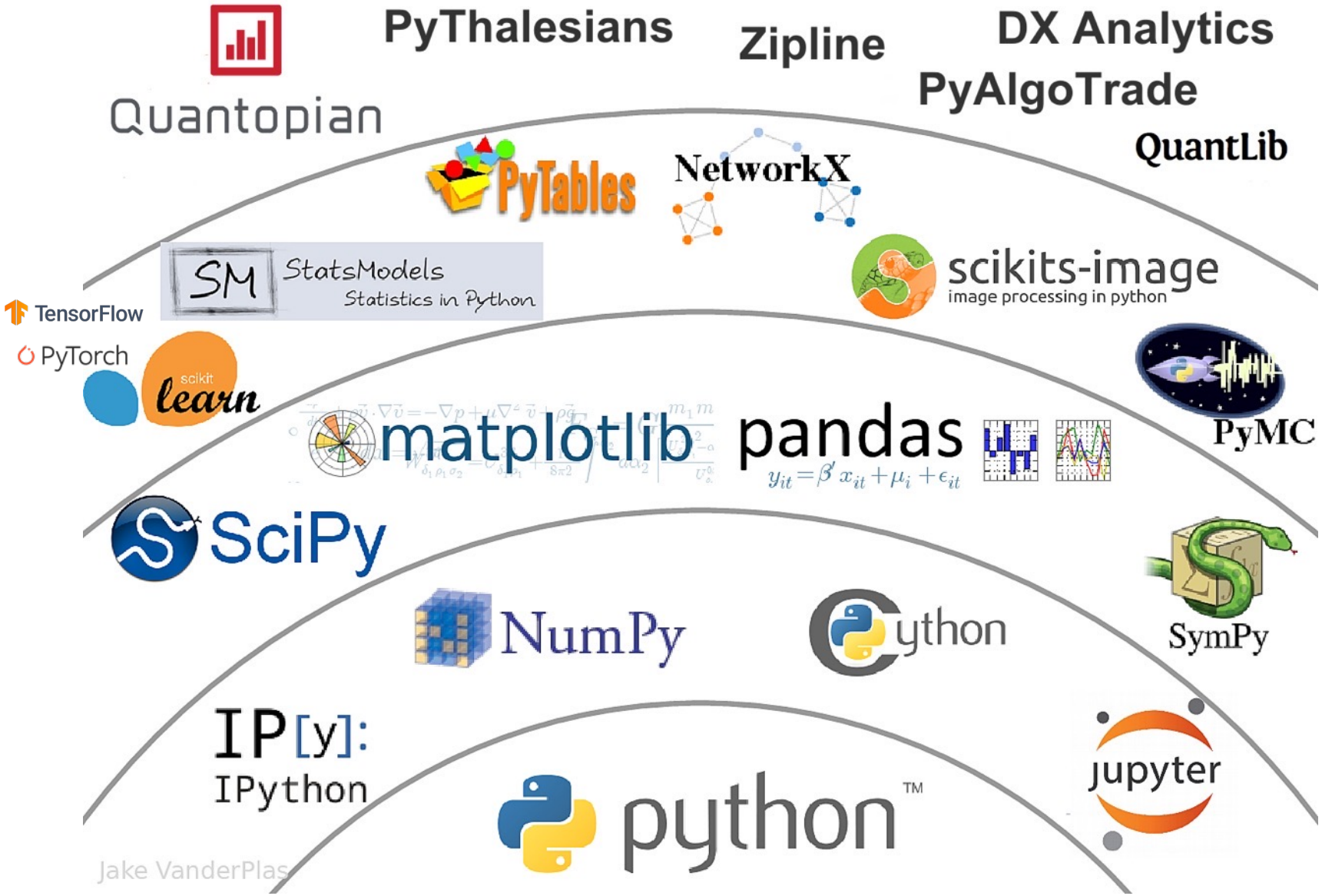
Source: https://medium.com/pyfinance/why-python-is-best-choice-for-financial-data-modeling-in-2019-c0d0d1858c45

Python Ecosystem for Data Science



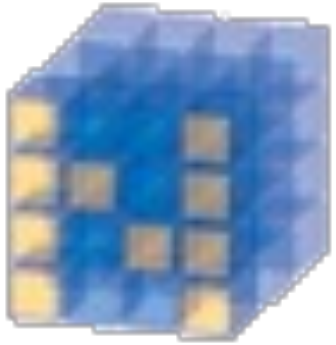
Source:https://duchesnay.github.io/pystatsml/introduction/python_ecosystem.html

The Quant Finance PyData Stack



Source: http://nbviewer.jupyter.org/format/slides/github/quantopian/pyfolio/blob/master/pyfolio/examples/overview_slides.ipynb#/5

Numpy



NumPy

Base

N-dimensional array

package

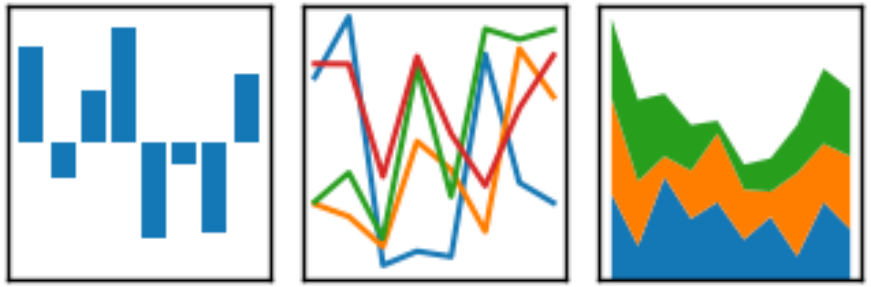
Python matplotlib

Source: https://matplotlib.org/

Python Pandas

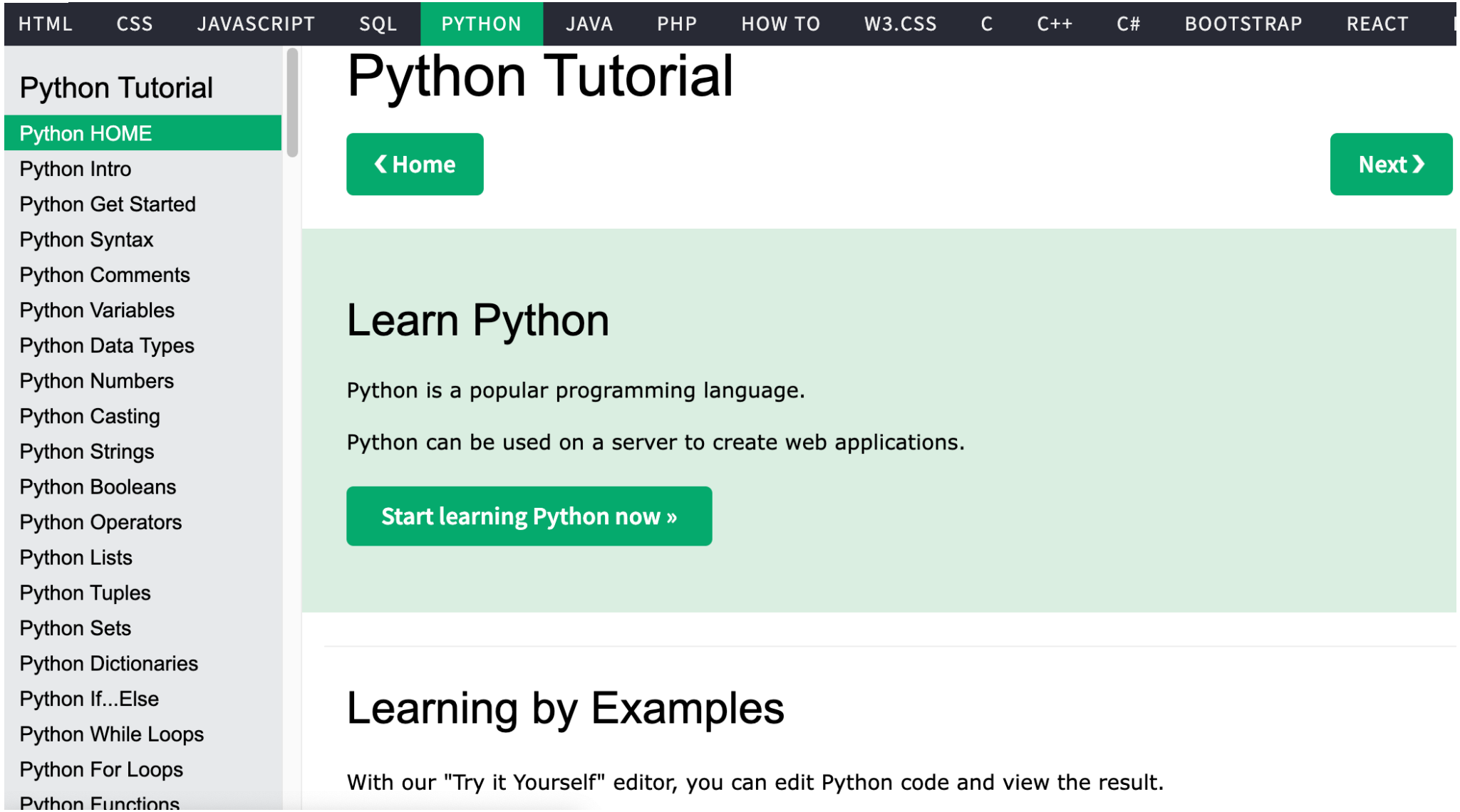
pandas

$$y_{it} = \beta' x_{it} + \mu_i + \epsilon_{it}$$



http://pandas.pydata.org/

W3Schools Python



https://www.w3schools.com/python/

W3Schools Python Numpy

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Python Modules

- NumPy Tutorial
- Pandas Tutorial
- SciPy Tutorial
- Django Tutorial

NumPy Tutorial

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- NumPy Data Types
- NumPy Copy vs View
- NumPy Array Shape
- NumPy Array Reshape
- NumPy Array Iterating
- NumPy Array Join
- NumPy Array Split
- NumPy Array Search
- NumPy Array Sort
- NumPy Array Filter

NumPy Random

- Random Intro
- Data Distribution

NumPy Tutorial

❮ Home Next ❯

NumPy is a Python library.

NumPy is used for working with arrays.

NumPy is short for "Numerical Python".

Learning by Reading

We have created 43 tutorial pages for you to learn more about NumPy.

Starting with a basic introduction and ends up with creating and plotting random data sets, and working with NumPy functions:

Basic Random ufunc

https://www.w3schools.com/python/numpy/default.asp

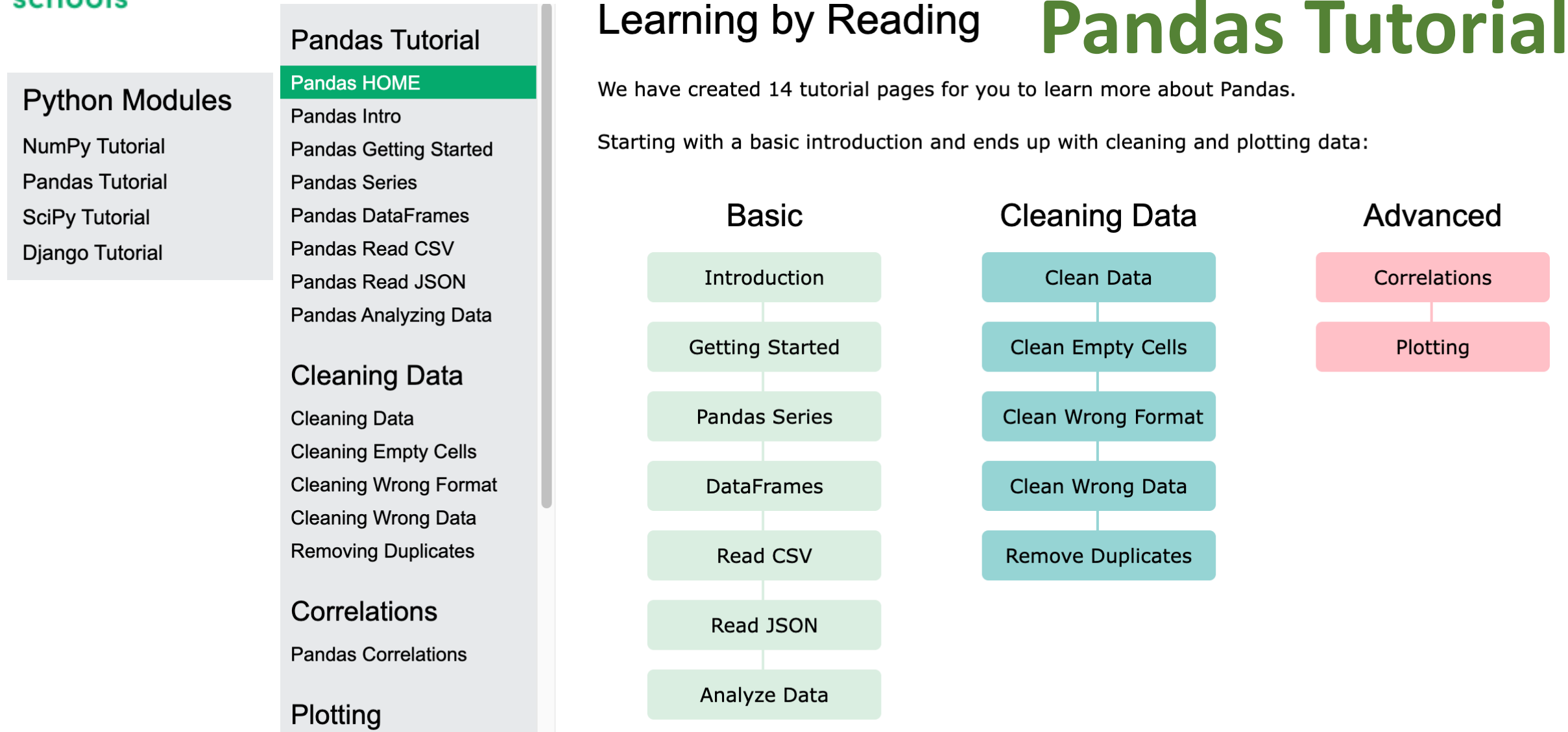
W3Schools Python Pandas

Learning by Reading

Pandas Tutorial

We have created 14 tutorial pages for you to learn more about Pandas.

Starting with a basic introduction and ends up with cleaning and plotting data:



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- Matplotlib Scatter
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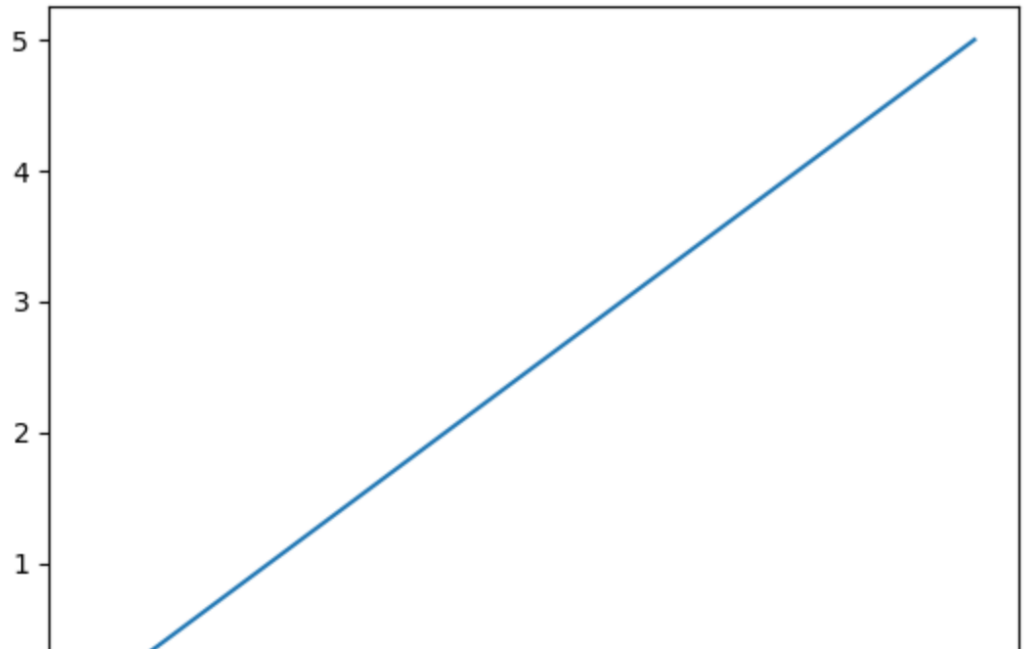
- Matplotlib Histograms
- Matplotlib Pie Charts

Matplotlib Tutorial

❮ Previous Next ❯



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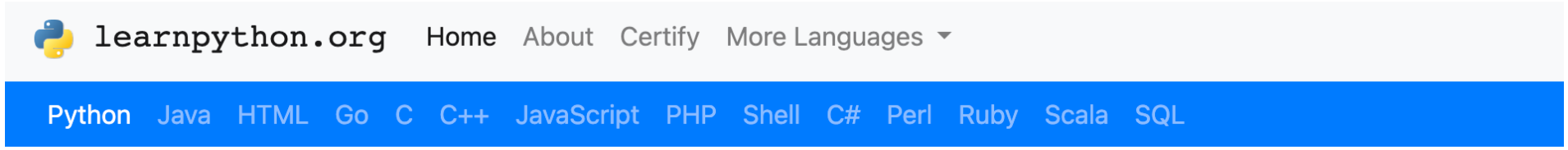
W3Schools Python: Try Python

https://www.w3schools.com/python/trypython.asp?filename=demo_default

LearnPython.org



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Welcome

Welcome to the LearnPython.org interactive Python tutorial.

Whether you are an experienced programmer or not, this website is intended for everyone who wishes to learn the Python programming language.

You are welcome to join our group on Facebook for questions, discussions and updates.

After you complete the tutorials, you can get certified at LearnX and add your certification to your LinkedIn profile.

