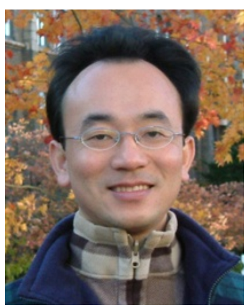
大數據分析
(Big Data Analysis)

Python 大數據分析基礎
(Foundations of Big Data Analysis in Python)

1091BDA03
MBA, IM, NTPU (M5127) (Fall 2020)
Wed 7, ,8, 9 (15:10-18:00) (B8F40)



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

2020-09-30

課程大綱 (Syllabus)

週次 (Week)	日期 (Date)	內容 (Subject/Topics)
1	2020/09/16	大數據分析介紹 (Introduction to Big Data Analysis)
2	2020/09/23	AI人工智慧與大數據分析 (AI and Big Data Analysis)
3	2020/09/30	Python 大數據分析基礎 (Foundations of Big Data Analysis in Python)
4	2020/10/07	數位沙盒第一堂課：數位沙盒服務平台簡介 (Digital Sandbox Lesson 1: Introduction to FintechSpace Digital Sandbox)
5	2020/10/14	數位沙盒第二堂課：工程師操作說明與實作教學 (Digital Sandbox Lesson 2: Hands-on Practices)
6	2020/10/21	Python Pandas 大數據量化分析 (Quantitative Big Data Analysis with Pandas in Python)

課程大綱 (Syllabus)

週次 (Week) 日期 (Date) 內容 (Subject/Topics)

7 2020/10/28 數位沙盒第三堂課：學生小組討論實作與成果發表
(Digital Sandbox Lesson 3: Learning Teams
Hands-on Project Discussion and Project Presentation)

8 2020/11/04 Python Scikit-Learn 機器學習 I
(Machine Learning with Scikit-Learn In Python I)

9 2020/11/11 期中報告 (Midterm Project Report)

10 2020/11/18 Python Scikit-Learn 機器學習 II
(Machine Learning with Scikit-Learn In Python II)

11 2020/11/25 TensorFlow 深度學習金融大數據分析 I
(Deep Learning for Finance Big Data Analysis with TensorFlow I)

12 2020/12/02 大數據分析個案研究
(Case Study on Big Data Analysis)

課程大綱 (Syllabus)

週次 (Week) 日期 (Date) 內容 (Subject/Topics)

13 2020/12/09 TensorFlow 深度學習金融大數據分析 II
(Deep Learning for Finance Big Data Analysis with TensorFlow II)

14 2020/12/16 TensorFlow 深度學習金融大數據分析 III
(Deep Learning for Finance Big Data Analysis with TensorFlow III)

15 2020/12/23 AI 機器人理財顧問
(Artificial Intelligence for Robo-Advisors)

16 2020/12/30 金融科技智慧型交談機器人
(Conversational Commerce and
Intelligent Chatbots for Fintech)

17 2021/01/06 期末報告 I (Final Project Report I)

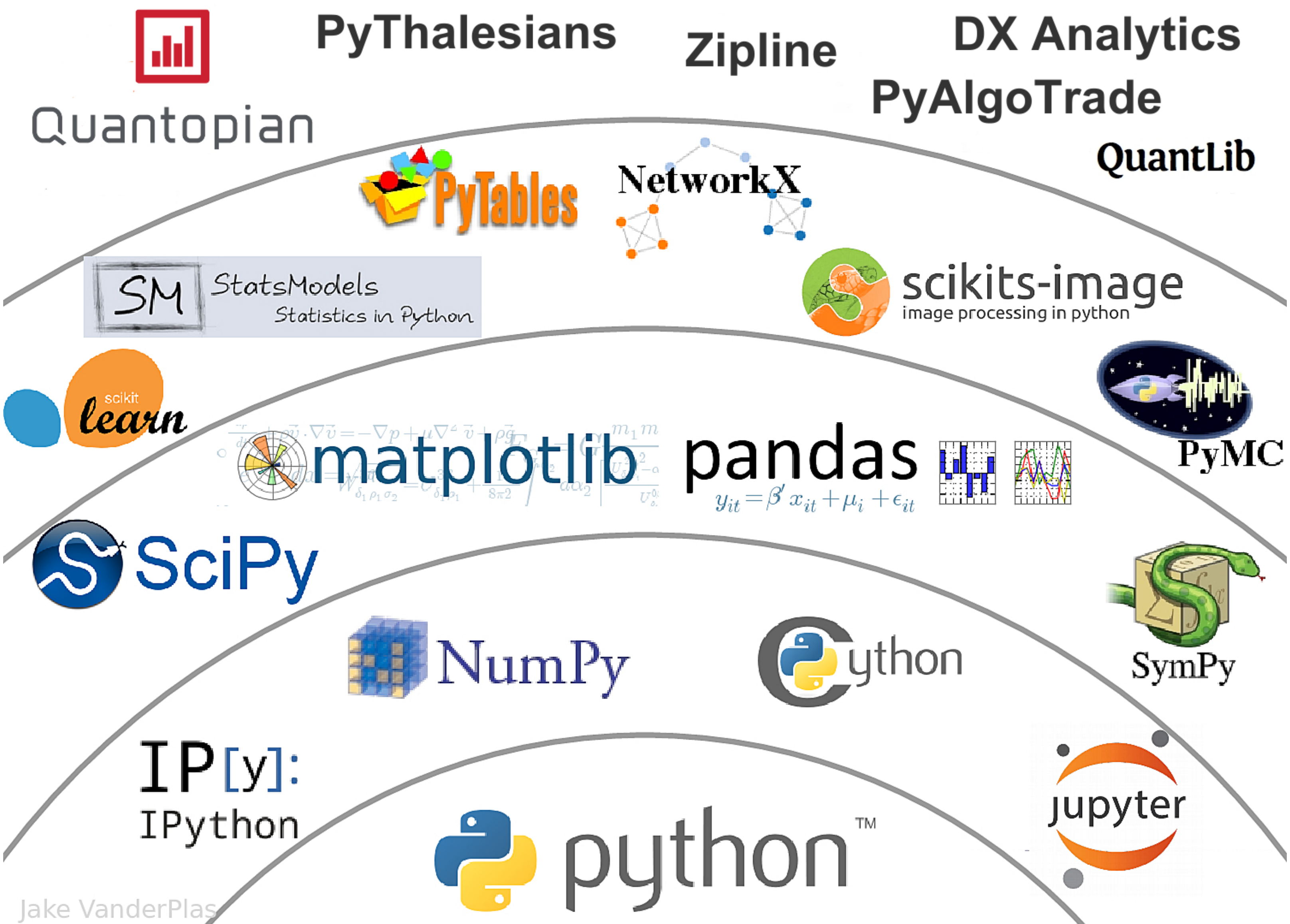
18 2021/01/13 期末報告 II (Final Project Report I)