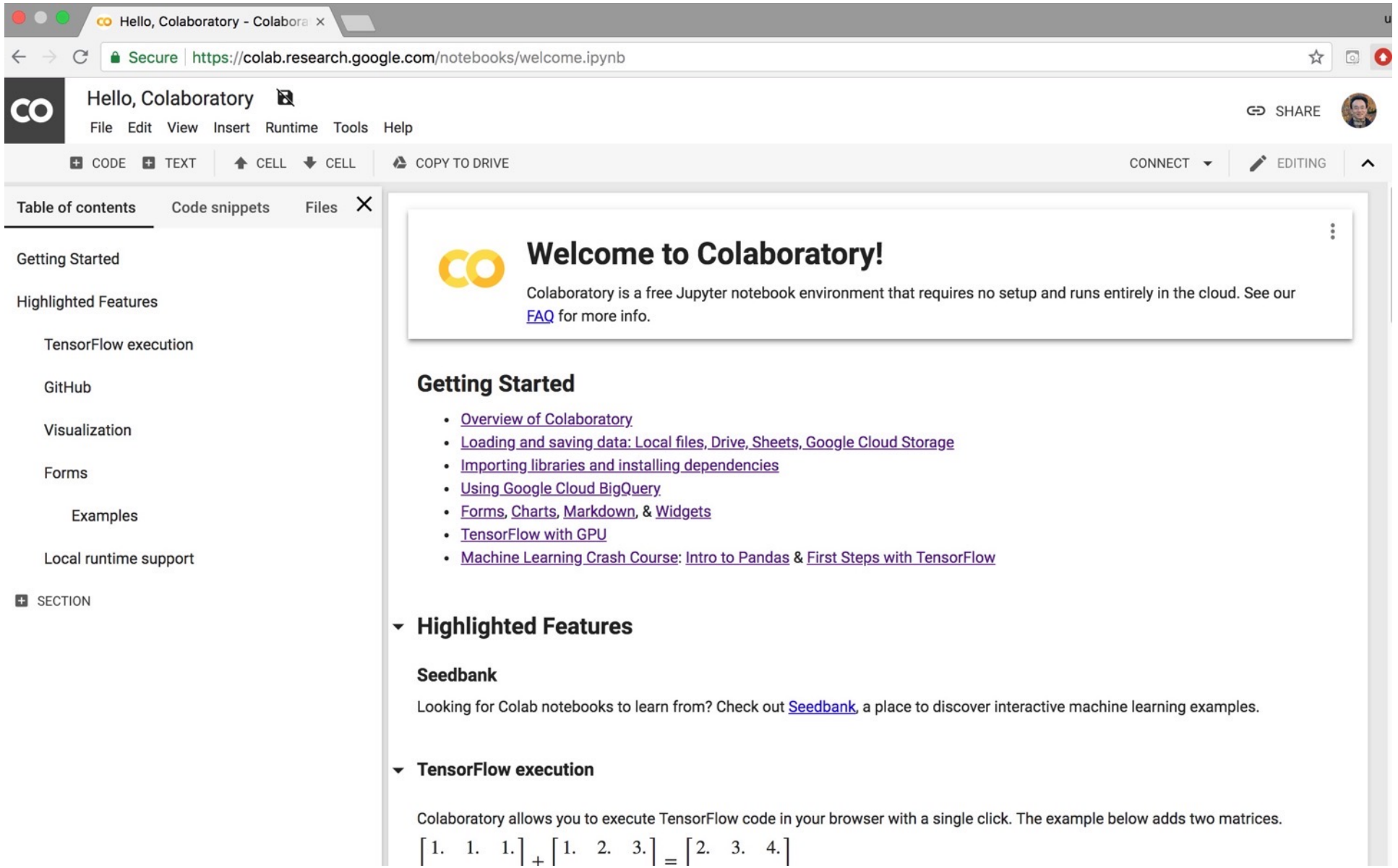
Just click on the chapter you wish to begin from, and follow the instructions. Good luck!

https://www.learnpython.org/

Google's Python Class

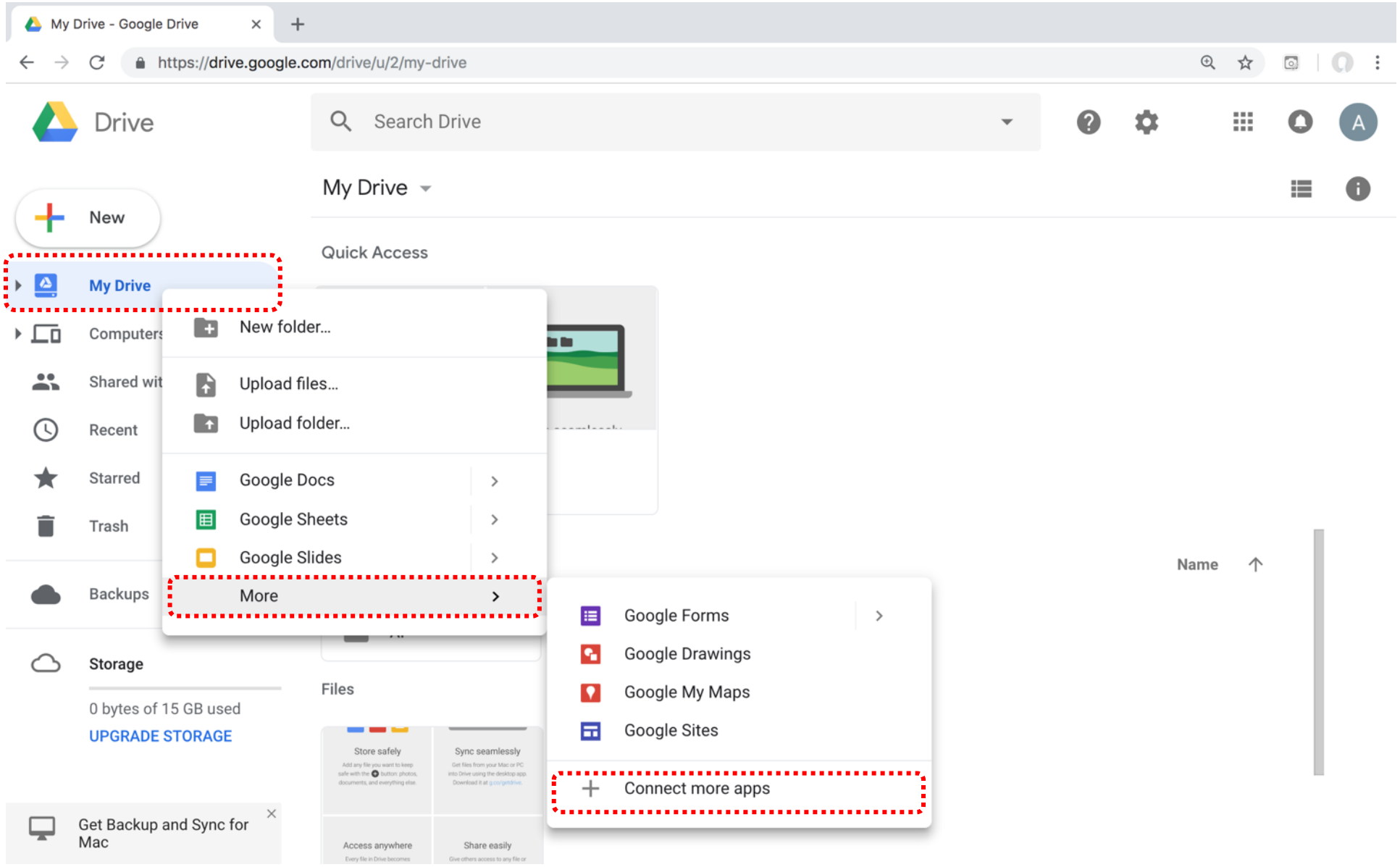
https://developers.google.com/edu/python

Google Colab

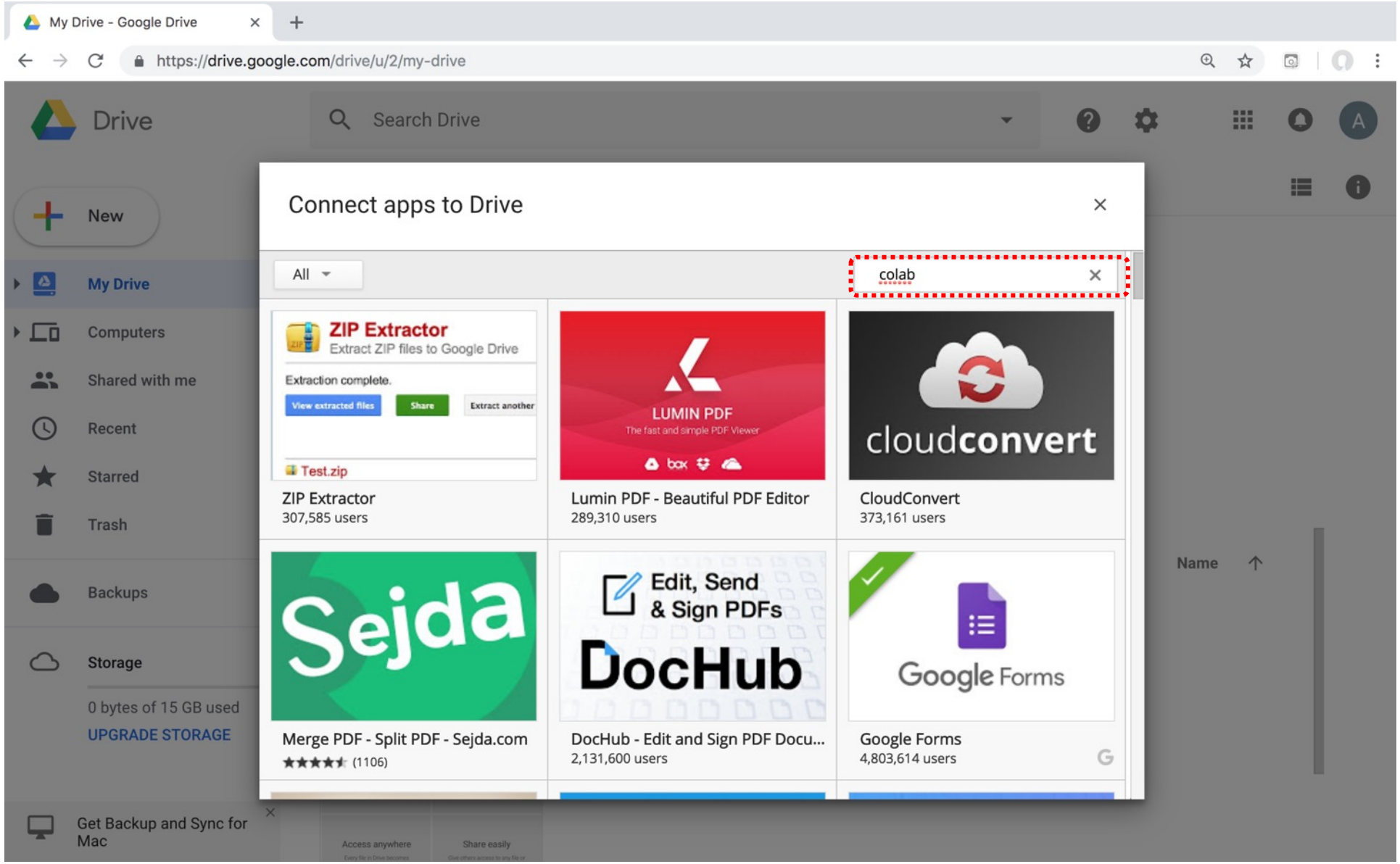


https://colab.research.google.com/notebooks/welcome.ipynb

Connect Google Colab in Google Drive



Google Colab



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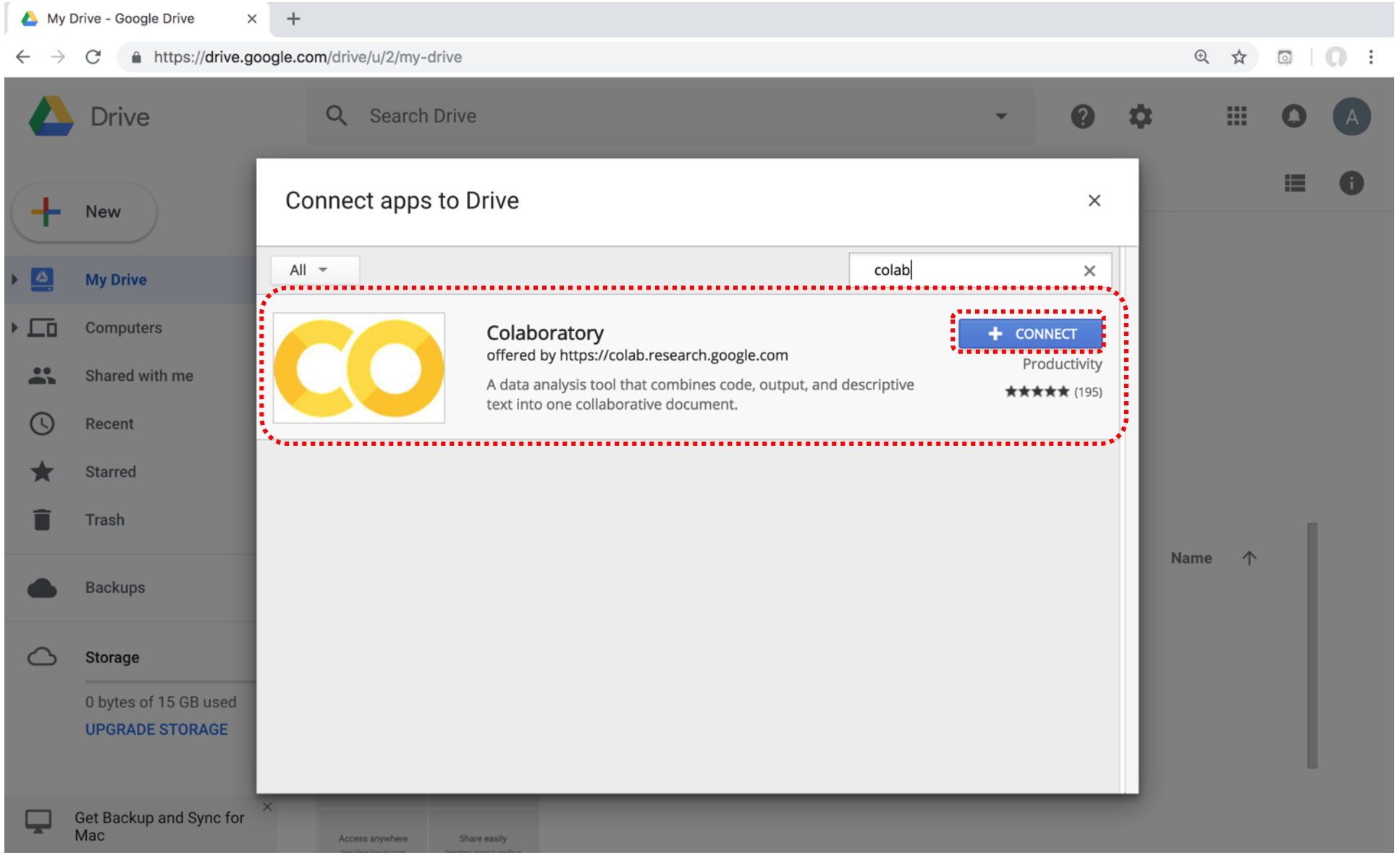
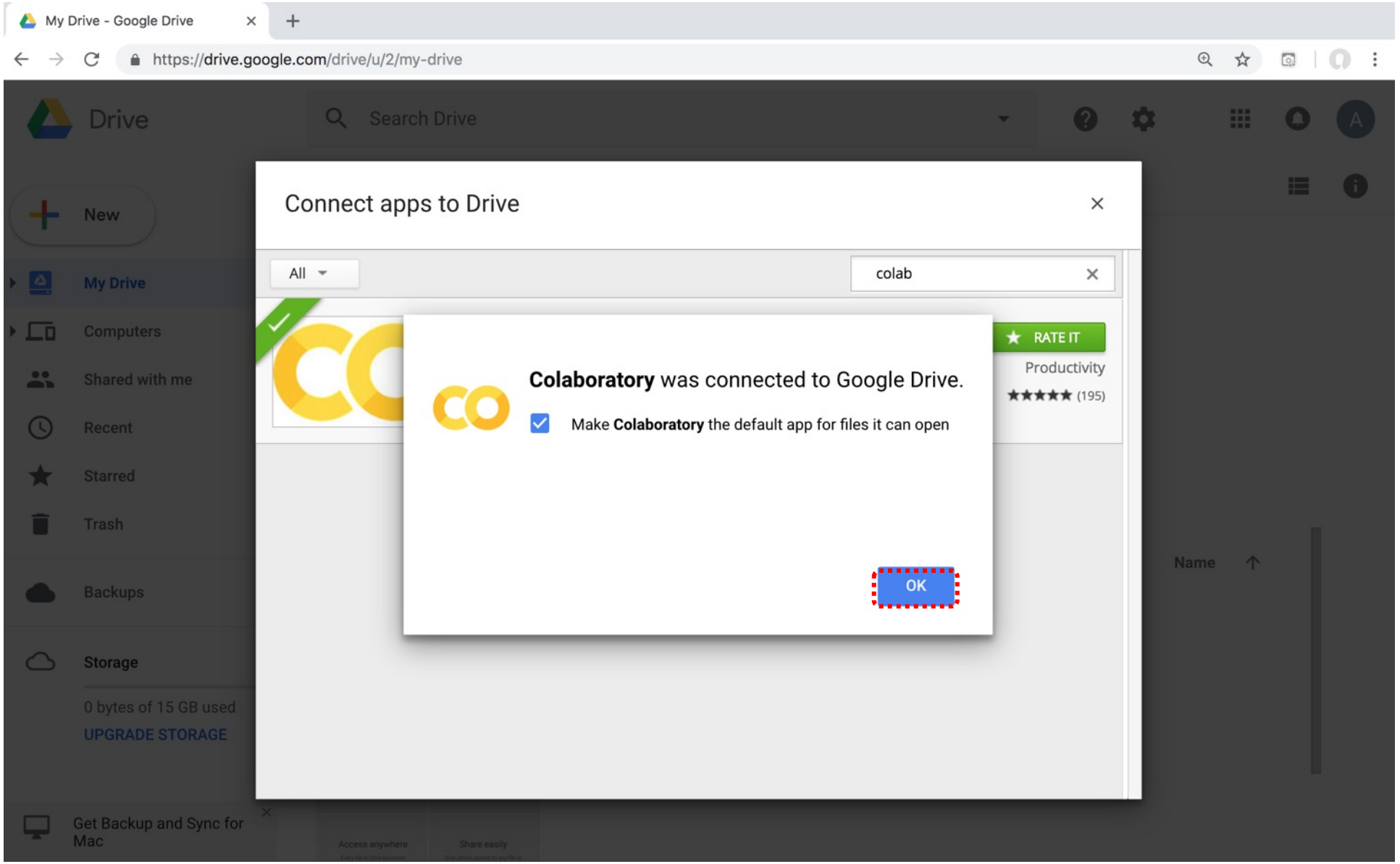
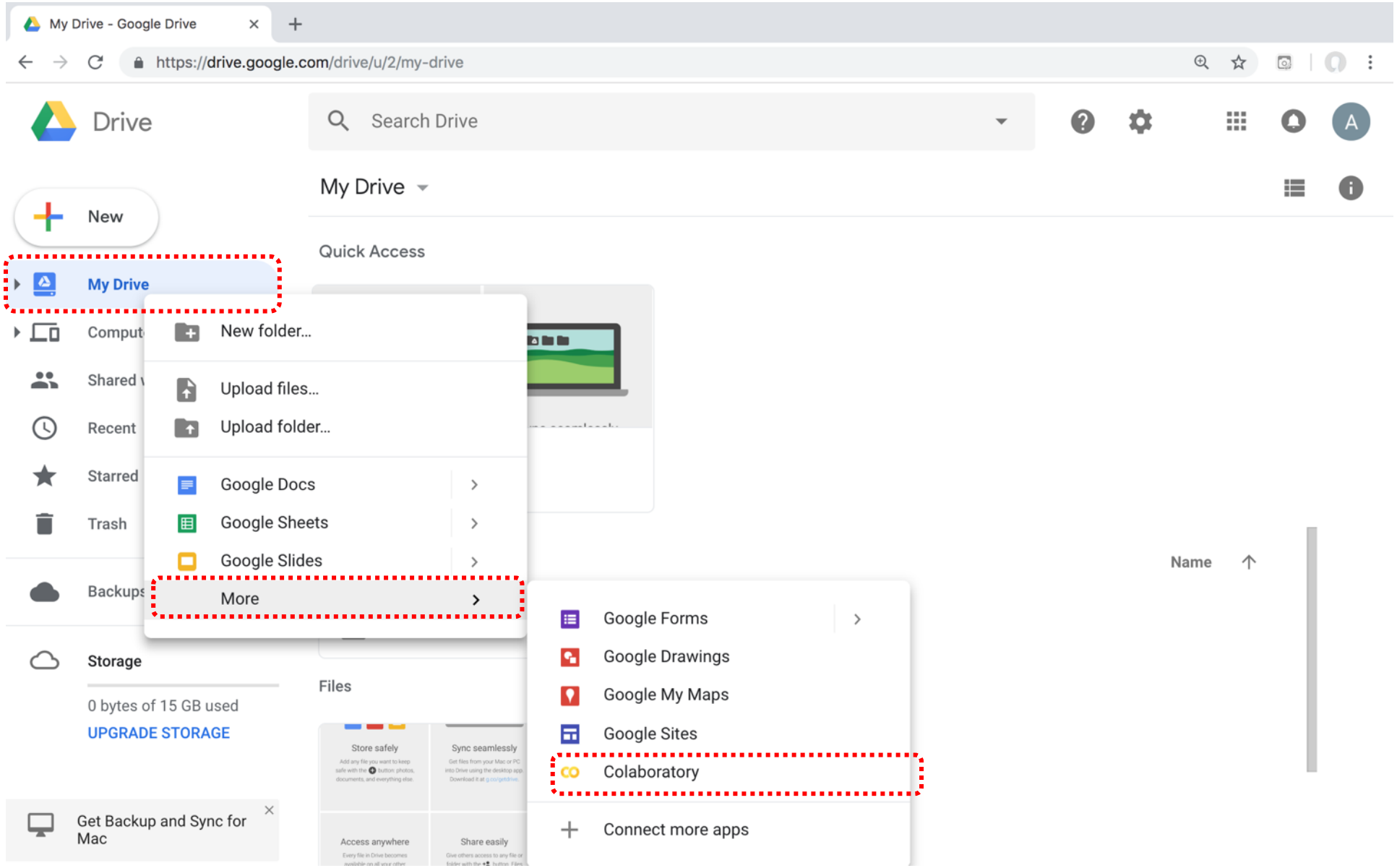


Connect Colaboratory to Google Drive



Google Colab



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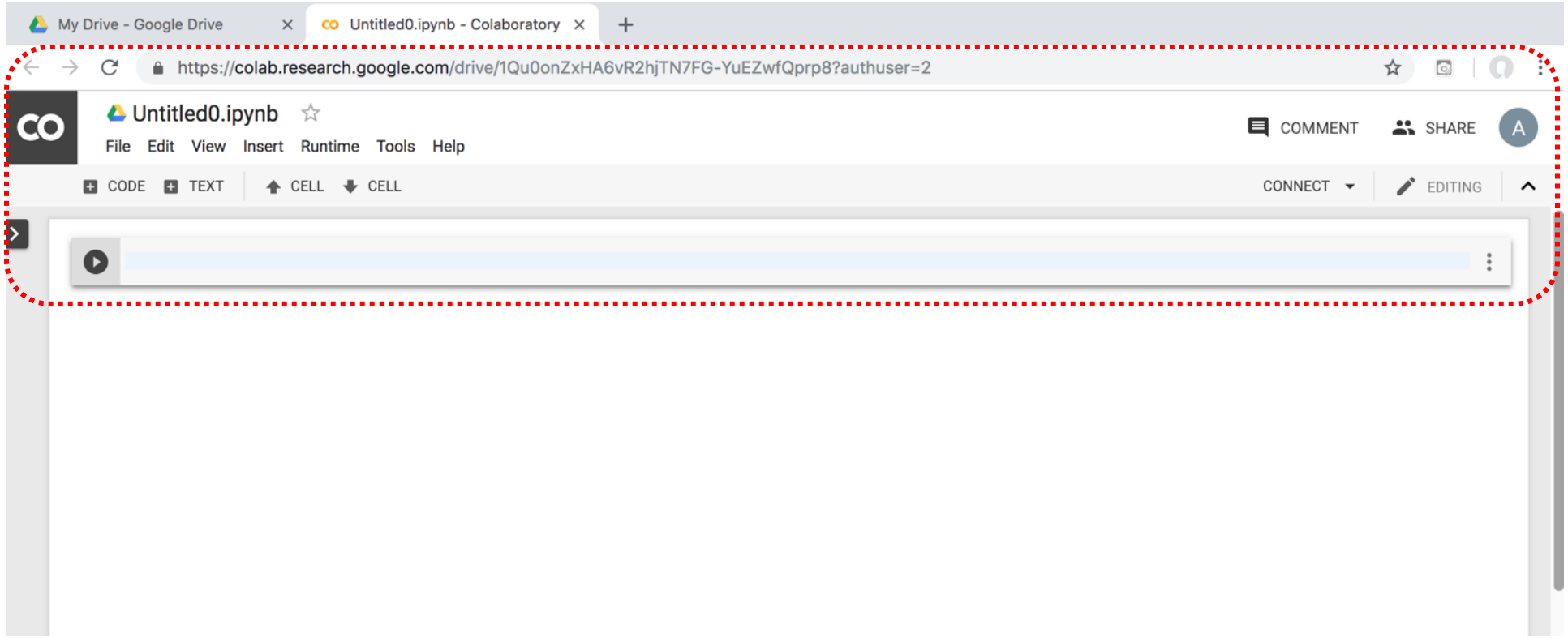

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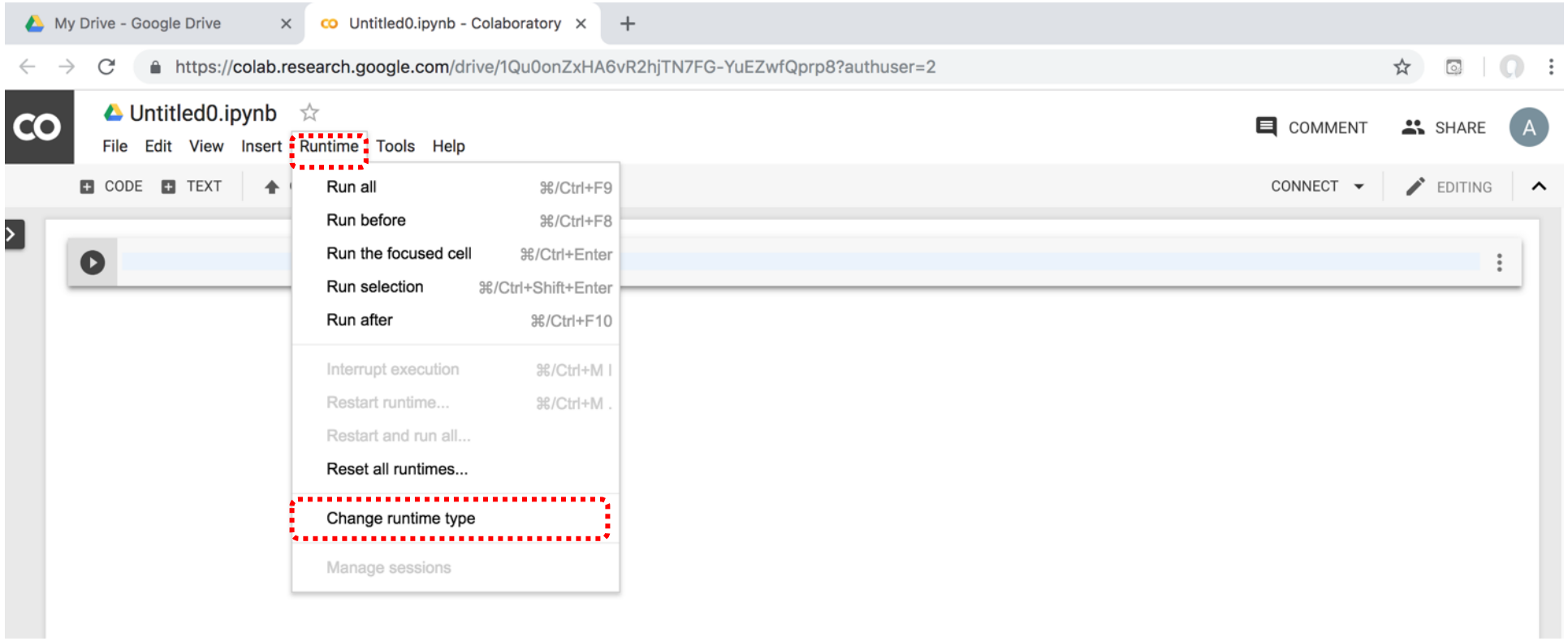
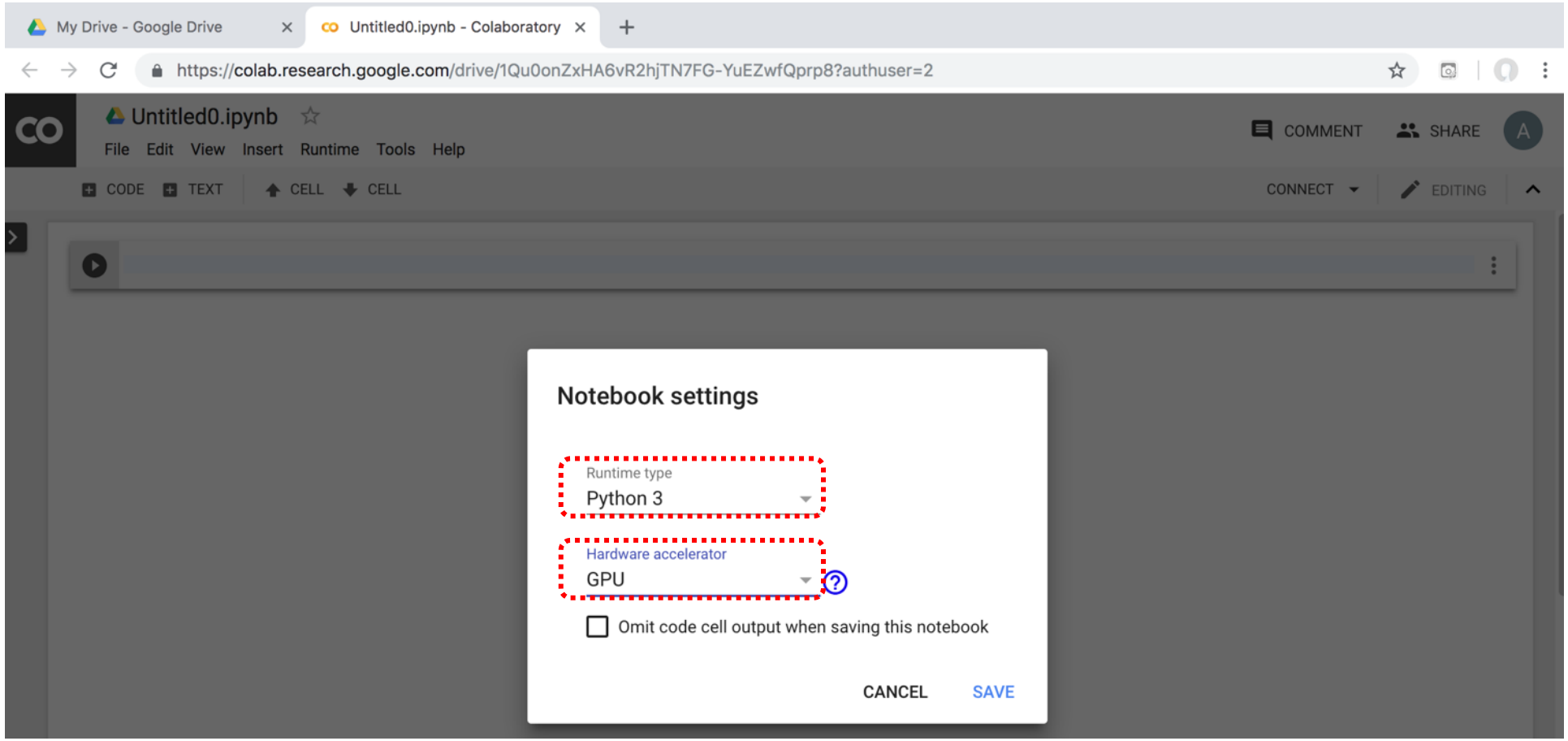


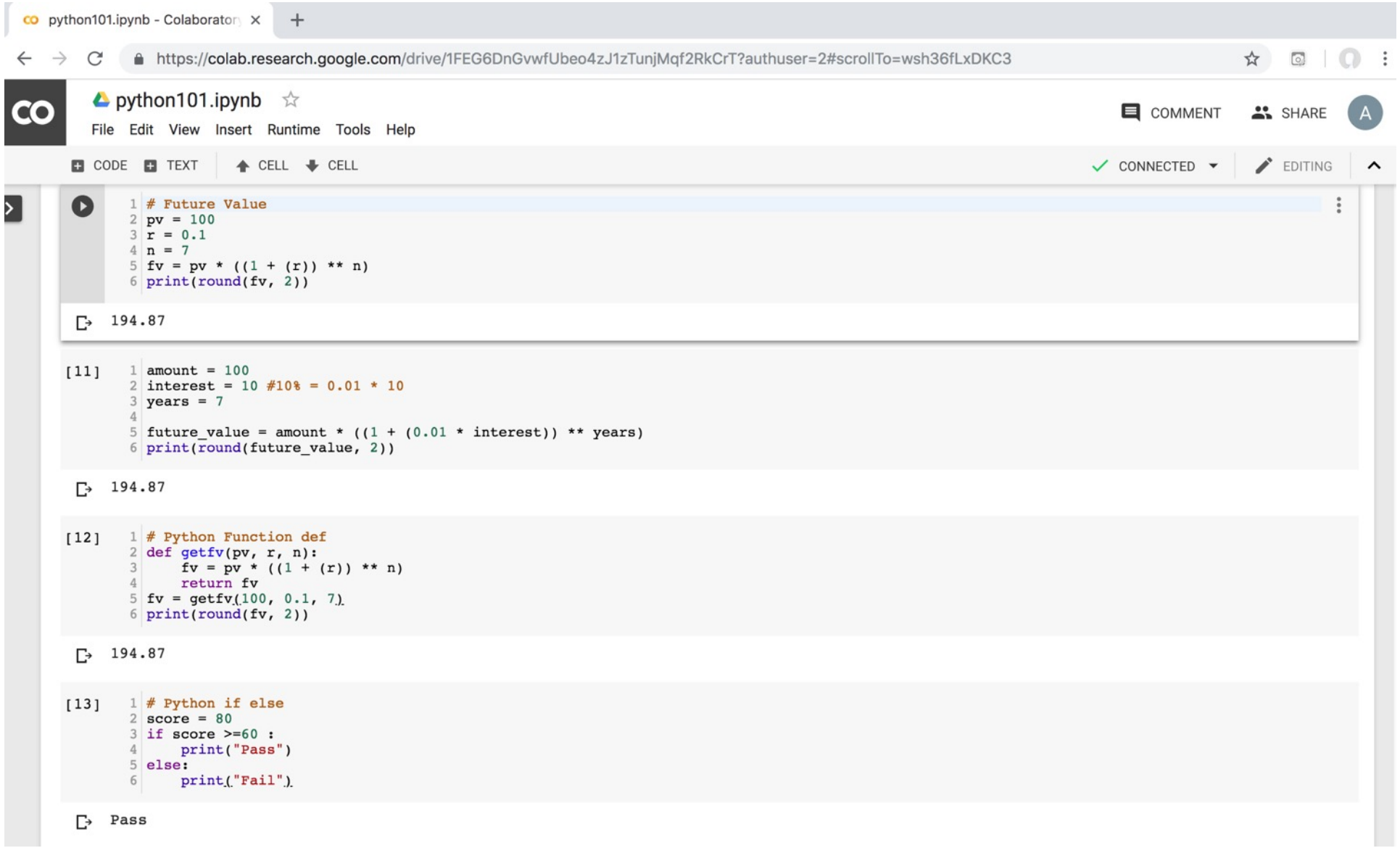
Run Jupyter Notebook
Python3 GPU
Google Colab



Google Colab Python Hello World
print('Hello World')

Python in Google Colab (Python101)

https://colab.research.google.com/drive/1FEG6DnGvwfUbeo4zJ1zTunjMqf2RkCrT



https://tinyurl.com/aintpupython101

Source: https://www.python.org/community/logos/

Python

Programming

Data Analytics and Visualization with Python

Data Analytics and Visualization with Python

- NumPy
  - Numerical Python N-dimensional array
- Pandas
  - Data Analytics
- Matplotlib
  - Basic Data Visualization
- Seaborn
  - Advanced Visualization

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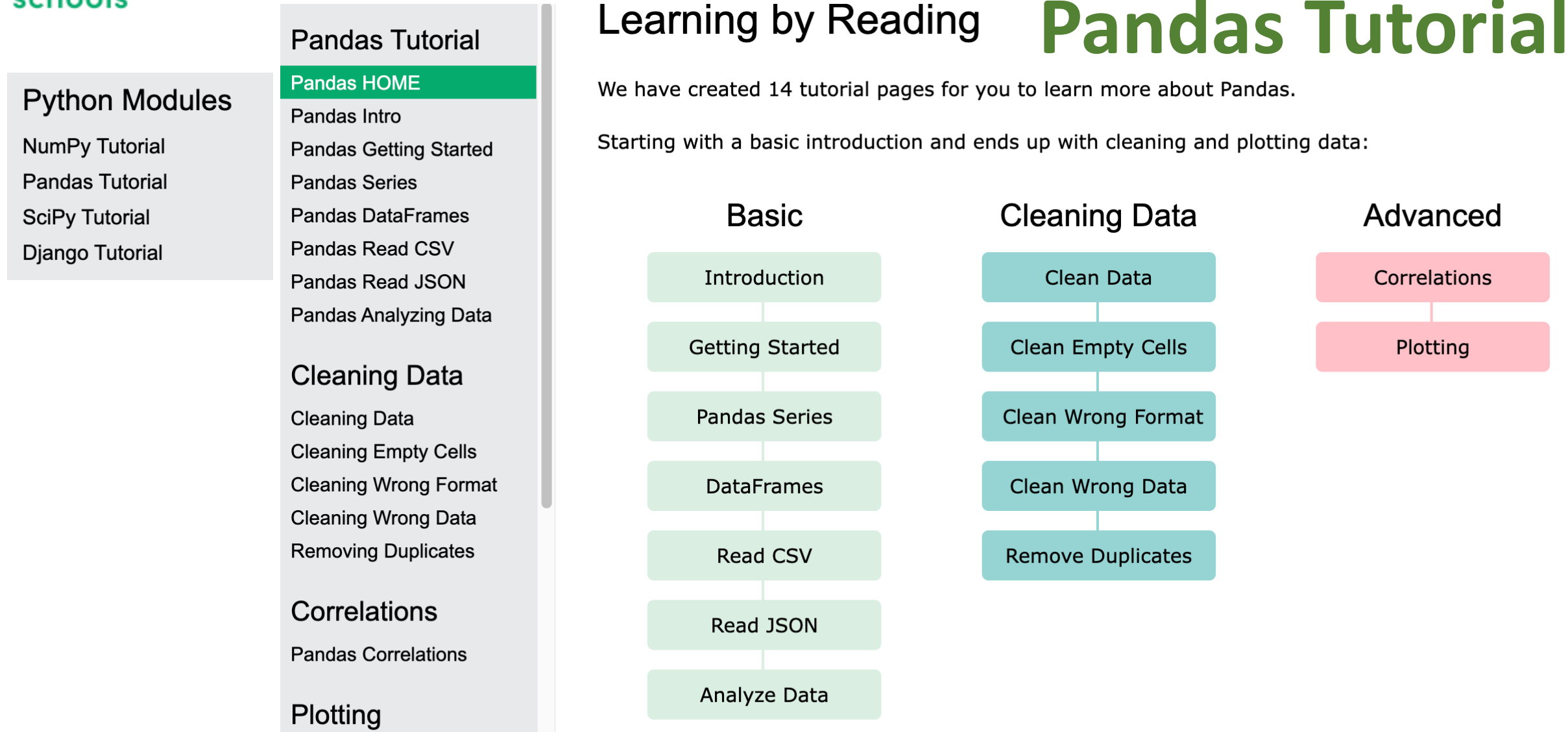

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Matplotlib Tutorial

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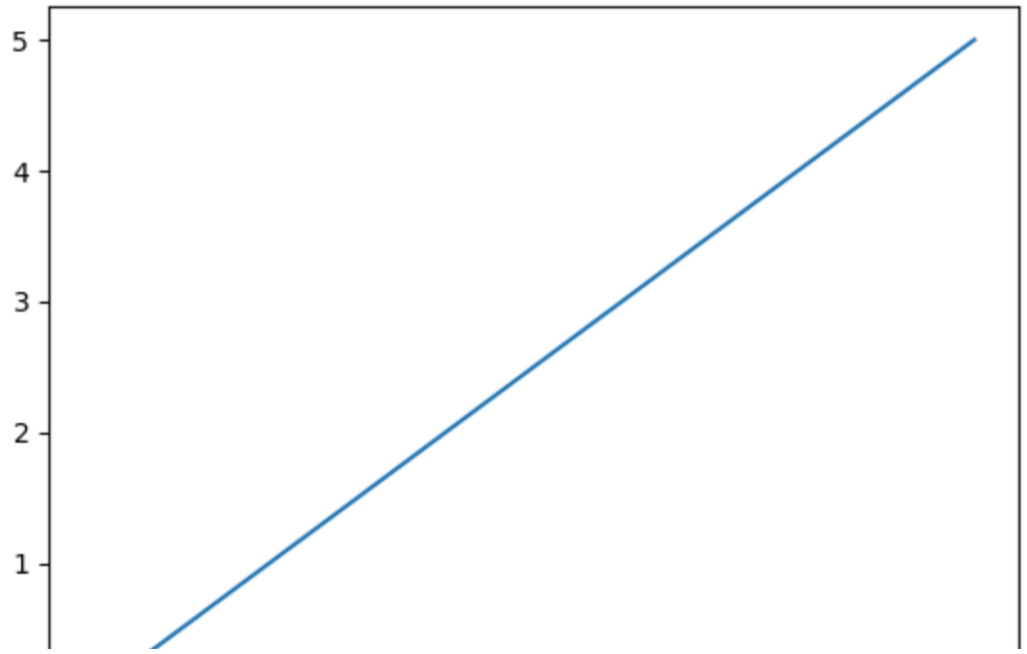