Foundations of Big Data Analysis in Python

Outline

- **Foundations of Big Data Analysis in Python**
  - **Python**
    - Programming language
  - **Numpy**
    - Scientific computing

The Quant Finance PyData Stack



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

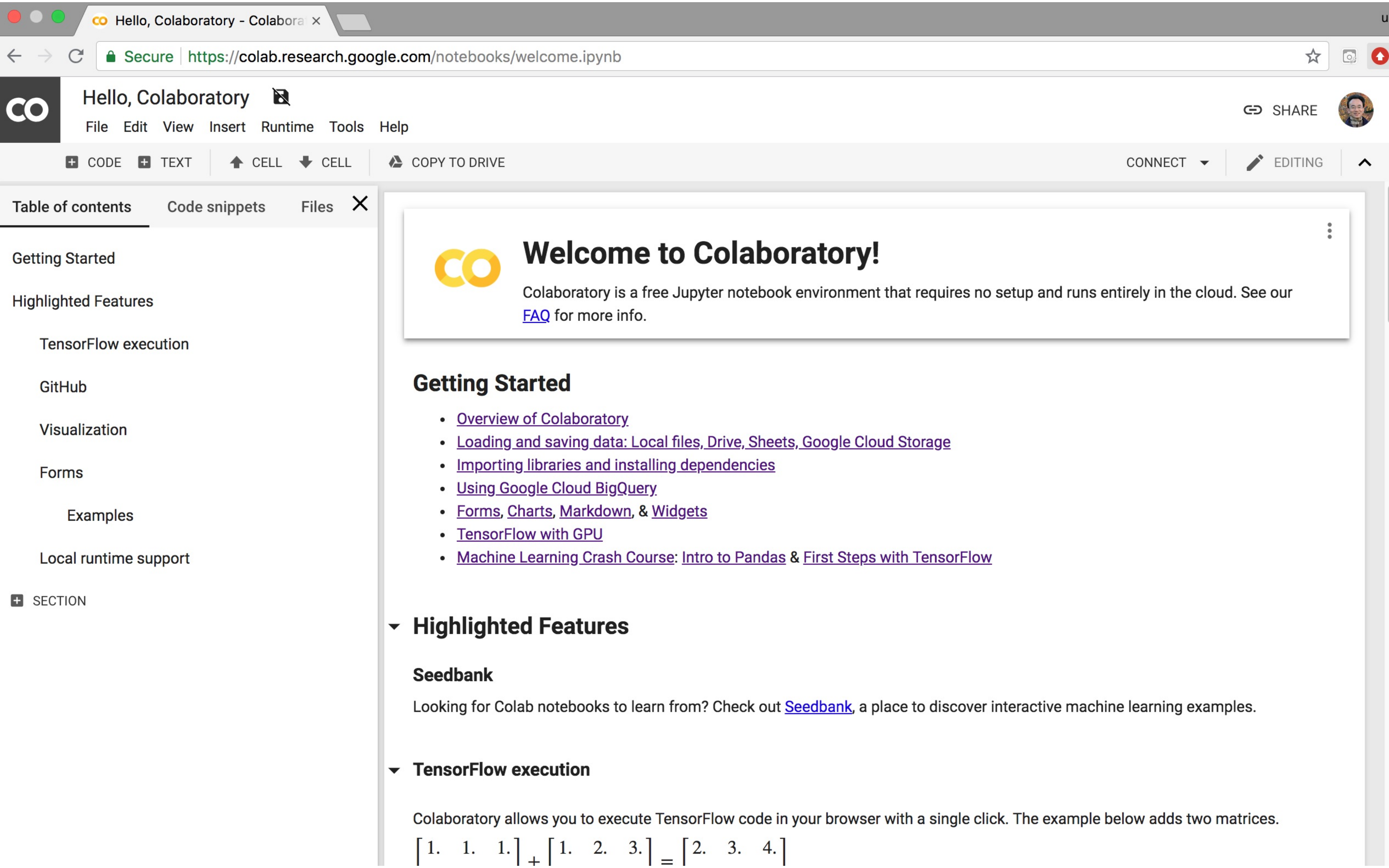
Python

python™

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

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

Google Colab



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

Python in Google Colab (Python101)

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

python101.ipynb - Colaboratory

https://colab.research.google.com/drive/1FEG6DnGvwfUbeo4zJ1zTunjMqf2RkCrT?authuser=2#scrollTo=wsh36fLxDKC3

python101.ipynb

File Edit View Insert Runtime Tools Help

COMMENT SHARE

CODE TEXT CELL CELL CONNECTED EDITING

```python
# Future Value
pv = 100
r = 0.1
n = 7
fv = pv * ((1 + (r)) ** n)
print(round(fv, 2))
```

```
194.87
```

[11]

```python
amount = 100
interest = 10 #10% = 0.01 * 10
years = 7

future_value = amount * ((1 + (0.01 * interest)) ** years)
print(round(future_value, 2))
```

```
194.87
```

[12]

```python
# Python Function def
def getfv(pv, r, n):
    fv = pv * ((1 + (r)) ** n)
    return fv
fv = getfv(100, 0.1, 7)
print(round(fv, 2))
```

```
194.87
```

[13]

```python
# Python if else
score = 80
if score >=60 :
    print("Pass")
else:
    print("Fail")
```

```
Pass
```