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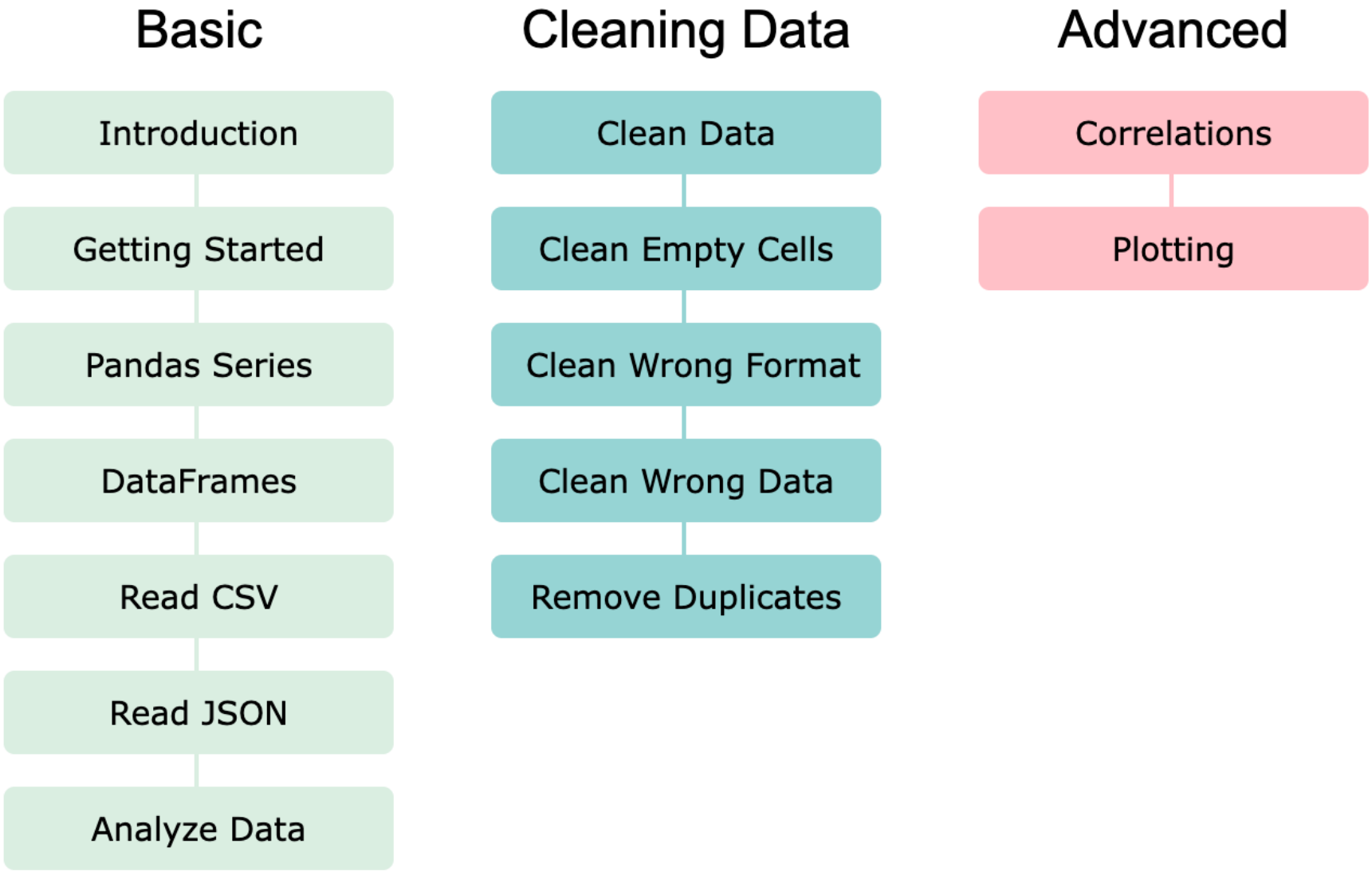
Pandas: Data Analytics and Visualization



https://www.w3schools.com/python/pandas/default.asp

Wes McKinney (2022), "Python for Data Analysis: Data Wrangling with pandas, NumPy, and Jupyter", 3rd Edition, O'Reilly Media.

wesm / pydata-book Public

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Code | Issues 2 | Pull requests 1 | Actions | Projects | Wiki | Security | Insights

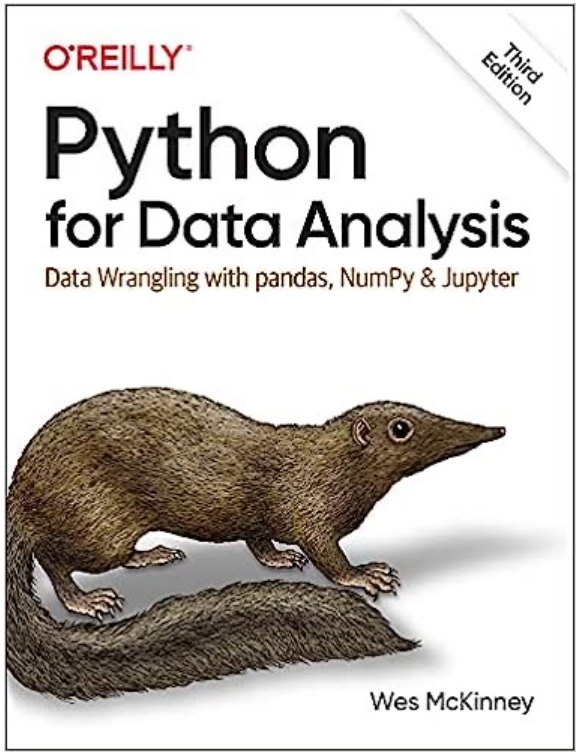
3rd-edition | 3 branches | 0 tags | Go to file | Code

wesm Upload cleaner notebook files without internal build toolchai... ... f1757b8 3 days ago 70 commits

datasets	Add fec.parquet	10 months ago
examples	Simplifying datasets	10 months ago
.gitignore	Add gitignore	8 years ago
COPYING	Update COPYING	4 months ago
README.md	Update notebooks in advance of publication	7 months ago
appa.ipynb	Upload cleaner notebook files without internal build toolchai...	3 days ago
appb.ipynb	Upload cleaner notebook files without internal build toolchai...	3 days ago
ch02.ipynb	Upload cleaner notebook files without internal build toolchai...	3 days ago
ch03.ipynb	Upload cleaner notebook files without internal build toolchai...	3 days ago
ch04.ipynb	Upload cleaner notebook files without internal build toolchai...	3 days ago
ch05.ipynb	Upload cleaner notebook files without internal build toolchai...	3 days ago
ch06.ipynb	Upload cleaner notebook files without internal build toolchai...	3 days ago

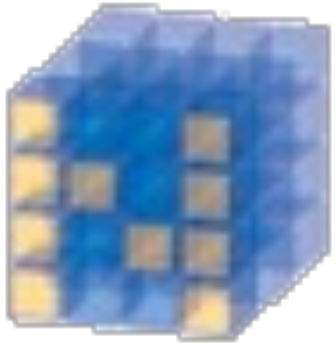
About

Materials and IPython notebooks for "Python for Data Analysis" by Wes McKinney, published by O'Reilly Media



https://github.com/wesm/pydata-book

Numpy



NumPy

Base

N-dimensional array

package

NumPy

is the

fundamental package

for

scientific computing

with Python.

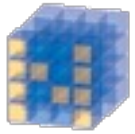
Source: http://www.numpy.org/

NumPy

NumPy

- **NumPy provides a multidimensional array object to store homogenous or heterogeneous data; it also provides optimized functions/methods to operate on this array object.**

Source: Yves Hilpisch (2014), Python for Finance: Analyze Big Financial Data, O'Reilly



NumPy

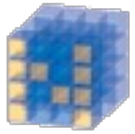
NumPy ndarray

One-dimensional Array (1-D Array)

0	1			n-1
1	**2**	**3**	**4**	**5**

Two-dimensional Array (2-D Array)

	0	1			n-1
0	**1**	**2**	**3**	**4**	**5**
1	**6**	**7**	**8**	**9**	**10**
	11	**12**	**13**	**14**	**15**
m-1	**16**	**17**	**18**	**19**	**20**

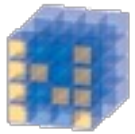


NumPy

NumPy

```
v = list(range(1, 6))
v
2 * v
import numpy as np
v = np.arange(1, 6)
v
2 * v
```

Source: Yves Hilpisch (2014), Python for Finance: Analyze Big Financial Data, O'Reilly



NumPy

Base
N-dimensional
array package

```
1 v = list(range(1, 6))
2 v
```

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

```
1 2 * v
```

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

```
1 import numpy as np
2 v = np.arange(1, 6)
3 v
```

```
array([1, 2, 3, 4, 5])
```

```
1 2 * v
```

```
array([ 2,  4,  6,  8, 10])
```

Python Data Structures

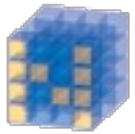
```
fruits = ["apple", "banana", "cherry"] #lists []
colors = ("red", "green", "blue") #tuples ()
animals = {'cat', 'dog'} #sets {}
person = {"name" : "Tom", "age" : 20} #dictionaries {}
```

https://tinyurl.com/aintpupython101

Lists []

```
x = [60, 70, 80, 90]
print(len(x))
print(x[0])
print(x[1])
print(x[-1])
```

```
4
60
70
90
```



NumPy

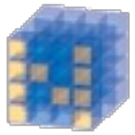
NumPy Create Array

```
import numpy as np
a = np.array([1, 2, 3])
b = np.array([4, 5, 6])
c = a * b
c
```

```
import numpy as np
a = np.array([1, 2, 3])
b = np.array([4, 5, 6])
c = a * b
c
```

```
array([ 4, 10, 18])
```

Source: Yves Hilpisch (2014), Python for Finance: Analyze Big Financial Data, O'Reilly



NumPy

NumPy

```python
import numpy as np

a = np.zeros((2,2))  # Create an array of all zeros
print(a)             # Prints "[[ 0.  0.]
                     #          [ 0.  0.]]"

b = np.ones((1,2))   # Create an array of all ones
print(b)             # Prints "[[ 1.  1.]]"

c = np.full((2,2), 7) # Create a constant array
print(c)               # Prints "[[ 7.  7.]
                       #          [ 7.  7.]]"

d = np.eye(2)        # Create a 2x2 identity matrix
print(d)             # Prints "[[ 1.  0.]
                     #          [ 0.  1.]]"

e = np.random.random((2,2)) # Create an array filled with random values
print(e)                    # Might print "[[ 0.91940167  0.08143941]
                            #               [ 0.68744134  0.87236687]]"
```

```
[[0. 0.]
 [0. 0.]]
[[1. 1.]]
[[7 7]
 [7 7]]
[[1. 0.]
 [0. 1.]]
[[0.66258211 0.65552598]
 [0.00429934 0.21695824]]
```

Source: http://cs231n.github.io/python-numpy-tutorial/

```
import numpy as np
a = np.arange(15).reshape(3, 5)
```

```
a.shape
a.ndim
a.dtype.name
```

```
import numpy as np
a = np.arange(15).reshape(3, 5)
a
```

```
array([[ 0,  1,  2,  3,  4],
       [ 5,  6,  7,  8,  9],
       [10, 11, 12, 13, 14]])
```

```
print(a.shape)
```

```
(3, 5)
```

```
a.ndim
```

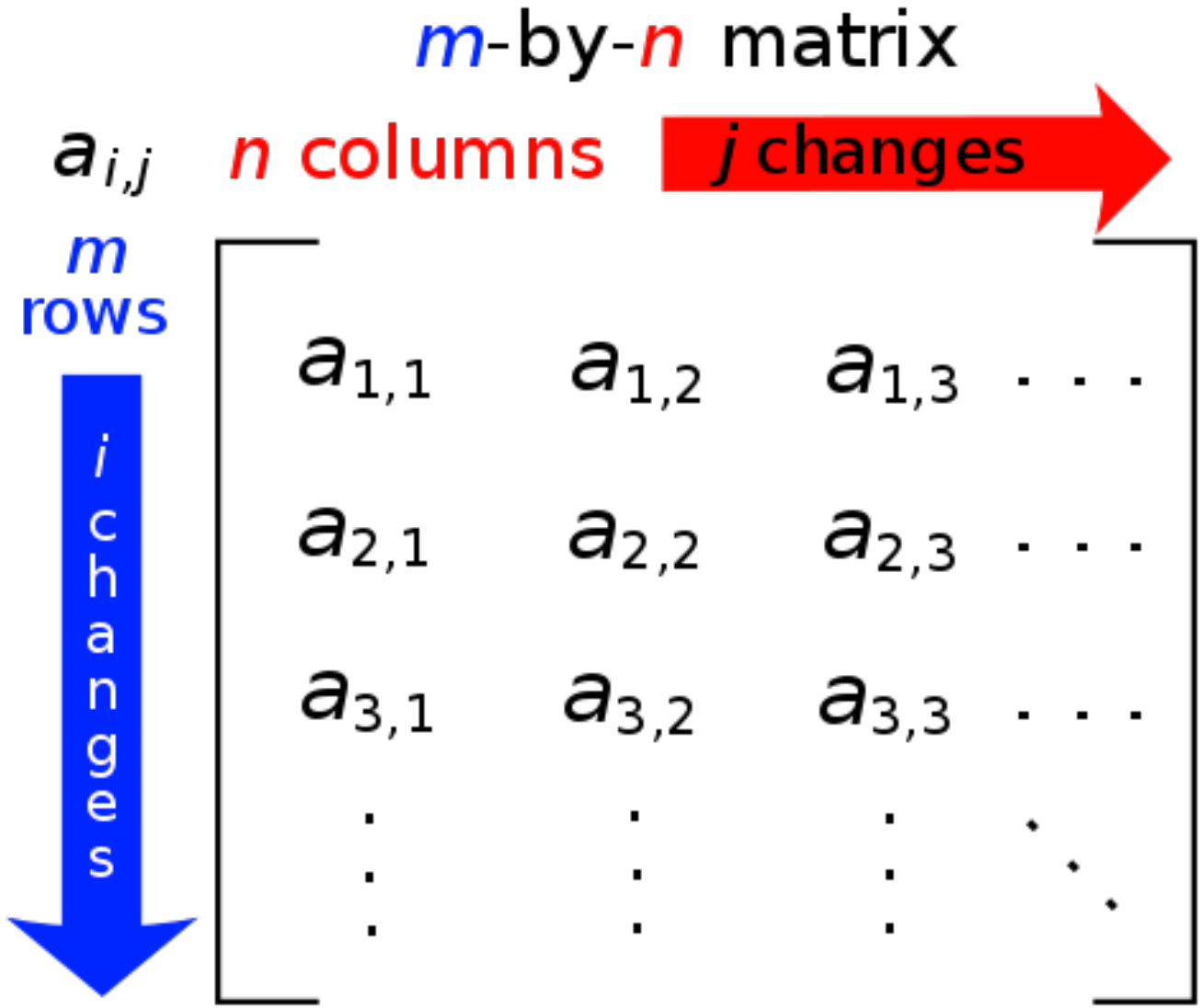
```
2
```

```
a.dtype.name
```

```
'int64'
```

Source: https://docs.scipy.org/doc/numpy-dev/user/quickstart.html

Matrix



Source: https://simple.wikipedia.org/wiki/Matrix_(mathematics)

NumPy ndarray:
Multidimensional Array Object

NumPy ndarray

One-dimensional Array (1-D Array)

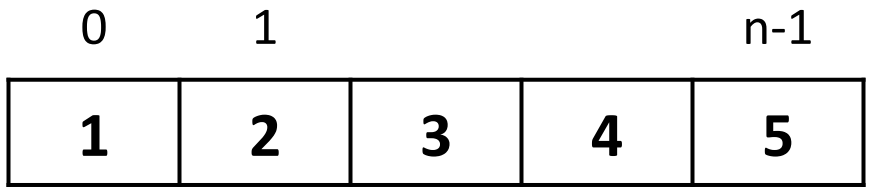
0	1			n-1
1	**2**	**3**	**4**	**5**

Two-dimensional Array (2-D Array)

	0	1			n-1
0	**1**	**2**	**3**	**4**	**5**
1	**6**	**7**	**8**	**9**	**10**
	11	**12**	**13**	**14**	**15**
m-1	**16**	**17**	**18**	**19**	**20**

```
import numpy as np
a = np.array([1,2,3,4,5])
```

One-dimensional Array (1-D Array)




```
a = np.array([1,2,3,4,5])
a
```

```
array([1, 2, 3, 4, 5])
```

```
a = np.array([[1,2,3,4,5],[6,7,8,9,10],[11,12,13,14,15],[16,17,18,19,20]])
```

Two-dimensional Array (2-D Array)

	0	1			n-1
0	**1**	**2**	**3**	**4**	**5**
1	**6**	**7**	**8**	**9**	**10**
	11	**12**	**13**	**14**	**15**
m-1	**16**	**17**	**18**	**19**	**20**

```
a = np.array([[1,2,3,4,5],[6,7,8,9,10],[11,12,13,14,15],[16,17,18,19,20]])
a
```

```
array([[ 1,  2,  3,  4,  5],
       [ 6,  7,  8,  9, 10],
       [11, 12, 13, 14, 15],
       [16, 17, 18, 19, 20]])
```

```
import numpy as np
a = np.array([[0, 1, 2, 3],
[10, 11, 12, 13],
[20, 21, 22, 23]])
a
```

0	1	2	3
10	11	12	13
20	21	22	23

a = np.array([[0, 1, 2, 3], [10, 11, 12, 13], [20, 21, 22, 23]])

```
a = np.array([[0, 1, 2, 3], [10, 11, 12, 13], [20, 21, 22, 23]])
a
```

```
array([[ 0,  1,  2,  3],
       [10, 11, 12, 13],
       [20, 21, 22, 23]])
```

```
print(a.ndim)
```

```
2
```

```
print(a.shape)
```

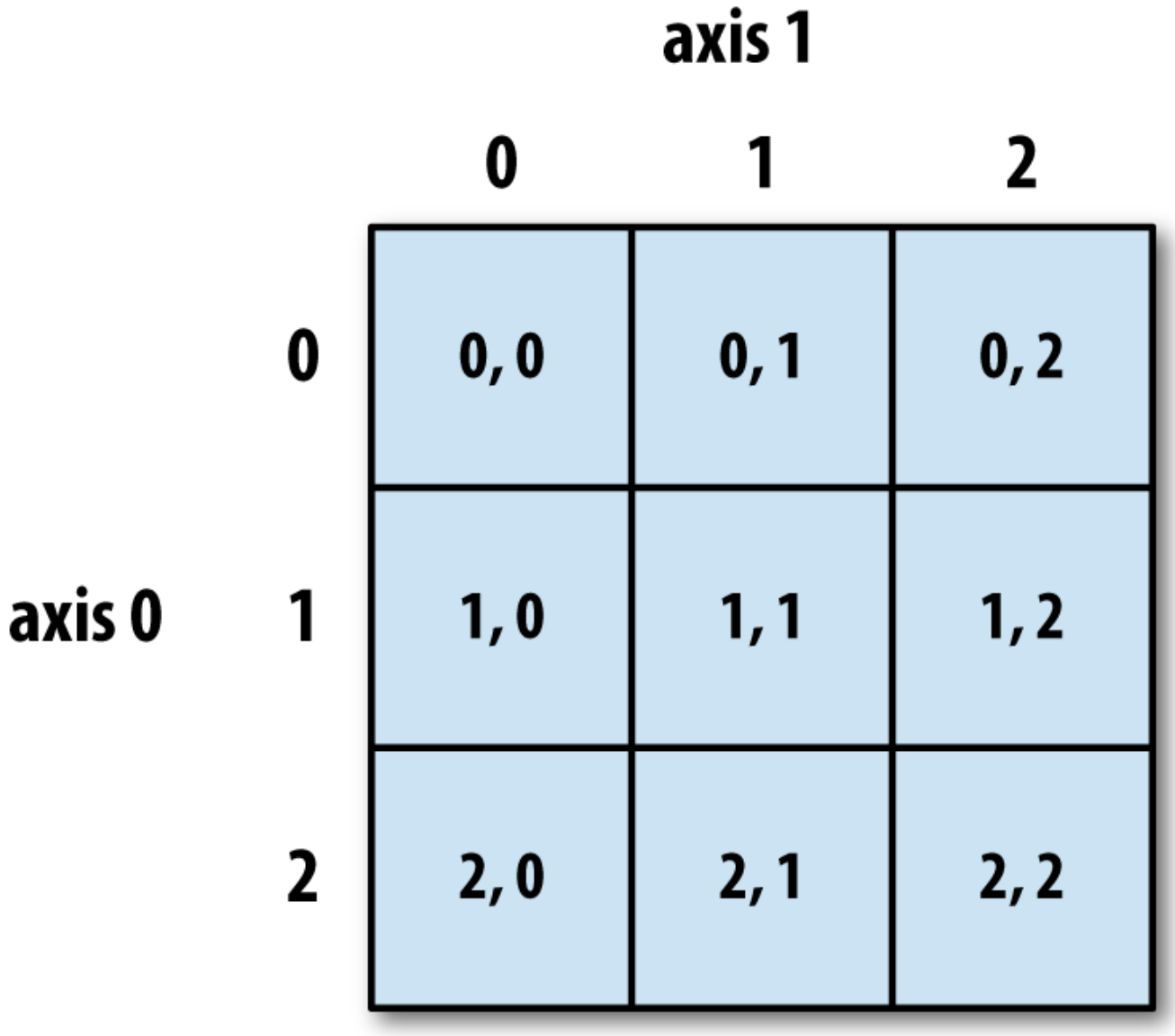
```
(3, 4)
```

0	1	2	3
10	11	12	13
20	21	22	23

NumPy Basics: Arrays and Vectorized Computation

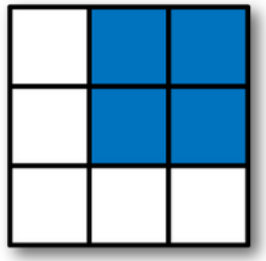
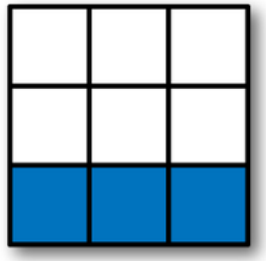
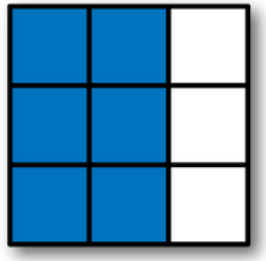
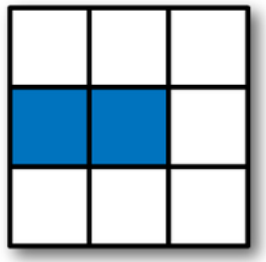
Source: https://www.safaribooksonline.com/library/view/python-for-data/9781449323592/ch04.html

NumPy Array



Source: https://www.safaribooksonline.com/library/view/python-for-data/9781449323592/ch04.html

Numpy Array

	Expression	Shape
	`arr[:2, 1:]`	`(2, 2)`
	`arr[2]`	`(3,)`
	`arr[2, :]`	`(3,)`
	`arr[2:, :]`	`(1, 3)`
	`arr[:, :2]`	`(3, 2)`
	`arr[1, :2]`	`(2,)`
	`arr[1:2, :2]`	`(1, 2)`

Source: https://www.safaribooksonline.com/library/view/python-for-data/9781449323592/ch04.html

TensorFlow

Tensor

- 3
  - a rank 0 tensor; this is a scalar with shape []
- [1. ,2., 3.]
  - a rank 1 tensor; this is a vector with shape [3]
- [[1., 2., 3.], [4., 5., 6.]]
  - a rank 2 tensor; a matrix with shape [2, 3]
- [[[1., 2., 3.]], [[7., 8., 9.]]]
  - a rank 3 tensor with shape [2, 1, 3]

https://www.tensorflow.org/

Scalar 80

Vector [50 60 70]

Matrix

$$\begin{bmatrix} 50 & 60 & 70 \\ 55 & 65 & 75 \end{bmatrix}$$

Tensor

$$\begin{bmatrix} [50 & 60 & 70] & [70 & 80 & 90] \\ [55 & 65 & 75] & [75 & 85 & 95] \end{bmatrix}$$

pandas

pandas

Python Data Analysis Library

providing high-performance, easy-to-use
data structures and data analysis tools
for the Python programming language.

Source: http://pandas.pydata.org/

pandas:
powerful Python data analysis toolkit

- **Tabular data with heterogeneously-typed columns, as in an SQL table or Excel spreadsheet**
- **Ordered and unordered (not necessarily fixed-frequency) time series data.**
- **Arbitrary matrix data (homogeneously typed or heterogeneous) with row and column labels**
- **Any other form of observational / statistical data sets. The data actually need not be labeled at all to be placed into a pandas data structure**

Source: http://pandas.pydata.org/pandas-docs/stable/

pandas

Series
DataFrame

- Primary data structures of pandas
  - Series (1-dimensional)
  - DataFrame (2-dimensional)
- Handle the vast majority of typical use cases in finance, statistics, social science, and many areas of engineering.

Source: http://pandas.pydata.org/pandas-docs/stable/

pandas

pandas DataFrame

- **DataFrame provides everything that R's data.frame provides and much more.**
- **pandas is built on top of NumPy and is intended to integrate well within a scientific computing environment with many other 3rd party libraries.**

pandas

pandas
Comparison with SAS

pandas	SAS
DataFrame	data set
column	variable
row	observation
groupby	BY-group
NaN	.

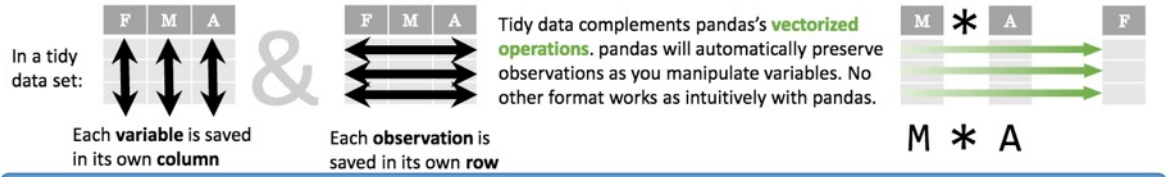
Source: http://pandas.pydata.org/pandas-docs/stable/comparison_with_sas.html

Python Pandas Cheat Sheet

Data Wrangling with pandas Cheat Sheet

http://pandas.pydata.org

Tidy Data – A foundation for wrangling in pandas



Tidy data complements pandas's vectorized operations. pandas will automatically preserve observations as you manipulate variables. No other format works as intuitively with pandas.

Syntax – Creating DataFrames

	a	b	c
1	4	7	10
2	5	8	11
3	6	9	12

```
df = pd.DataFrame(
        {"a" : [4 ,5, 6],
         "b" : [7, 8, 9],
         "c" : [10, 11, 12]},
       index = [1, 2, 3])
```

Specify values for each column.

```
df = pd.DataFrame(
    [[4, 7, 10],
     [5, 8, 11],
     [6, 9, 12]],
    index=[1, 2, 3],
    columns=['a', 'b', 'c'])
```

Specify values for each row.

		a	b	c
n	v			
d	1	4	7	10
	2	5	8	11
e	2	6	9	12

```
df = pd.DataFrame(
        {"a" : [4 ,5, 6],
         "b" : [7, 8, 9],
         "c" : [10, 11, 12]},
index = pd.MultiIndex.from_tuples(
        [('d',1),('d',2),('e',2)],
          names=['n','v'])))
```

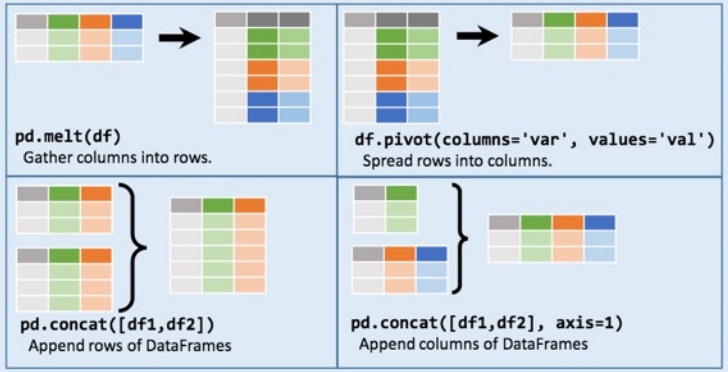
Create DataFrame with a MultiIndex

Method Chaining

Most pandas methods return a DataFrame so that another pandas method can be applied to the result. This improves readability of code.

```
df = (pd.melt(df)
        .rename(columns={
                'variable' : 'var',
                'value' : 'val'})
        .query('val >= 200')
    )
```

Reshaping Data – Change the layout of a data set



pd.melt(df)
Gather columns into rows.

df.pivot(columns='var', values='val')
Spread rows into columns.

pd.concat([df1,df2])
Append rows of DataFrames

pd.concat([df1,df2], axis=1)
Append columns of DataFrames

df=df.sort_values('mpg')
Order rows by values of a column (low to high).

df=df.sort_values('mpg',ascending=False)
Order rows by values of a column (high to low).

df=df.rename(columns = {'y':'year'})
Rename the columns of a DataFrame

df=df.sort_index()
Sort the index of a DataFrame

df=df.reset_index()
Reset index of DataFrame to row numbers, moving index to columns.

df=df.drop(['Length','Height'], axis=1)
Drop columns from DataFrame

Subset Observations (Rows)

df[df.Length > 7]
Extract rows that meet logical criteria.

df.drop_duplicates()
Remove duplicate rows (only considers columns).

df.head(n)
Select first n rows.

df.tail(n)
Select last n rows.

df.sample(frac=0.5)
Randomly select fraction of rows.

df.sample(n=10)
Randomly select n rows.

df.iloc[10:20]
Select rows by position.

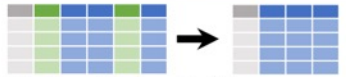
df.nlargest(n, 'value')
Select and order top n entries.

df.nsmallest(n, 'value')
Select and order bottom n entries.

Logic in Python (and pandas)

<	Less than	!=	Not equal to
>	Greater than	df.column.isin(*values*)	Group membership
==	Equals	pd.isnull(*obj*)	Is NaN
<=	Less than or equals	pd.notnull(*obj*)	Is not NaN
>=	Greater than or equals	&,|,~,^,df.any(),df.all()	Logical and, or, not, xor, any, all

Subset Variables (Columns)



df[['width','length','species']]
Select multiple columns with specific names.

df['width'] *or* **df.width**
Select single column with specific name.

df.filter(regex='*regex*')
Select columns whose name matches regular expression *regex*.

regex (Regular Expressions) Examples

'\.'	Matches strings containing a period '.'
'Length$'	Matches strings ending with word 'Length'
'^Sepal'	Matches strings beginning with the word 'Sepal'
'^x[1-5]$'	Matches strings beginning with 'x' and ending with 1,2,3,4,5
''^(?!Species$).*'	Matches strings except the string 'Species'

df.loc[:,'x2':'x4']
Select all columns between x2 and x4 (inclusive).

df.iloc[:,[1,2,5]]
Select columns in positions 1, 2 and 5 (first column is 0).

df.loc[df['a'] > 10, ['a','c']]
Select rows meeting logical condition, and only the specific columns .

http://pandas.pydata.org/ This cheat sheet inspired by Rstudio Data Wrangling Cheatsheet (https://www.rstudio.com/wp-content/uploads/2015/02/data-wrangling-cheatsheet.pdf) Written by Irv Lustig, Princeton Consultants

Source: https://github.com/pandas-dev/pandas/blob/master/doc/cheatsheet/Pandas_Cheat_Sheet.pdf

Creating pd.DataFrame

	a	b	c
1	4	7	10
2	5	8	11
3	6	9	12

In [1]:
```
import numpy as np
import pandas as pd
df = pd.DataFrame({"a": [4, 5, 6],
                   "b": [7, 8, 9],
                   "c": [10, 11, 12]},
                  index = [1, 2, 3])
df
```

Out[1]:

	a	b	c
1	4	7	10
2	5	8	11
3	6	9	12

```
import pandas as pd
df = pd.DataFrame({"a": [4, 5, 6],
                   "b": [7, 8, 9],
                   "c": [10, 11, 12]},
                  index = [1, 2, 3])
```

Source: https://github.com/pandas-dev/pandas/blob/master/doc/cheatsheet/Pandas_Cheat_Sheet.pdf

Pandas DataFrame

```
type(df)
```

```
type(df)
```

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

pandas

```
import numpy as np
import pandas as pd
import matplotlib.pyplot as plt
print('pandas imported')
```

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

```
dates = pd.date_range('20181001',
periods=6)
dates
```

Source: http://pandas.pydata.org/pandas-docs/stable/10min.html

```
1 import numpy as np
2 import pandas as pd
3 import matplotlib.pyplot as plt
4 print('pandas imported')
```

```
pandas imported
```

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

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

```
1 dates = pd.date_range('20181001', periods=6)
2 dates
```

```
DatetimeIndex(['2018-10-01', '2018-10-02', '2018-10-03', '2018-10-04',
               '2018-10-05', '2018-10-06'],
              dtype='datetime64[ns]', freq='D')
```

pandas

```
df = pd.DataFrame(np.random.randn(6,4), index=dates, columns=list('ABCD'))
df
```

```
1 df = pd.DataFrame(np.random.randn(6,4), index=dates, columns=list('ABCD'))
2 df
```

	A	B	C	D
2018-10-01	-0.336188	0.584621	-1.061433	-0.036278
2018-10-02	0.903683	-0.839723	-0.270219	-1.099606
2018-10-03	0.920208	-0.240353	-0.818598	-1.105489
2018-10-04	0.221045	-0.314589	0.042071	-1.447280
2018-10-05	0.946862	-1.570305	-1.009180	-0.375659
2018-10-06	-0.225148	0.510691	2.002372	-0.335005

```
df = pd.DataFrame(np.random.randn(3,5),
index=['student1','student2','student3']
, columns=list('ABCDE'))
df
```

```
1 df = pd.DataFrame(np.random.randn(3,5), index=['student1','student2','student3'], columns=list('ABCDE'))
2 df
```

	A	B	C	D	E
student1	-0.346884	-1.232934	-0.302072	-1.345084	-0.723880
student2	1.090955	-0.010483	1.280072	-0.253958	-0.030604
student3	0.325660	0.808956	-0.395820	-1.498926	1.603471

pandas

```
df2 = pd.DataFrame({ 'A' : 1.,
'B' : pd.Timestamp('20181001'),
'C' : pd.Series(2.5,index=list(range(4)),dtype='float32'),
'D' : np.array([3] * 4,dtype='int32'),
'E' : pd.Categorical(["test","train","test","train"]),
'F' : 'foo' })
df2
```

```
1 df2 = pd.DataFrame({ 'A' : 1.,
2 'B' : pd.Timestamp('20181001'),
3 'C' : pd.Series(2.5,index=list(range(4)),dtype='float32'),
4 'D' : np.array([3] * 4,dtype='int32'),
5 'E' : pd.Categorical(["test","train","test","train"]),
6 'F' : 'foo' })
7 df2
```

	A	B	C	D	E	F
0	1.0	2018-10-01	2.5	3	test	foo
1	1.0	2018-10-01	2.5	3	train	foo
2	1.0	2018-10-01	2.5	3	test	foo
3	1.0	2018-10-01	2.5	3	train	foo

pandas

df2.dtypes

```
df2.dtypes
```

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

Python Accounting Application with Pandas

```python
import pandas as pd

# Create a DataFrame to store transactions
columns = ['Date', 'Description', 'Amount']
ledger = pd.DataFrame(columns=columns)

# Function to add a transaction
def add_transaction(date, description, amount):
global ledger
new_transaction = pd.DataFrame([[date, description, amount]], columns=columns)
ledger = pd.concat([ledger, new_transaction], ignore_index=True)

# Function to view the ledger
def view_ledger():
print(ledger)

# Function to get the current balance
def get_balance():
return ledger['Amount'].sum()

# Adding sample transactions
add_transaction('2023-11-01', 'Income', 1000)
add_transaction('2023-11-02', 'Groceries', -200)
add_transaction('2023-11-03', 'Utilities', -100)

# Viewing the ledger
view_ledger()

# Checking the current balance
print("Current Balance:", get_balance())
```

```
  Date Description Amount
0 2023-11-01 Income 1000
1 2023-11-02 Groceries -200
2 2023-11-03 Utilities -100
Current Balance: 700
```

https://tinyurl.com/aintpupython101

Python Data Analysis and Visualization

Python Pandas

http://pandas.pydata.org/

Python matplotlib

Source: https://matplotlib.org/

Python seaborn

seaborn

Source: https://seaborn.pydata.org/

Python plotly

Source: https://plotly.com/python/

Python bokeh

Source: https://bokeh.org/

Python Altair

Altair

Source: https://altair-viz.github.io/

Python matplotlib

matplotlib
Version 3.3.4

Fork me on GitHub

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home | contents » Matplotlib: Python plotting modules | index

Matplotlib: Visualization with Python

Matplotlib is a comprehensive library for creating static, animated, and interactive visualizations in Python.

Matplotlib makes easy things easy and hard things possible.

Create

- Develop publication quality plots with just a few lines of code
- Use interactive figures that can zoom, pan, update...

Customize

- Take full control of line styles, font properties, axes properties...
- Export and embed to a number of file formats and interactive environments

Extend

- Explore tailored functionality provided by third party packages
- Learn more about Matplotlib through the many external learning resources

Latest stable release
3.3.4: docs | changelog

Last release for Python 2
2.2.5: docs | changelog

Development version
docs

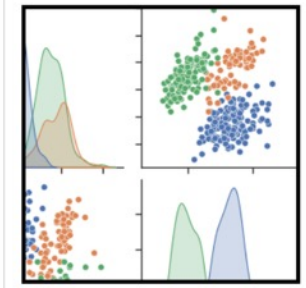
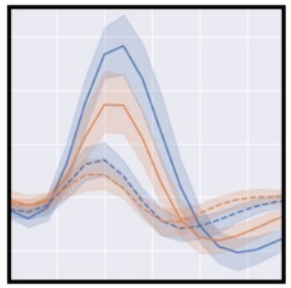
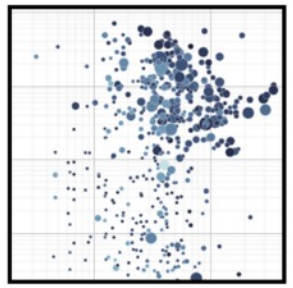
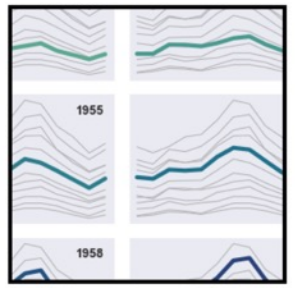
Support Matplotlib

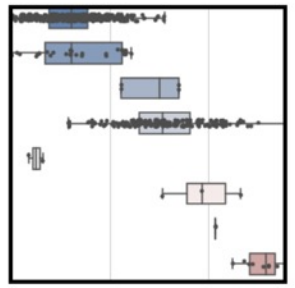
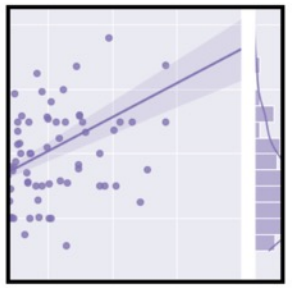
https://matplotlib.org/

Python Seaborn

seaborn 0.11.1 Gallery Tutorial API Site Page Search

seaborn: statistical data visualization

Seaborn is a Python data visualization library based on matplotlib. It provides a high-level interface for drawing attractive and informative statistical graphics.

For a brief introduction to the ideas behind the library, you can read the introductory notes. Visit the installation page to see how you can download the package and get started with it. You can browse the example gallery to see what you can do with seaborn, and then check out the tutorial and API reference to find out how.

To see the code or report a bug, please visit the GitHub repository. General support questions are most at home on stackoverflow or discourse, which have dedicated channels for seaborn.

Contents

- Introduction
- Release notes
- Installing
- Example gallery
- Tutorial
- API reference

Features

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- Distribution: API | Tutorial
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https://seaborn.pydata.org/

plotly

Python Plotly Graphing Library

plotly | Graphing Libraries

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Quick Start

- Getting Started
- Is Plotly Free?
- Figure Reference
- API Reference
- Dash
- GitHub
- community.plotly.com

Examples

- Fundamentals
- Basic Charts
- Statistical Charts
- Artificial Intelligence and Machine Learning
- Scientific Charts
- Financial Charts
- Maps
- 3D Charts

Plotly Python Open Source Graphing Library

Plotly's Python graphing library makes interactive, publication-quality graphs. Examples of how to make line plots, scatter plots, area charts, bar charts, error bars, box plots, histograms, heatmaps, subplots, multiple-axes, polar charts, and bubble charts.
Plotly.py is free and open source and you can view the source, report issues or contribute on GitHub.

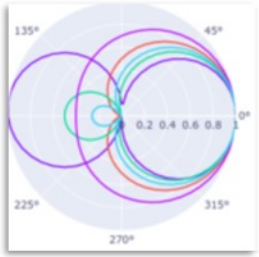
Our recommended IDE for Plotly's Python graphing library is Dash Enterprise's Data Science Workspaces, which has both Jupyter notebook and Python code file support.
Find out if your company is using Dash Enterprise.