https://tinyurl.com/aintpupython101

Numpy

NumPy
Base
N-dimensional array
package

Python matplotlib

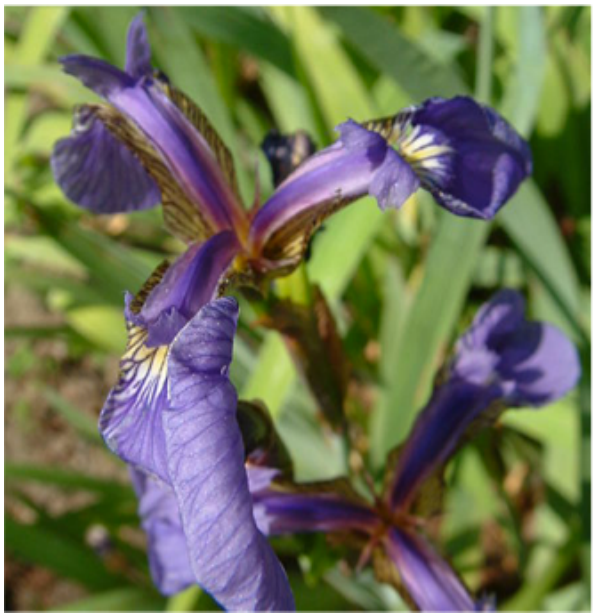
Source: https://matplotlib.org/

Python Pandas

http://pandas.pydata.org/

Iris flower data set

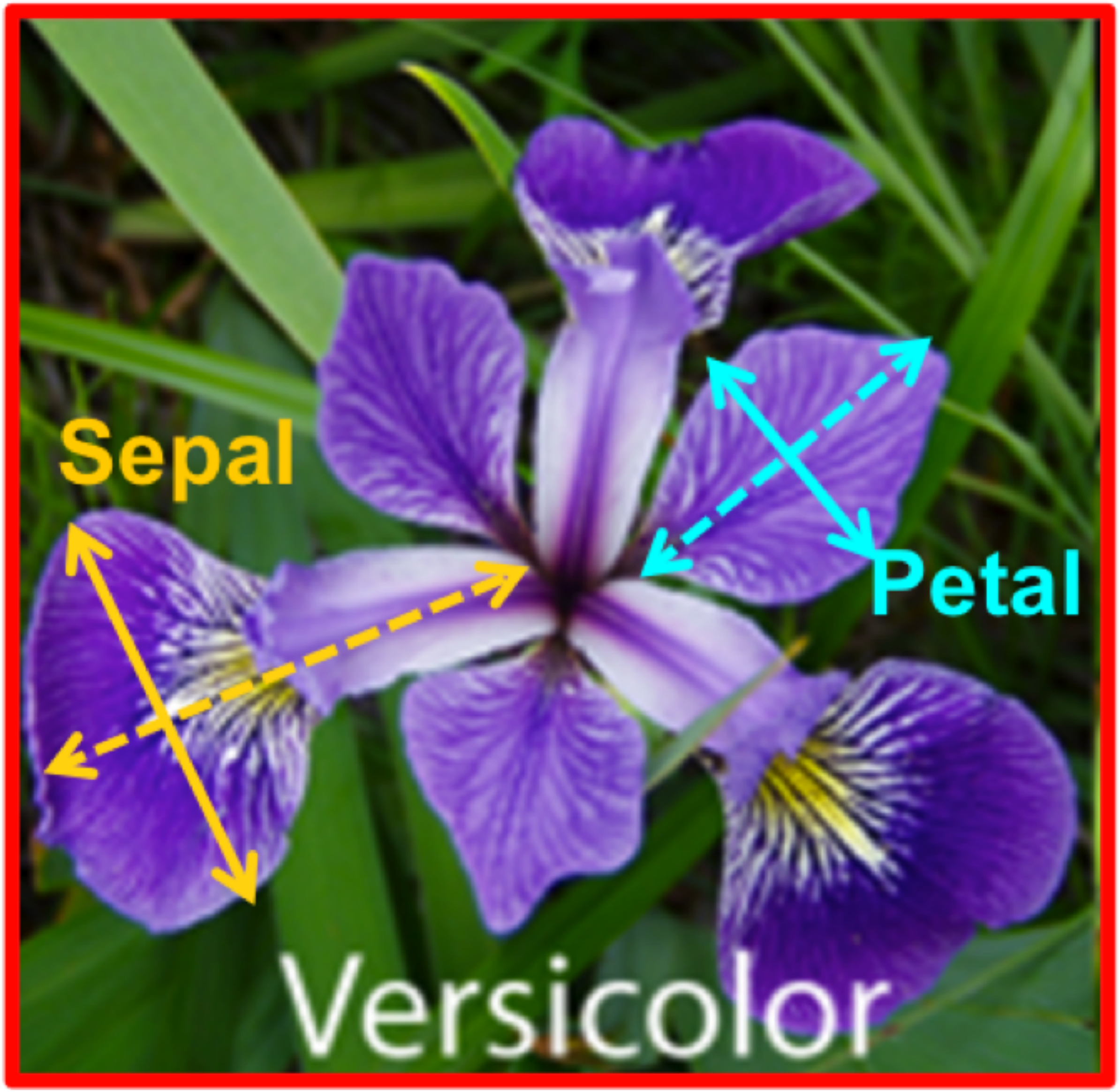
setosa versicolor virginica



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

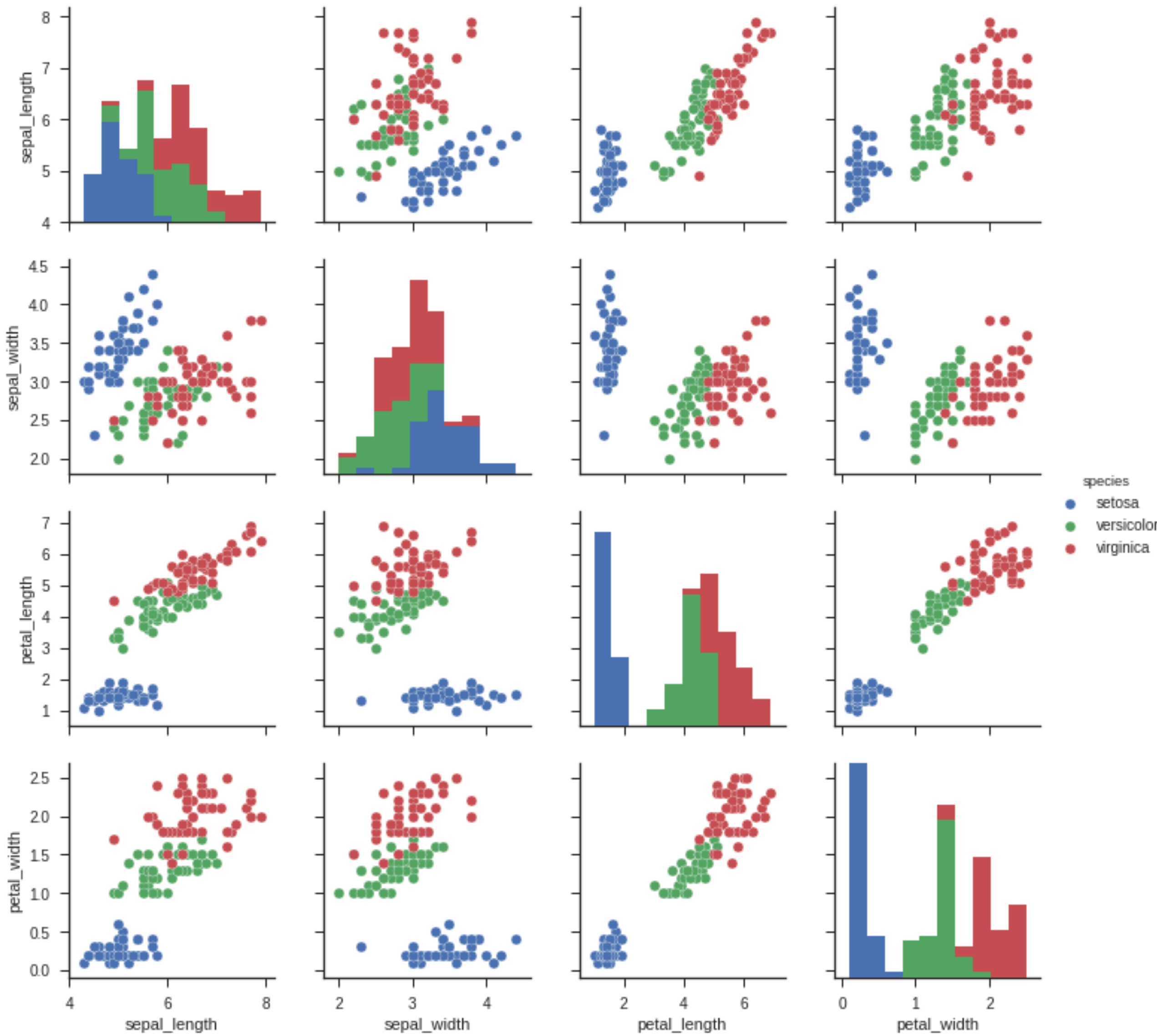
```
5.1,3.5,1.4,0.2,Iris-setosa
4.9,3.0,1.4,0.2,Iris-setosa
4.7,3.2,1.3,0.2,Iris-setosa
4.6,3.1,1.5,0.2,Iris-setosa
5.0,3.6,1.4,0.2,Iris-setosa
5.4,3.9,1.7,0.4,Iris-setosa
4.6,3.4,1.4,0.3,Iris-setosa
5.0,3.4,1.5,0.2,Iris-setosa
4.4,2.9,1.4,0.2,Iris-setosa
4.9,3.1,1.5,0.1,Iris-setosa
5.4,3.7,1.5,0.2,Iris-setosa
4.8,3.4,1.6,0.2,Iris-setosa
4.8,3.0,1.4,0.1,Iris-setosa
4.3,3.0,1.1,0.1,Iris-setosa
5.8,4.0,1.2,0.2,Iris-setosa
5.7,4.4,1.5,0.4,Iris-setosa
5.4,3.9,1.3,0.4,Iris-setosa
5.1,3.5,1.4,0.3,Iris-setosa
5.7,3.8,1.7,0.3,Iris-setosa
5.1,3.8,1.5,0.3,Iris-setosa
5.4,3.4,1.7,0.2,Iris-setosa
5.1,3.7,1.5,0.4,Iris-setosa
4.6,3.6,1.0,0.2,Iris-setosa
5.1,3.3,1.7,0.5,Iris-setosa
4.8,3.4,1.9,0.2,Iris-setosa
5.0,3.0,1.6,0.2,Iris-setosa
```

setosa

virginica

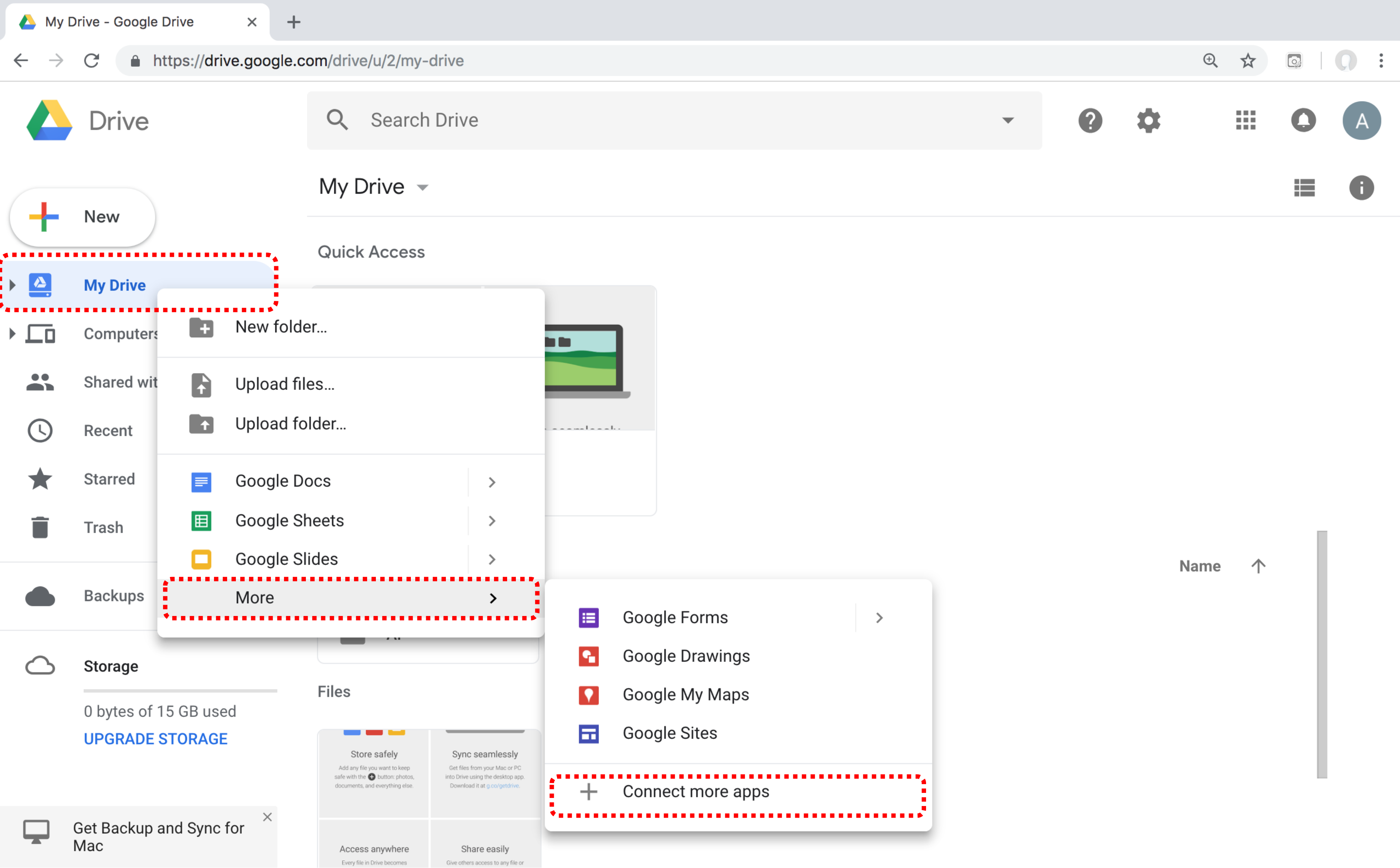
versicolor

Iris Data Visualization

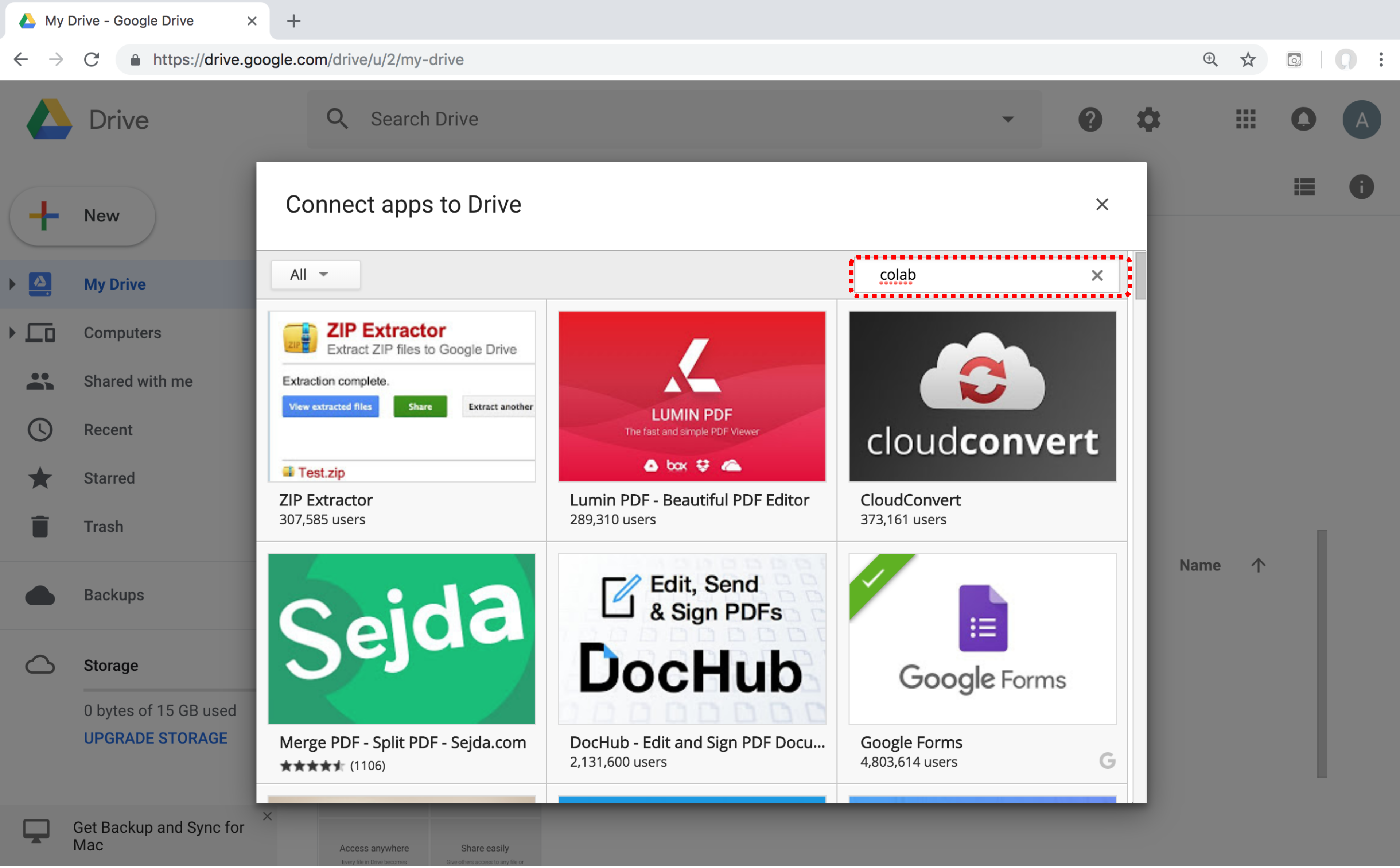