Install Dash Enterprise on Azure | ***Install Dash Enterprise on AWS***

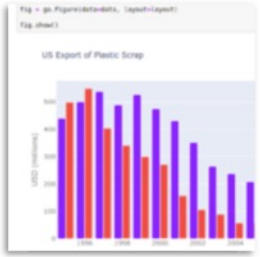
Fundamentals

More Fundamentals »

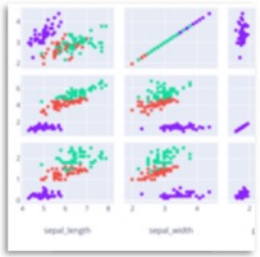
The Figure Data Structure



Creating and Updating Figures



Displaying Figures



Plotly Express

Analytical Apps with Dash

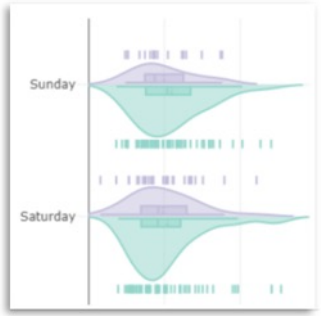
https://plotly.com/python/

plotly

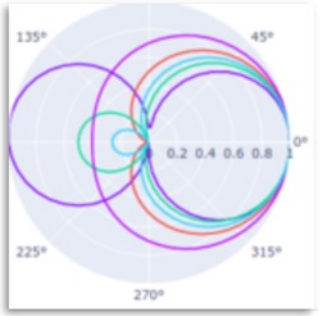
Python Plotly Graphing Library

Fundamentals

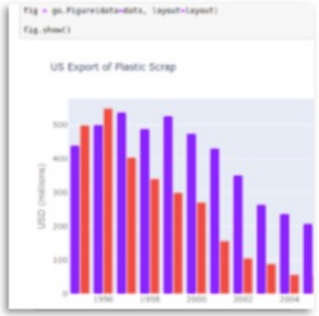
More Fundamentals »



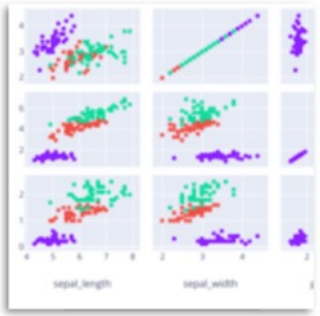
The Figure Data Structure



Creating and Updating Figures



Displaying Figures

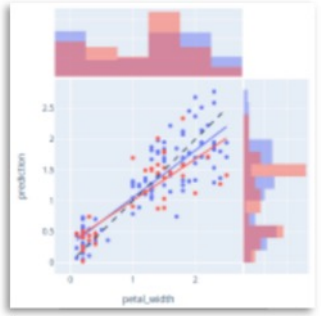


Plotly Express

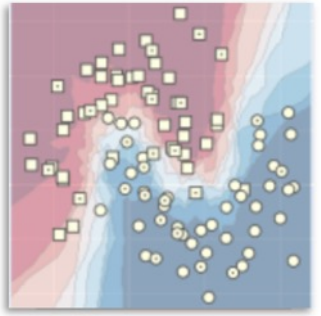
Analytical Apps with Dash

Artificial Intelligence and Machine Learning

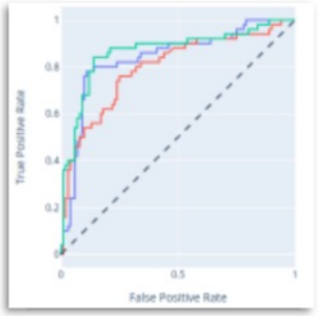
More AI and ML »



ML Regression

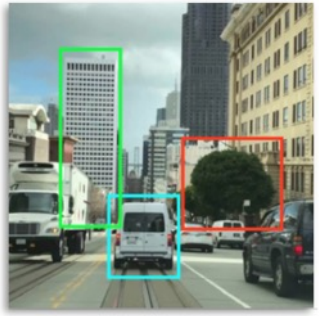


kNN Classification



ROC and PR Curves

PCA Visualization



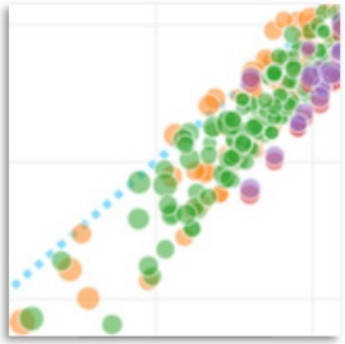
AI/ML Apps with Dash

https://plotly.com/python/

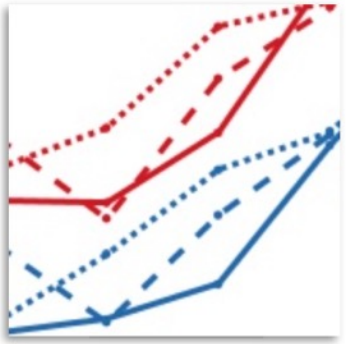
Python Plotly Graphing Library

Basic Charts

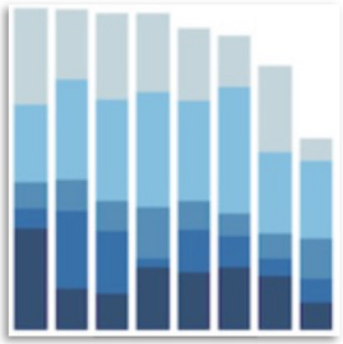
More Basic Charts »



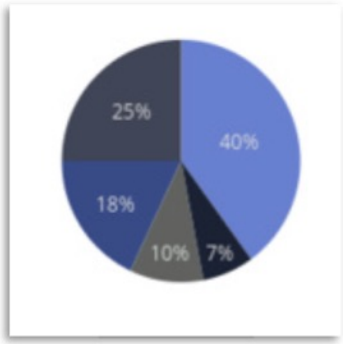
Scatter Plots



Line Charts



Bar Charts

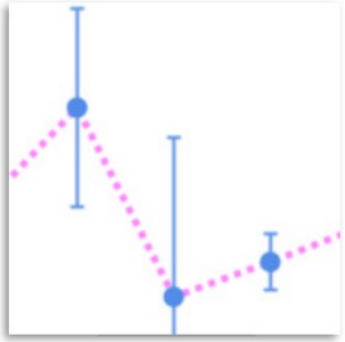


Pie Charts

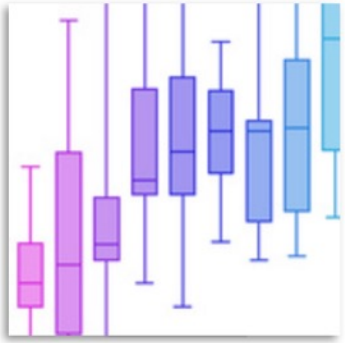
Bubble Charts

Statistical Charts

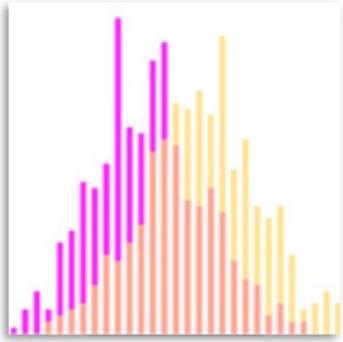
More Statistical Charts »



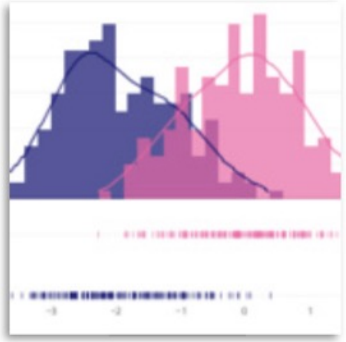
Error Bars



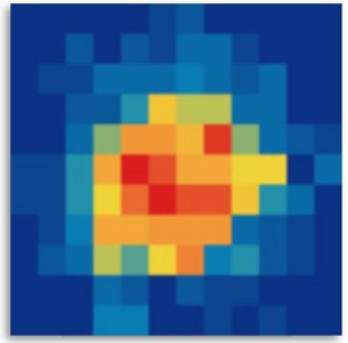
Box Plots



Histograms



Distplots



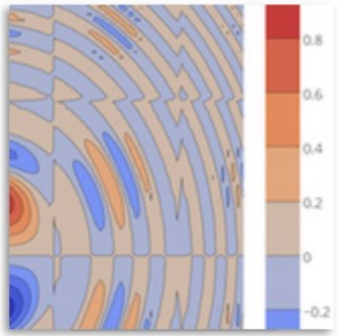
2D Histograms

https://plotly.com/python/

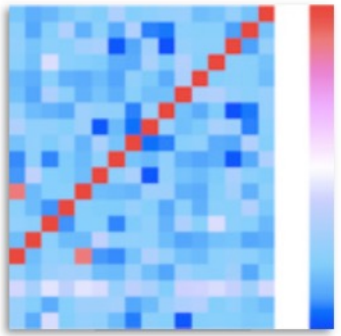
Python Plotly Graphing Library

Scientific Charts

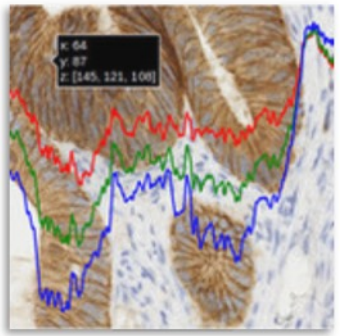
More Scientific Charts »



Contour Plots



Heatmaps



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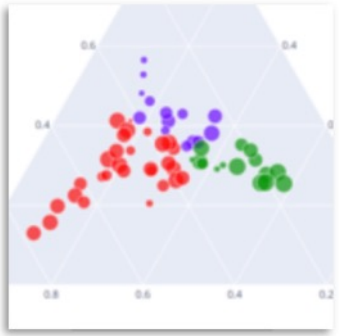
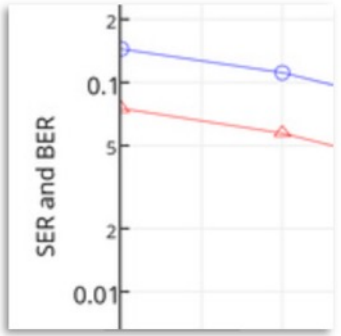


Ternary Plots



Log Plots

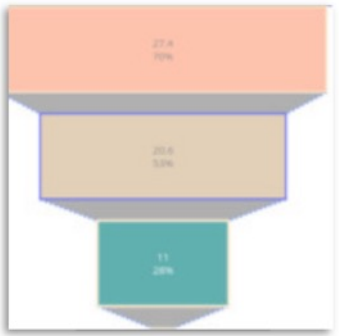
Financial Charts

More Financial Charts »

Time Series and Date Axes

Candlestick Charts

Waterfall Charts



Funnel Chart

OHLC Charts

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Python Plotly Graphing Library

Maps

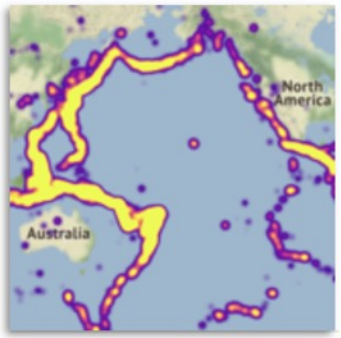
More Maps »

Mapbox Choropleth Maps

Lines on Mapbox

Filled Area on Maps

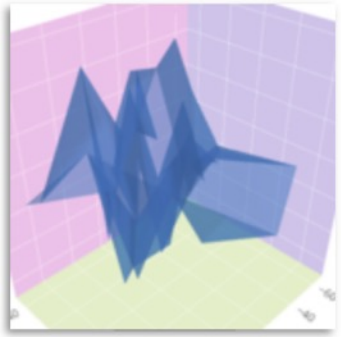
Bubble Maps



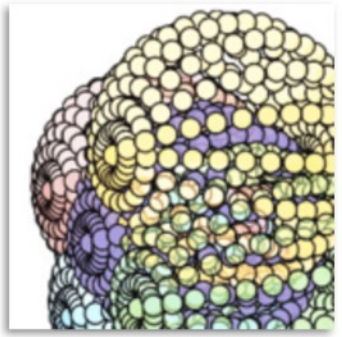
Mapbox Density Heatmap

3D Charts

More 3D Charts »

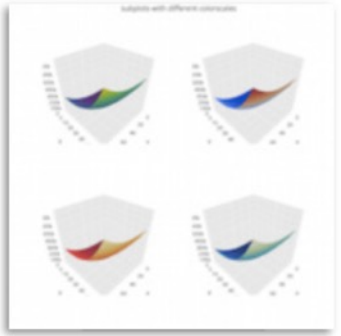


3D Axes

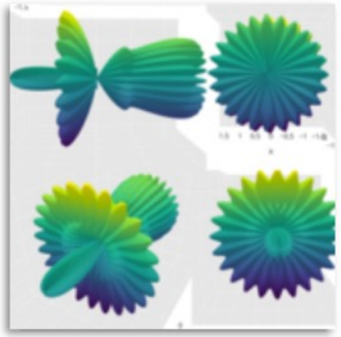


3D Scatter Plots

3D Surface Plots



3D Subplots



3D Camera Controls

https://plotly.com/python/

Python Plotly Graphing Library

Subplots

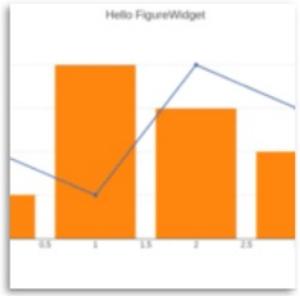
Mixed Subplots

Map Subplots

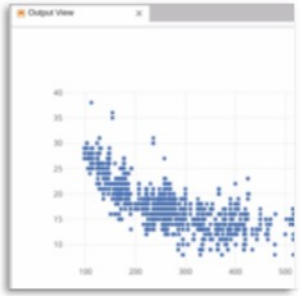
Table and Chart Subplots

Figure Factory Subplots

Jupyter Widgets Interaction

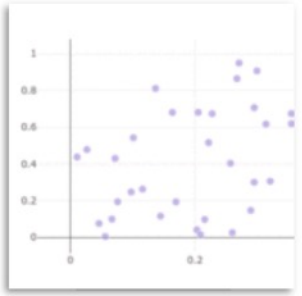


Plotly FigureWidget Overview



Jupyter Lab with FigureWidget

Interactive Data Analysis with FigureWidget ipywidgets



Click Events

https://plotly.com/python/

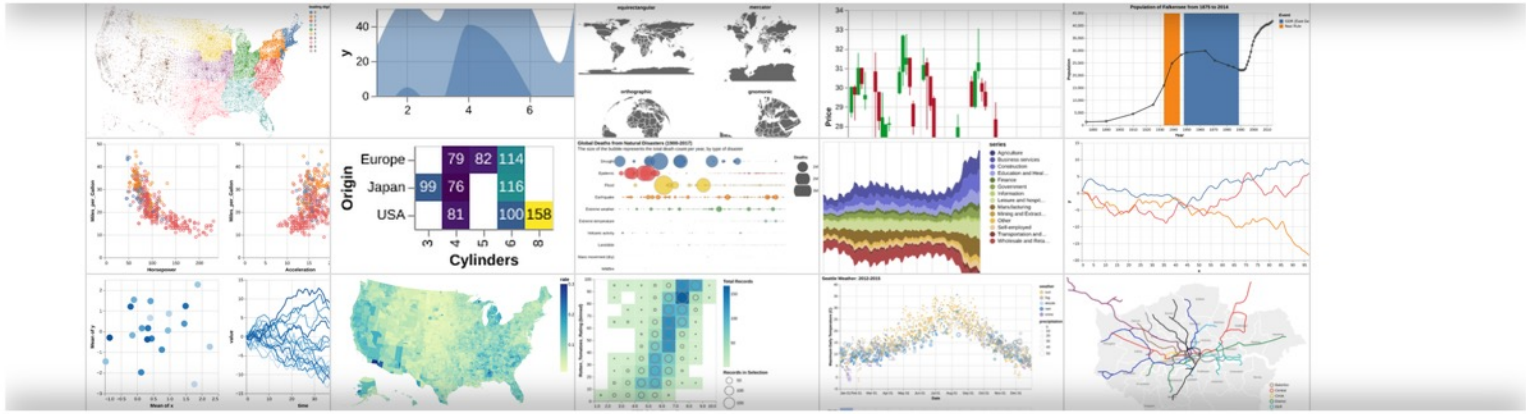
Python Bokeh

https://bokeh.org/

Python Altair

Vega-Altair Getting Started User Guide Examples API Reference Ecosystem Release Notes

Vega-Altair: Declarative Visualization in Python



Vega-Altair is a declarative statistical visualization library for Python, based on Vega and Vega-Lite.

The Vega-Altair open source project is not affiliated with Altair Engineering, Inc.

With Vega-Altair, you can spend more time understanding your data and its meaning. Altair's API is simple, friendly and consistent and built on top of the powerful Vega-Lite visualization grammar. This elegant simplicity produces beautiful and effective visualizations with a minimal amount of code.

You can browse this documentation via the links in the top navigation panel. In addition to reading this documentation page, it can be helpful to also browse the Vega-Lite documentation.

https://altair-viz.github.io/

Iris flower data set

setosa

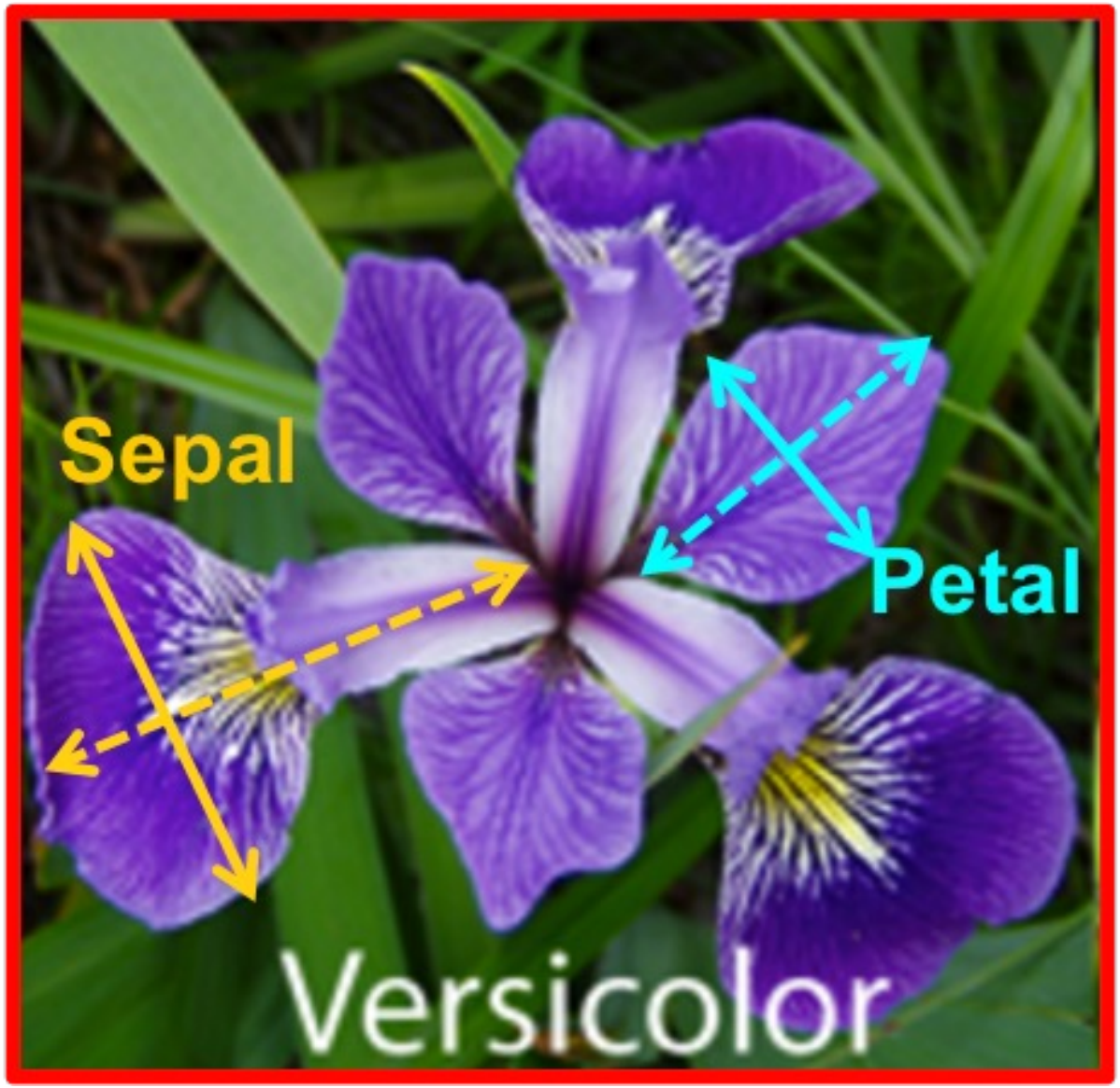
versicolor

virginica

Source: https://en.wikipedia.org/wiki/Iris_flower_data_set

Source: http://suruchifialoke.com/2016-10-13-machine-learning-tutorial-iris-classification/

Iris Classfication



Source: http://suruchifialoke.com/2016-10-13-machine-learning-tutorial-iris-classification/

iris.data

https://archive.ics.uci.edu/ml/machine-learning-databases/iris/iris.data

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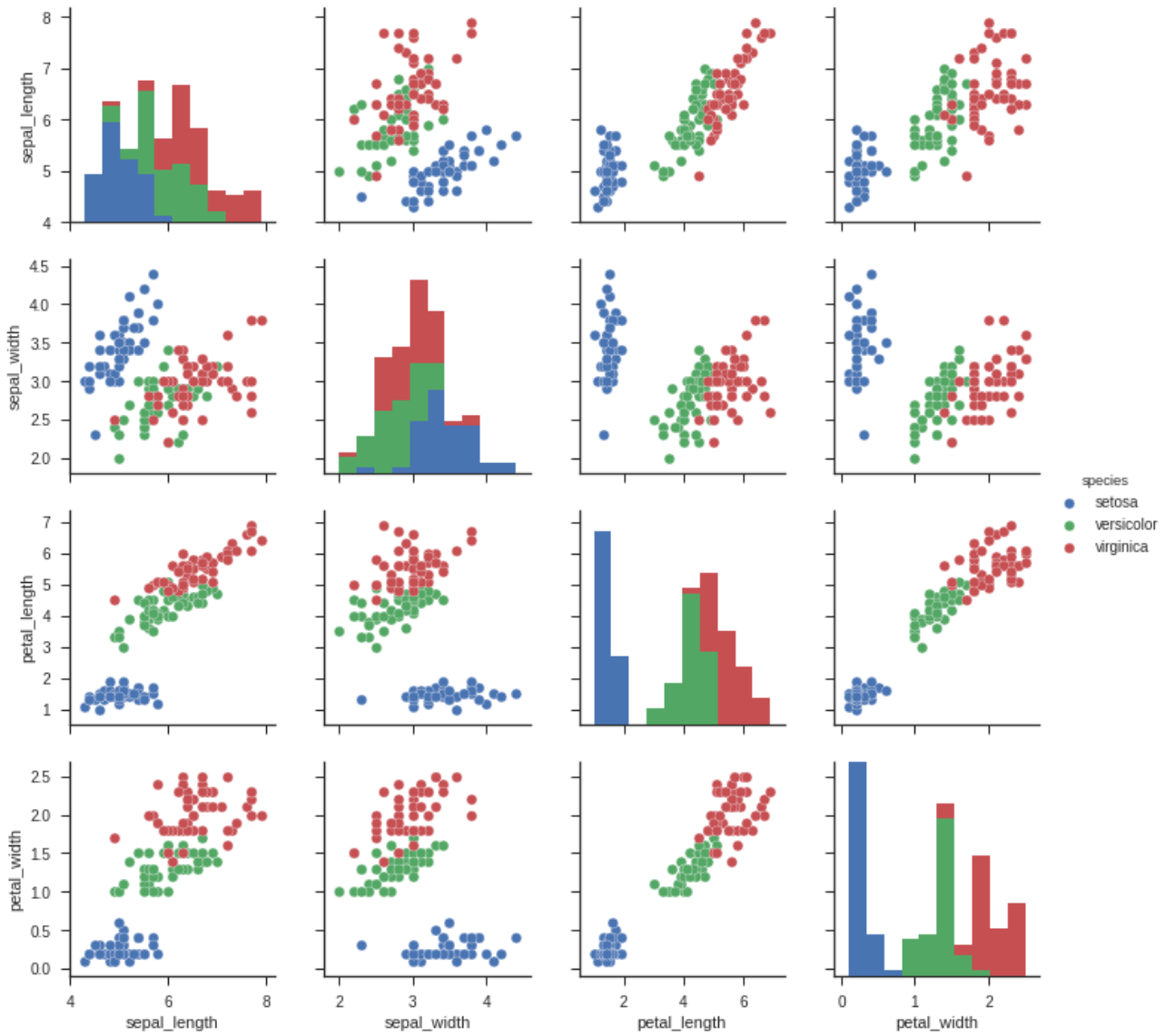
setosa

virginica

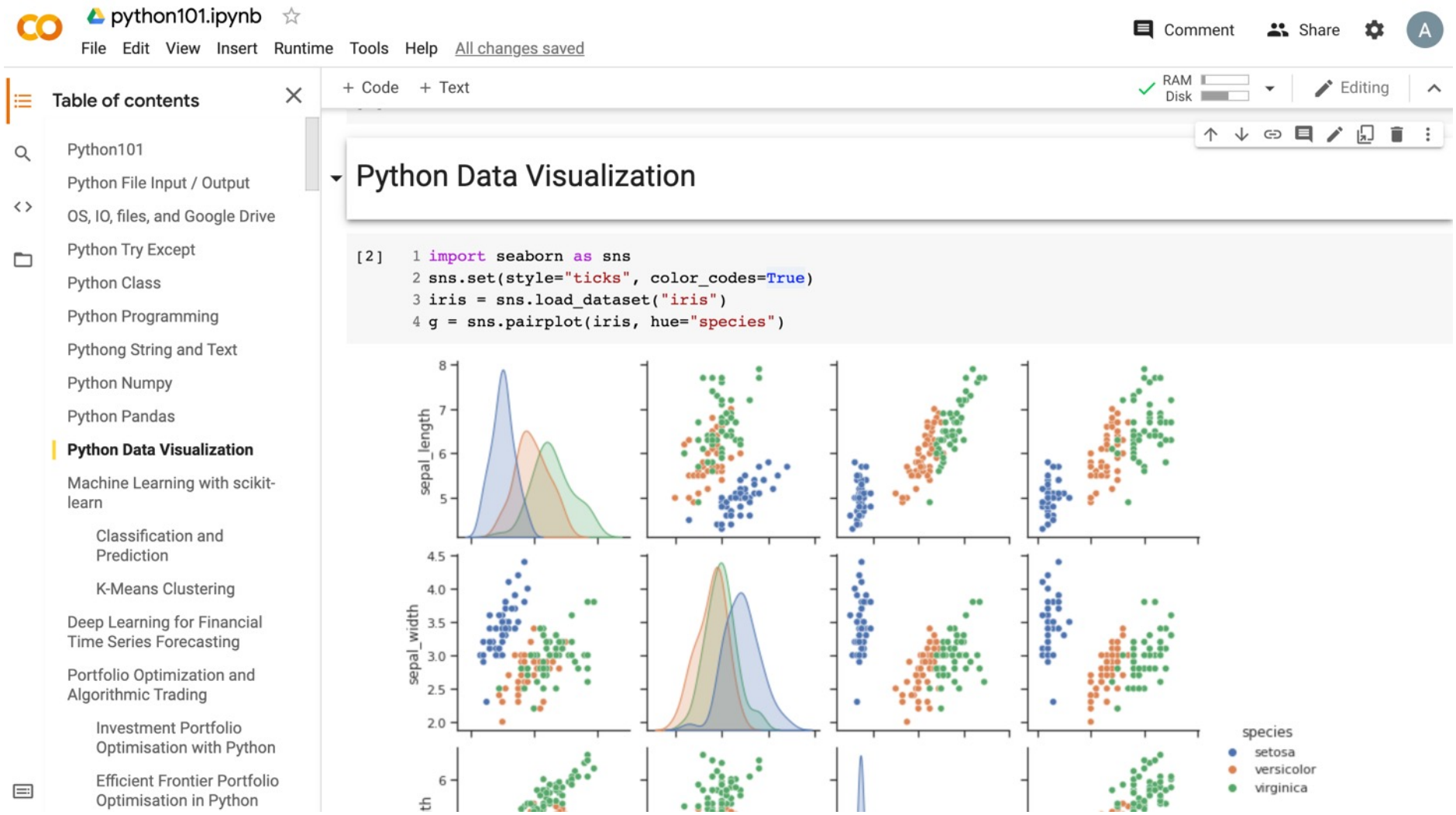
versicolor

Iris Data Visualization



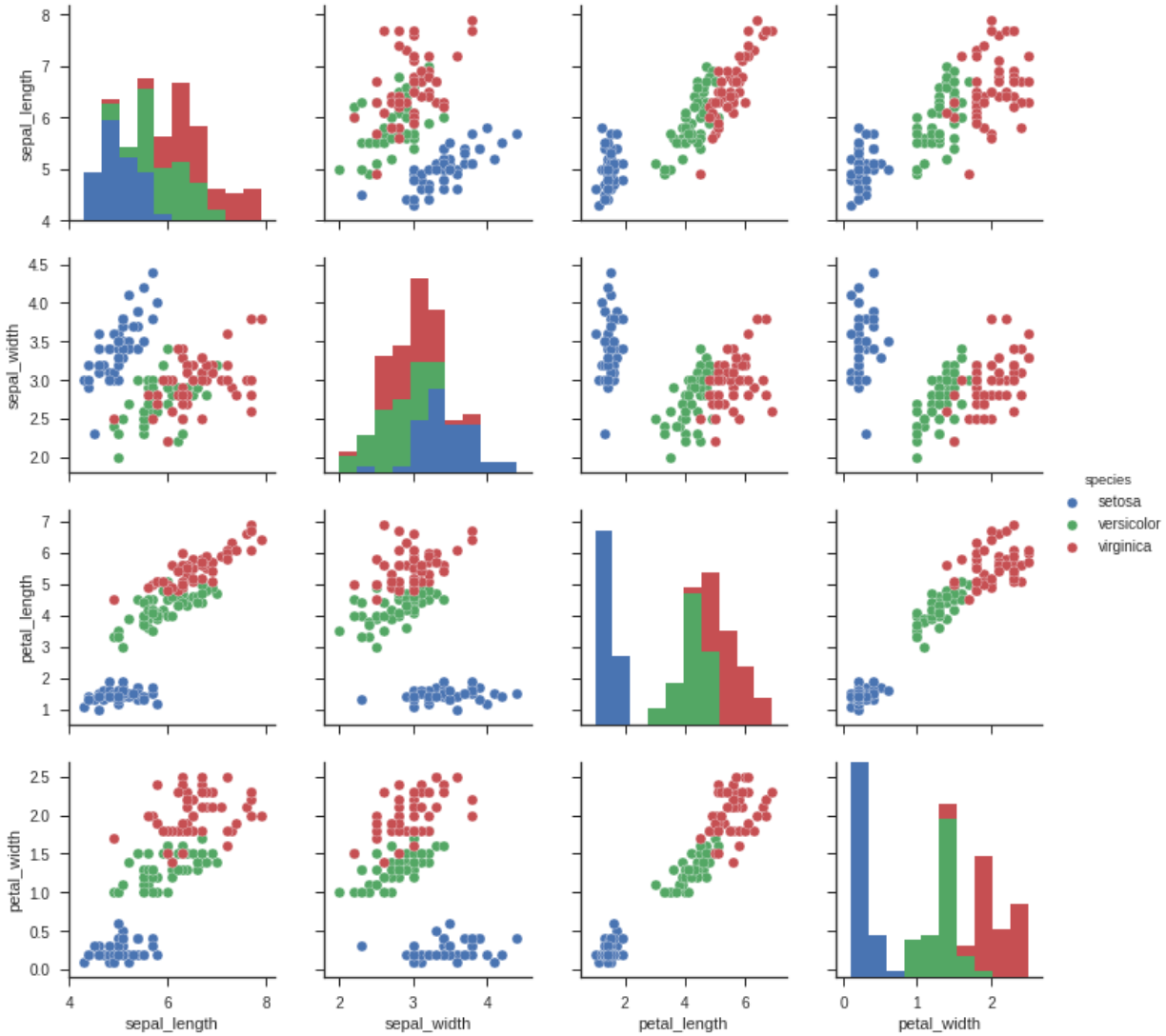
Source: https://seaborn.pydata.org/generated/seaborn.pairplot.html

Data Visualization in Google Colab



https://tinyurl.com/aintpupython101

```
import seaborn as sns
sns.set(style="ticks", color_codes=True)
iris = sns.load_dataset("iris")
g = sns.pairplot(iris, hue="species")
```



Source: https://seaborn.pydata.org/generated/seaborn.pairplot.html

```
import numpy as np
import pandas as pd
%matplotlib inline
import matplotlib.pyplot as plt
import seaborn as sns
from pandas.plotting import scatter_matrix
```

```
# Import Libraries
import numpy as np
import pandas as pd
%matplotlib inline
import matplotlib.pyplot as plt
import seaborn as sns
from pandas.plotting import scatter_matrix
print('imported')
```

```
imported
```

```
url = "https://archive.ics.uci.edu/ml/machine-learning-databases/iris/iris.data"
names = ['sepal-length', 'sepal-width', 'petal-length', 'petal-width', 'class']
df = pd.read_csv(url, names=names)
print(df.head(10))
```

```
# Load dataset
url = "https://archive.ics.uci.edu/ml/machine-learning-databases/iris/iris.data"
names = ['sepal-length', 'sepal-width', 'petal-length', 'petal-width', 'class']
df = pd.read_csv(url, names=names)
print(df.head(10))
```

	sepal-length	sepal-width	petal-length	petal-width	class
0	5.1	3.5	1.4	0.2	Iris-setosa
1	4.9	3.0	1.4	0.2	Iris-setosa
2	4.7	3.2	1.3	0.2	Iris-setosa
3	4.6	3.1	1.5	0.2	Iris-setosa
4	5.0	3.6	1.4	0.2	Iris-setosa
5	5.4	3.9	1.7	0.4	Iris-setosa
6	4.6	3.4	1.4	0.3	Iris-setosa
7	5.0	3.4	1.5	0.2	Iris-setosa
8	4.4	2.9	1.4	0.2	Iris-setosa
9	4.9	3.1	1.5	0.1	Iris-setosa

df.tail(10)

```
print(df.tail(10))
```

	sepal-length	sepal-width	petal-length	petal-width	class
140	6.7	3.1	5.6	2.4	Iris-virginica
141	6.9	3.1	5.1	2.3	Iris-virginica
142	5.8	2.7	5.1	1.9	Iris-virginica
143	6.8	3.2	5.9	2.3	Iris-virginica
144	6.7	3.3	5.7	2.5	Iris-virginica
145	6.7	3.0	5.2	2.3	Iris-virginica
146	6.3	2.5	5.0	1.9	Iris-virginica
147	6.5	3.0	5.2	2.0	Iris-virginica
148	6.2	3.4	5.4	2.3	Iris-virginica
149	5.9	3.0	5.1	1.8	Iris-virginica

df.describe()

```
print(df.describe())
```

```
       sepal-length  sepal-width  petal-length  petal-width
count    150.000000   150.000000    150.000000   150.000000
mean       5.843333     3.054000      3.758667     1.198667
std        0.828066     0.433594      1.764420     0.763161
min        4.300000     2.000000      1.000000     0.100000
25%        5.100000     2.800000      1.600000     0.300000
50%        5.800000     3.000000      4.350000     1.300000
75%        6.400000     3.300000      5.100000     1.800000
max        7.900000     4.400000      6.900000     2.500000
```

```
print(df.info())
print(df.shape)
```

```
print(df.info())
```

```
<class 'pandas.core.frame.DataFrame'>
RangeIndex: 150 entries, 0 to 149
Data columns (total 5 columns):
sepal-length    150 non-null float64
sepal-width     150 non-null float64
petal-length    150 non-null float64
petal-width     150 non-null float64
class           150 non-null object
dtypes: float64(4), object(1)
memory usage: 5.9+ KB
None
```

```
print(df.shape)
```

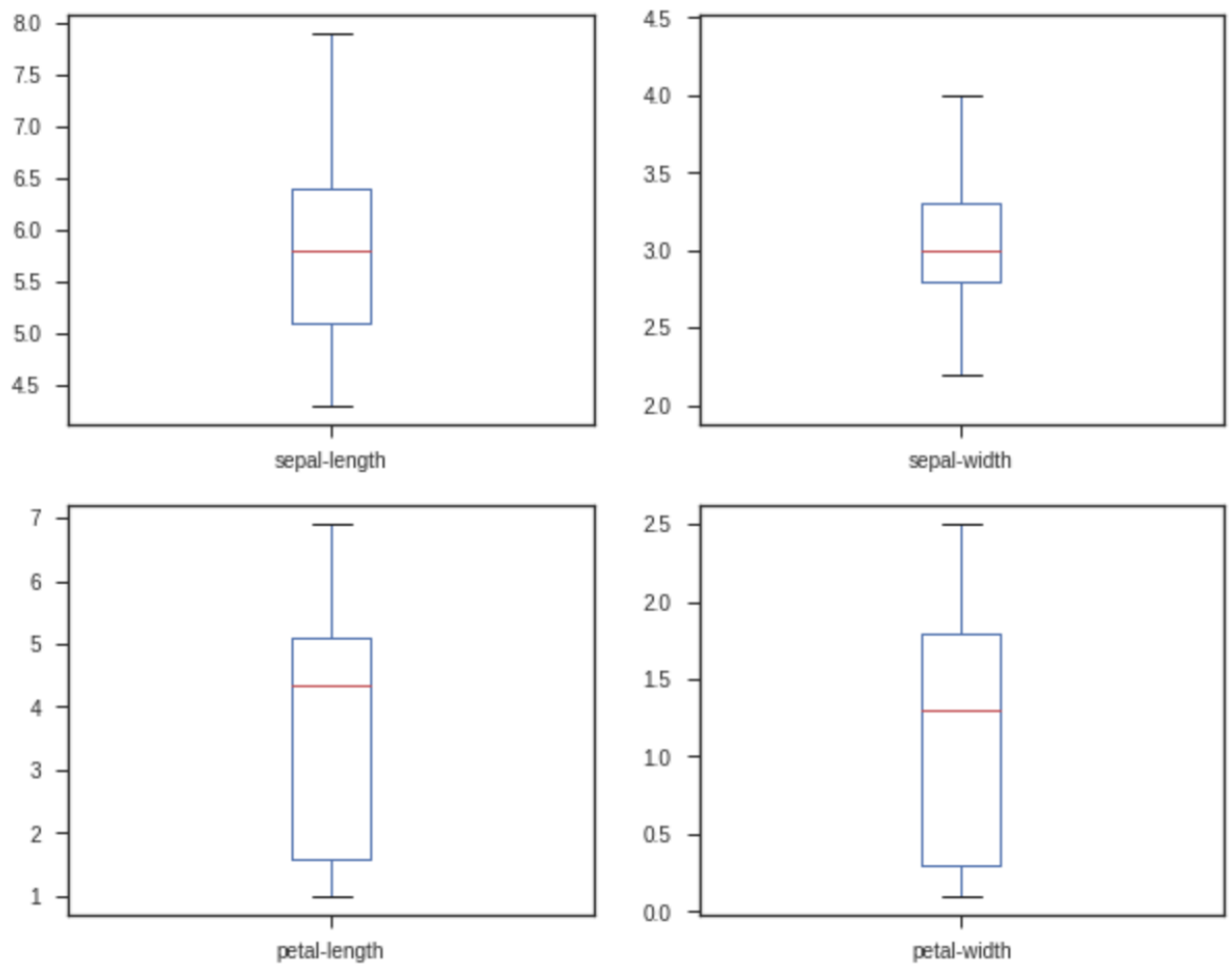
```
(150, 5)
```

```
df.groupby('class').size()
```

```
print(df.groupby('class').size())
```

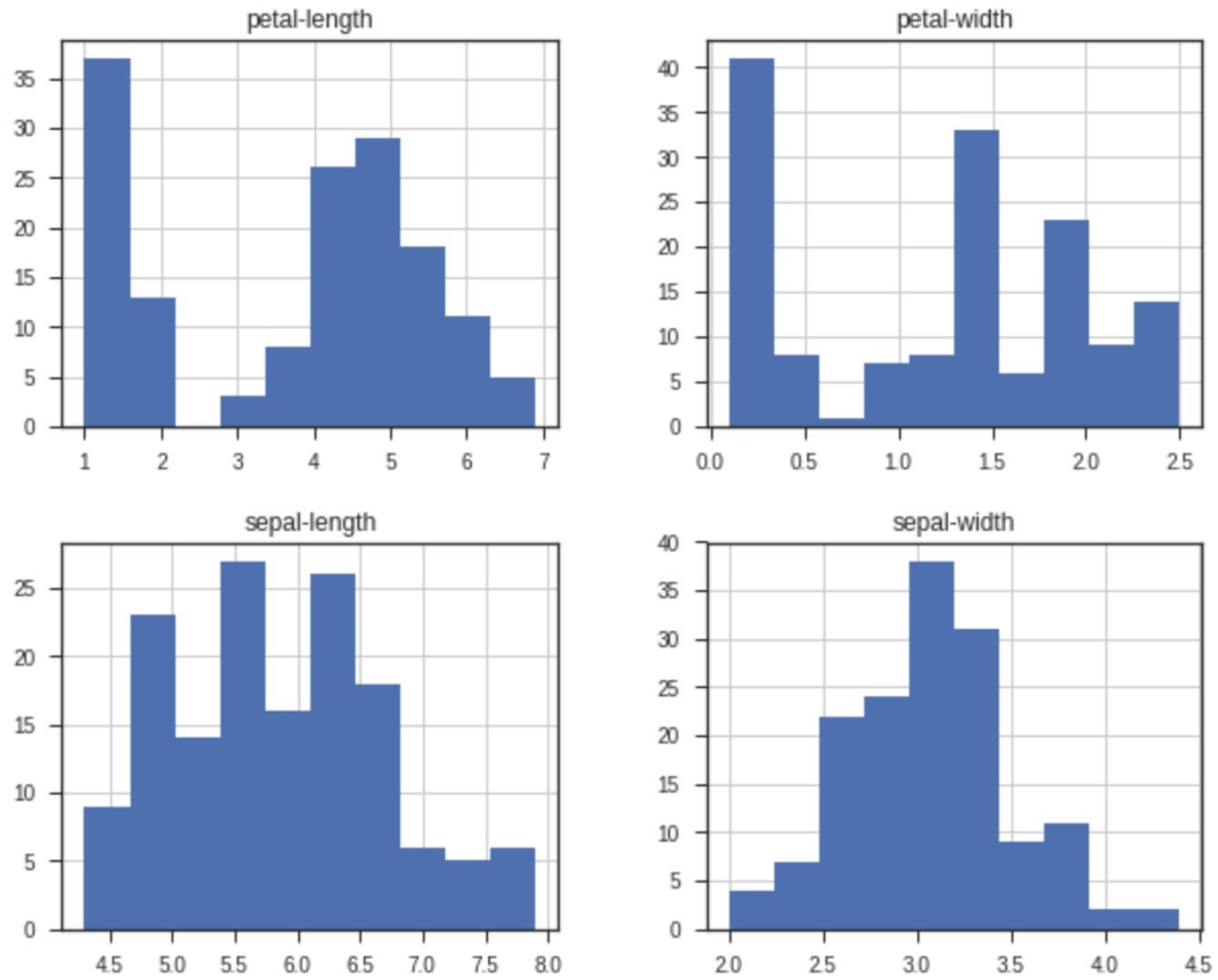
```
class
Iris-setosa        50
Iris-versicolor    50
Iris-virginica     50
dtype: int64
```

```
plt.rcParams["figure.figsize"] = (10,8)
df.plot(kind='box', subplots=True, layout=(2,2), sharex=False, sharey=False)
plt.show()
```