Source: https://seaborn.pydata.org/generated/seaborn.pairplot.html

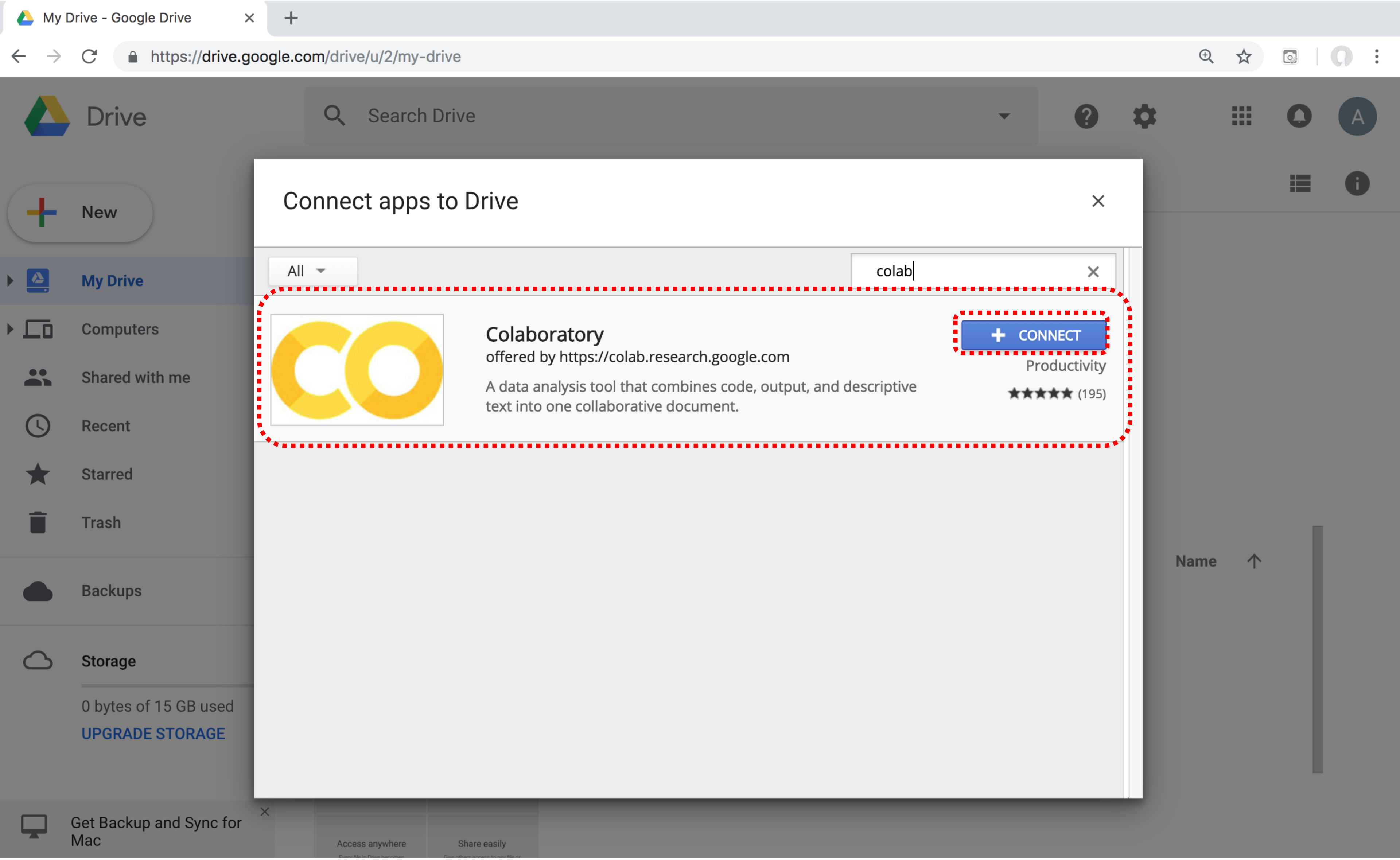
Connect Google Colab in Google Drive