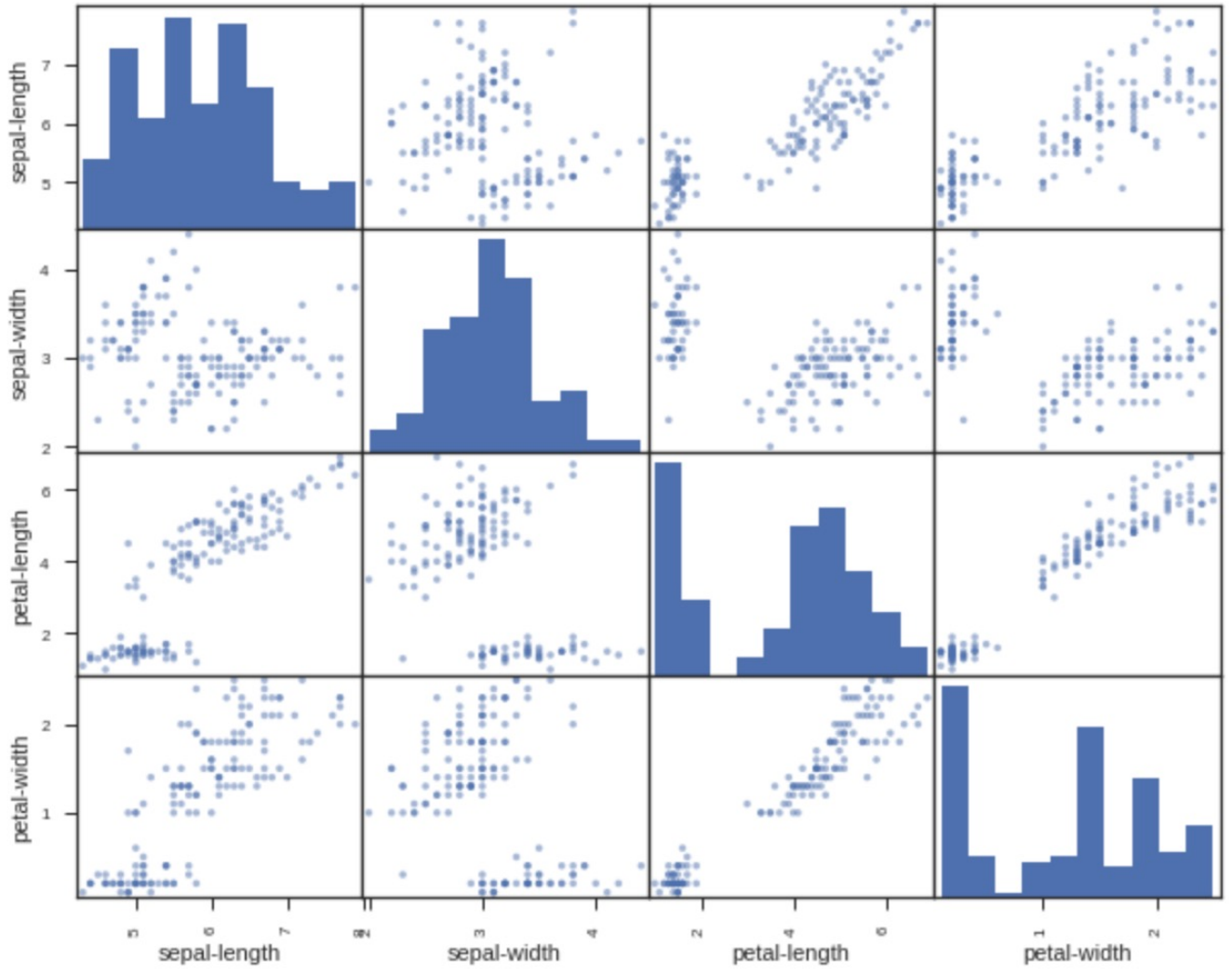
```
df.hist()
plt.show()
```

```
df.hist()
plt.show()
```



```
scatter_matrix(df)
plt.show()
```

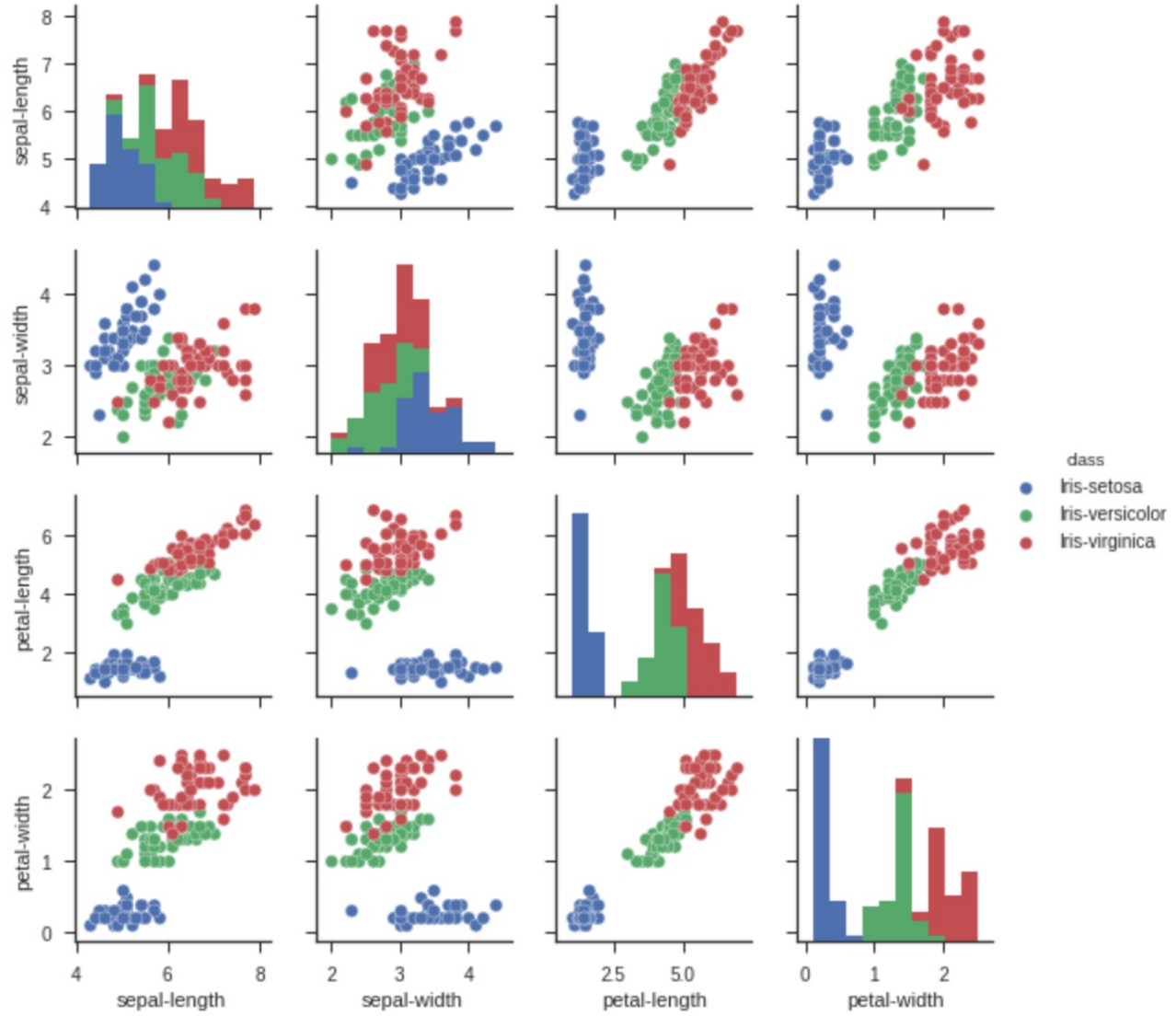

```
scatter_matrix(df)
plt.show()
```

sns.pairplot(df, hue="class", size=2)

```
sns.pairplot(df, hue="class", size=2)
```

```
<seaborn.axisgrid.PairGrid at 0x7f1d21267390>
```



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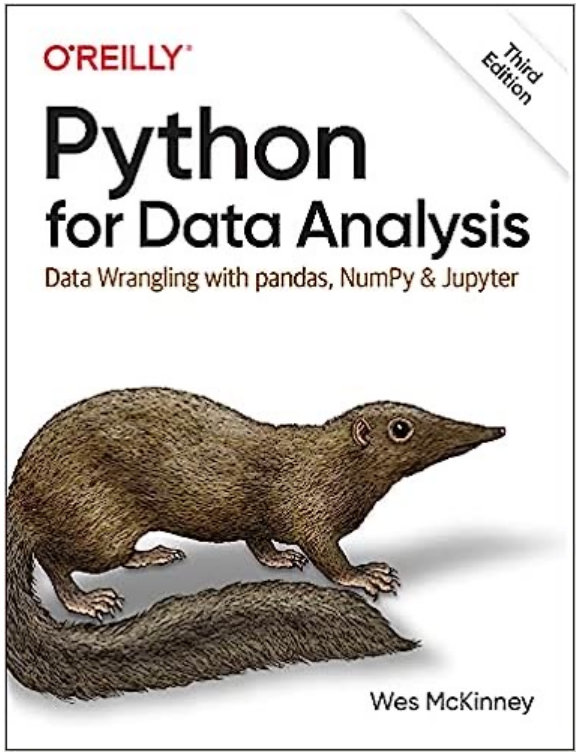

https://github.com/wesm/pydata-book

Wes McKinney (2022), "Python for Data Analysis: Data Wrangling with pandas, NumPy, and Jupyter", 3rd Edition, O'Reilly Media.

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3 contributors

1224 lines (1224 sloc) | 21.9 KB · Raw · Blame

In [1]:
```
import numpy as np
np.random.seed(12345)
import matplotlib.pyplot as plt
plt.rc("figure", figsize=(10, 6))
np.set_printoptions(precision=4, suppress=True)
```

In [2]:
```
import numpy as np

my_arr = np.arange(1_000_000)
my_list = list(range(1_000_000))
```

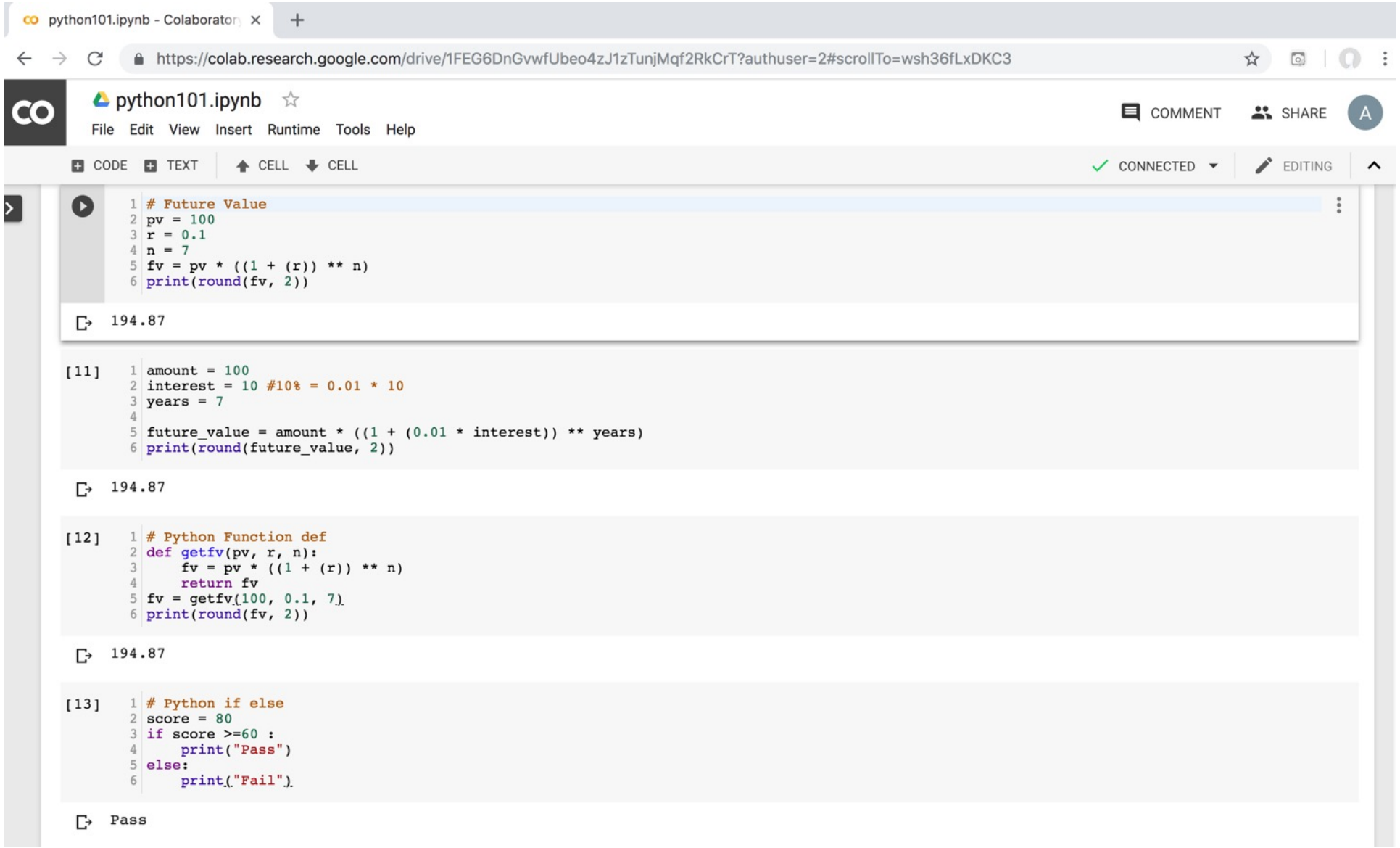
In [3]:
```
%timeit my_arr2 = my_arr * 2
%timeit my_list2 = [x * 2 for x in my_list]
```

In [4]:
```
import numpy as np
data = np.array([[1.5, -0.1, 3], [0, -3, 6.5]])
data
```

Source: https://github.com/wesm/pydata-book/blob/3rd-edition/ch04.ipynb

Python in Google Colab (Python101)

https://colab.research.google.com/drive/1FEG6DnGvwfUbeo4zJ1zTunjMqf2RkCrT



https://tinyurl.com/aintpupython101

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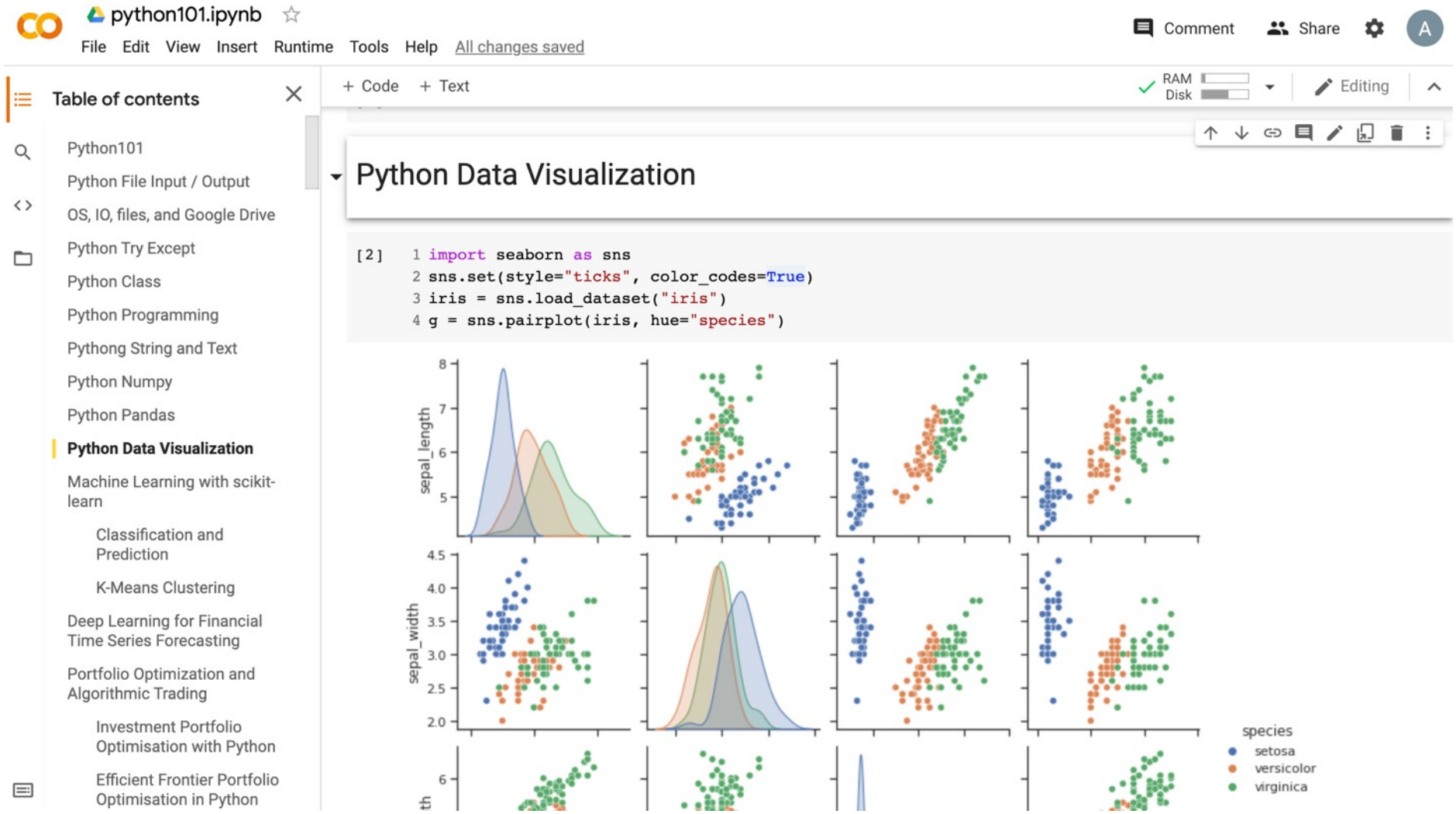

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Summary

- NumPy
  - Numerical Python N-dimensional array
- Pandas
  - Data Analytics
- Matplotlib
  - Basic Data Visualization
- Seaborn
  - Advanced Visualization

References

- Wes McKinney (2022), "Python for Data Analysis: Data Wrangling with pandas, NumPy, and Jupyter", 3rd Edition, O'Reilly Media.
- Aurélien Géron (2023), Hands-On Machine Learning with Scikit-Learn, Keras, and TensorFlow: Concepts, Tools, and Techniques to Build Intelligent Systems, 3rd Edition, O'Reilly Media.
- Steven D'Ascoli (2022), Artificial Intelligence and Deep Learning with Python: Every Line of Code Explained For Readers New to AI and New to Python, Independently published.
- Stuart Russell and Peter Norvig (2020), Artificial Intelligence: A Modern Approach, 4th Edition, Pearson.
- Varun Grover, Roger HL Chiang, Ting-Peng Liang, and Dongsong Zhang (2018), "Creating Strategic Business Value from Big Data Analytics: A Research Framework", Journal of Management Information Systems, 35, no. 2, pp. 388-423.
- Junliang Wang, Chuqiao Xu, Jie Zhang, and Ray Zhong (2022). "Big data analytics for intelligent manufacturing systems: A review." Journal of Manufacturing Systems 62 (2022): 738-752.
- Ramesh Sharda, Dursun Delen, and Efraim Turban (2017), Business Intelligence, Analytics, and Data Science: A Managerial Perspective, 4th Edition, Pearson
- Python Programming, https://pythonprogramming.net/
- Python, https://www.python.org/
- Python Programming Language, http://pythonprogramminglanguage.com/
- Numpy, http://www.numpy.org/
- Pandas, http://pandas.pydata.org/
- Skikit-learn, http://scikit-learn.org/
- W3Schools Python, https://www.w3schools.com/python/
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