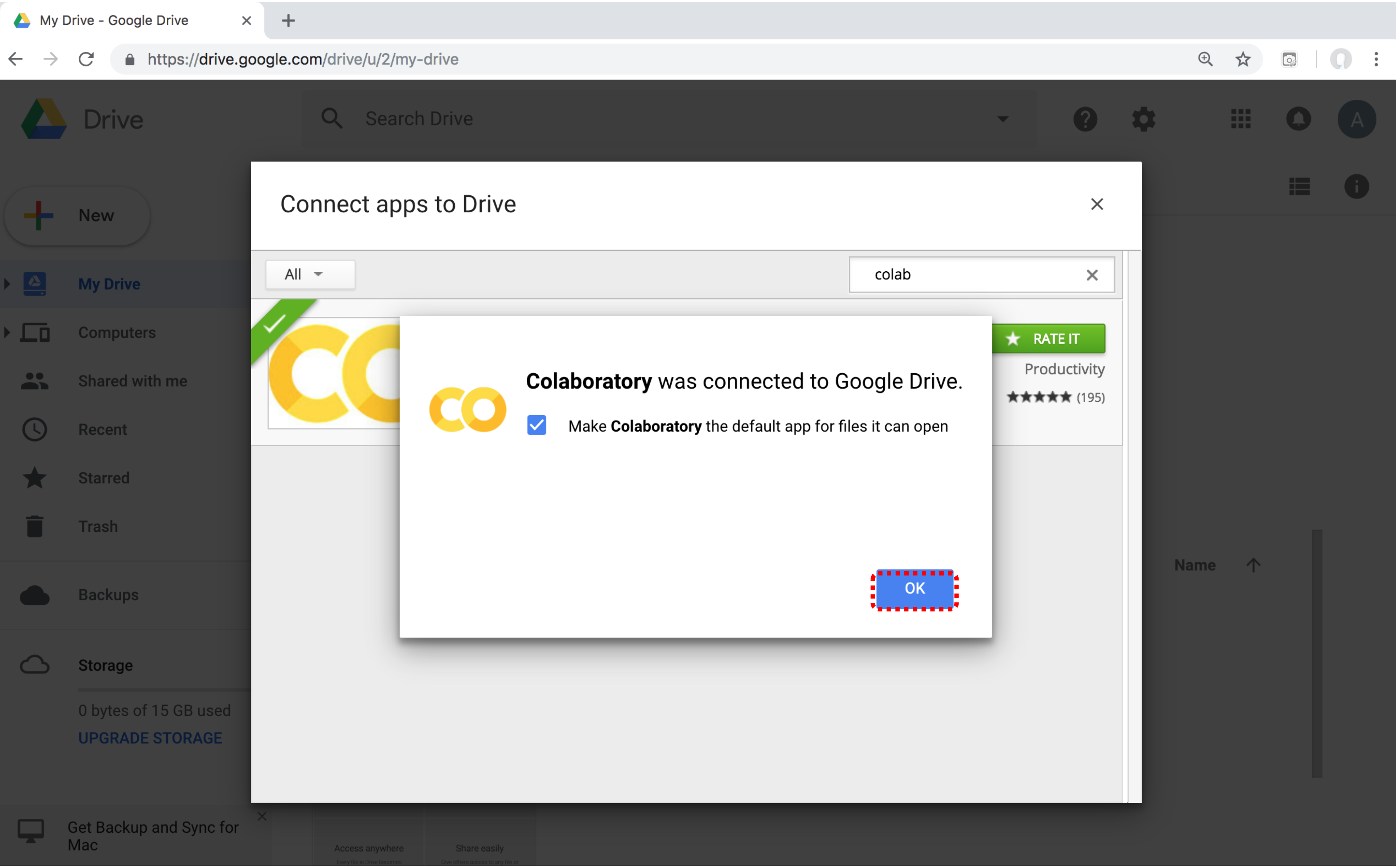
Google Colab



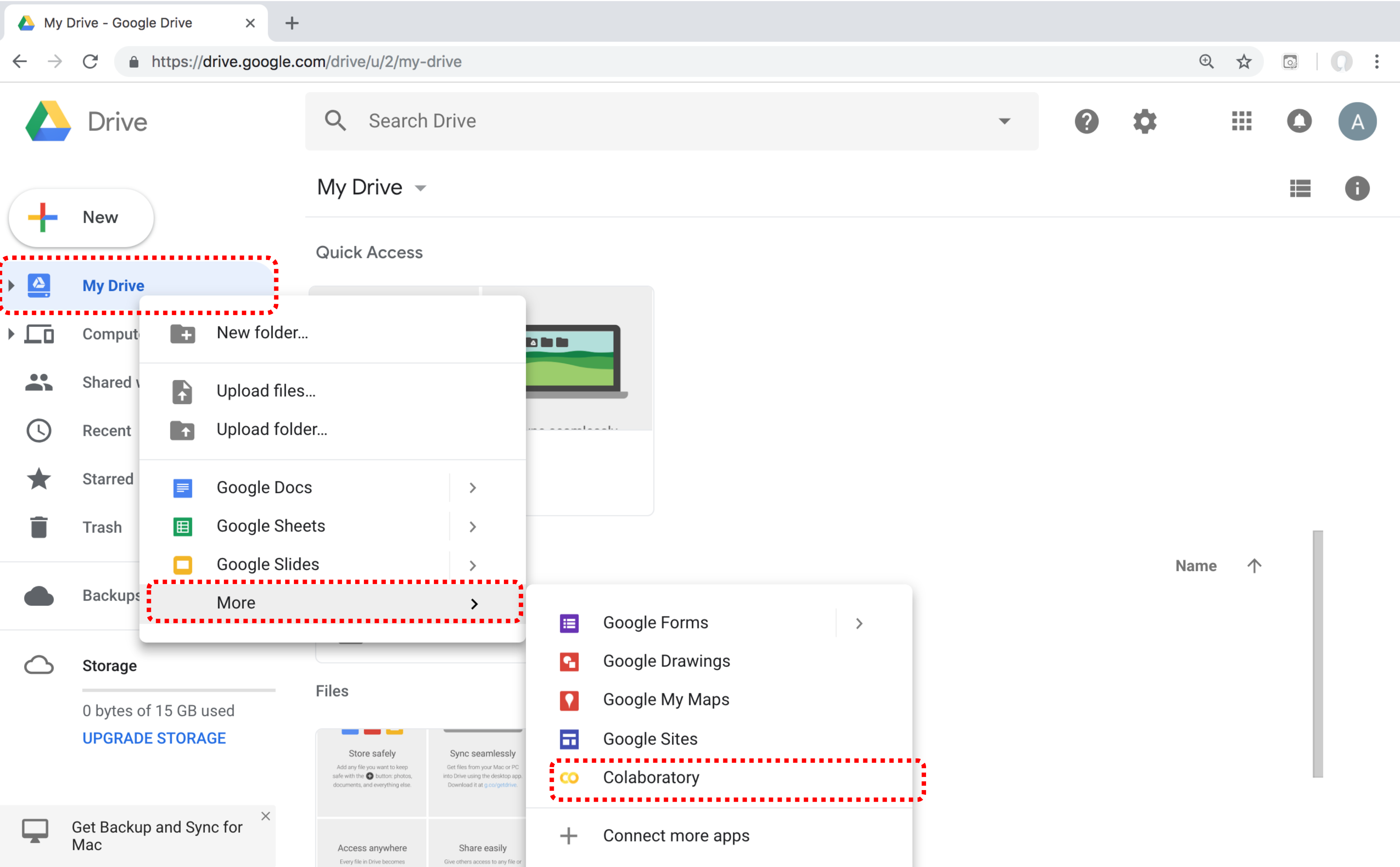
Google Colab



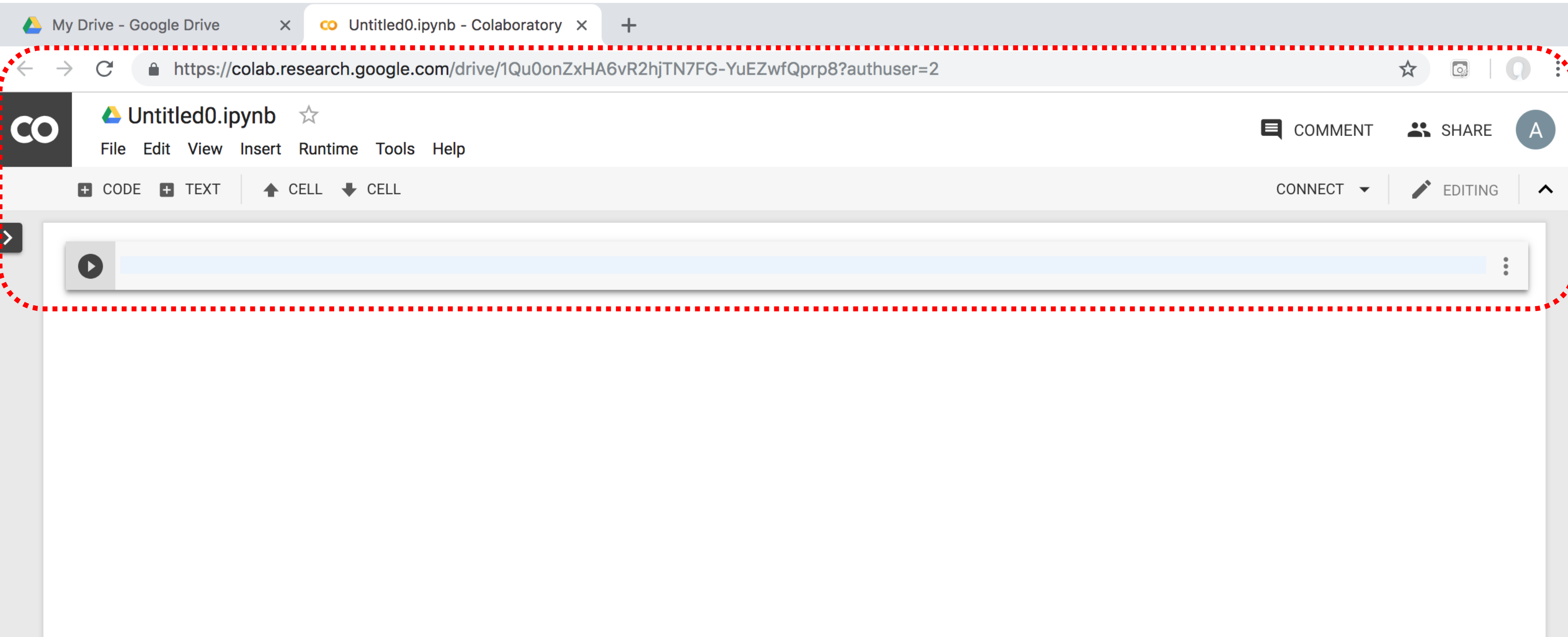
Connect Colaboratory to Google Drive



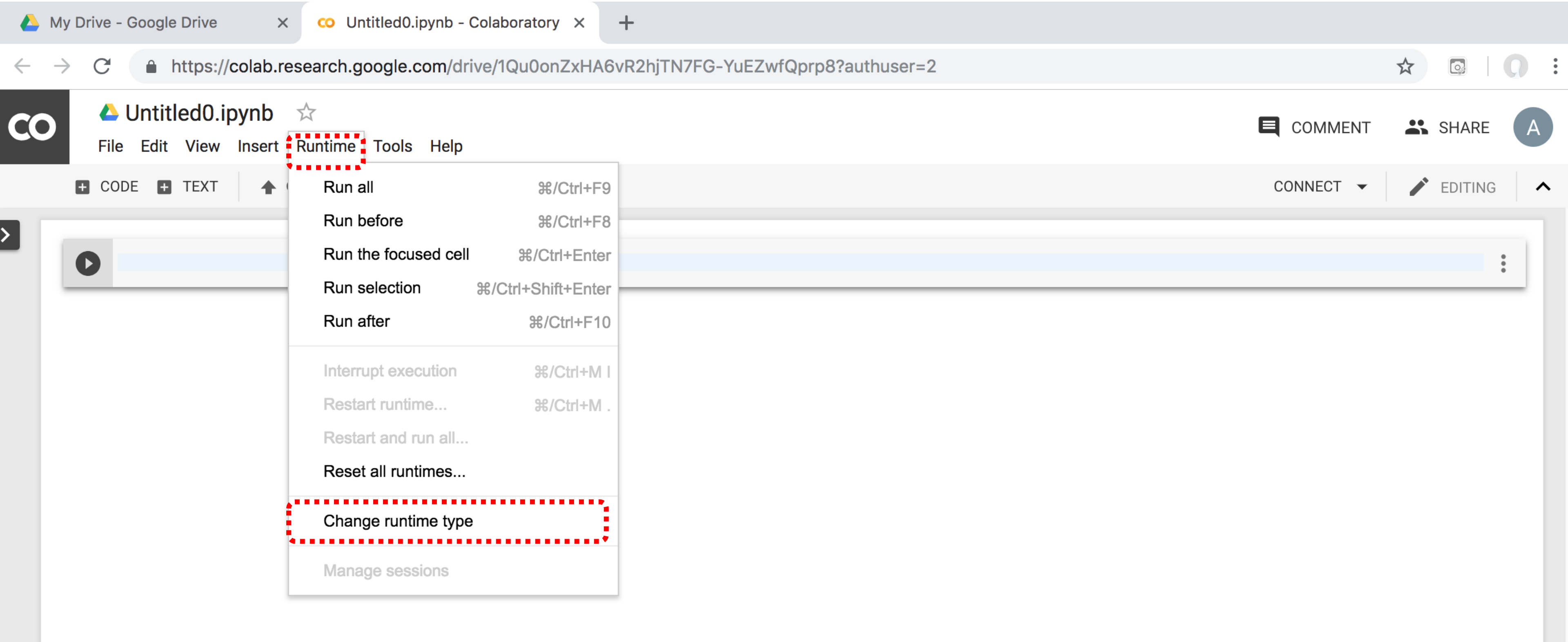
Google Colab



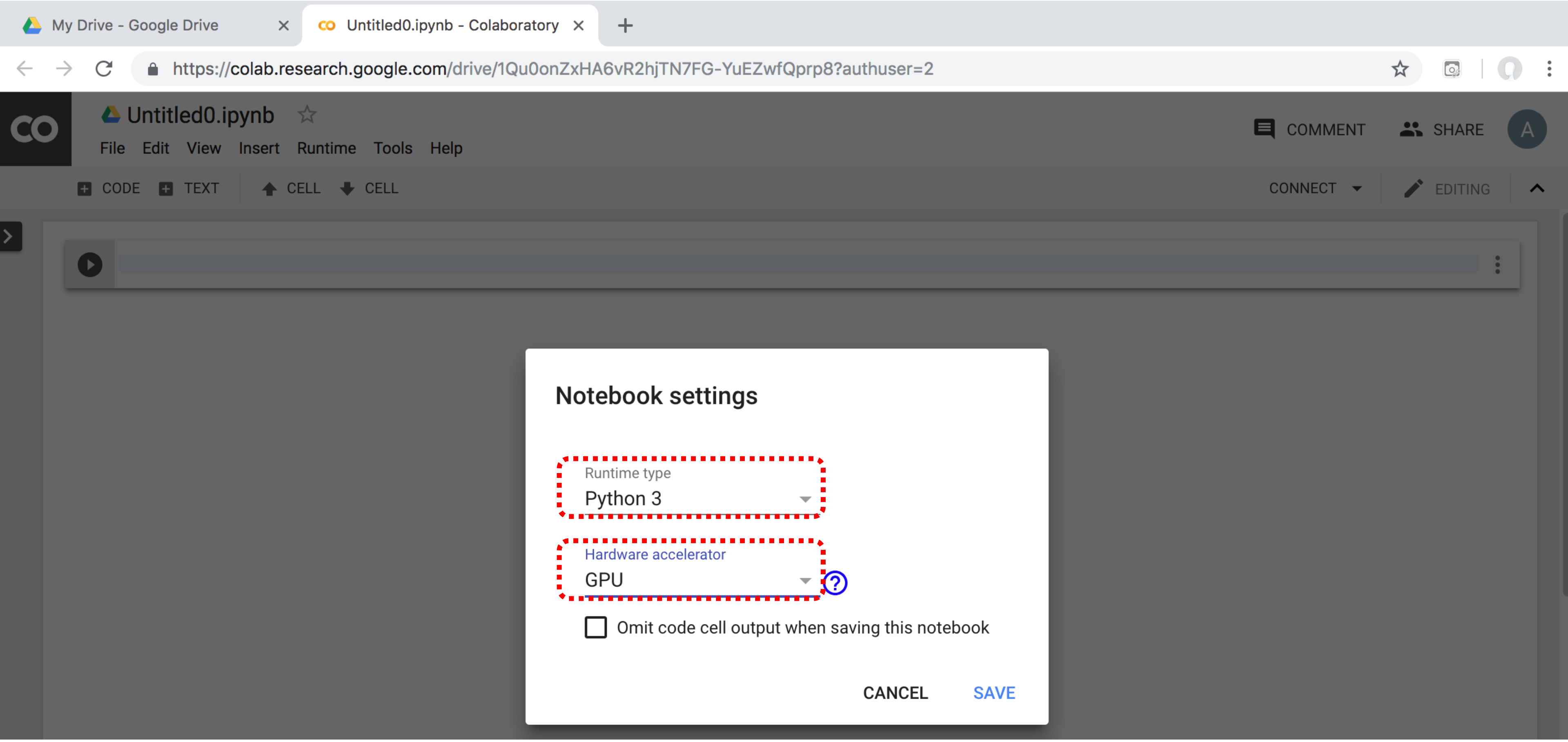
Google Colab



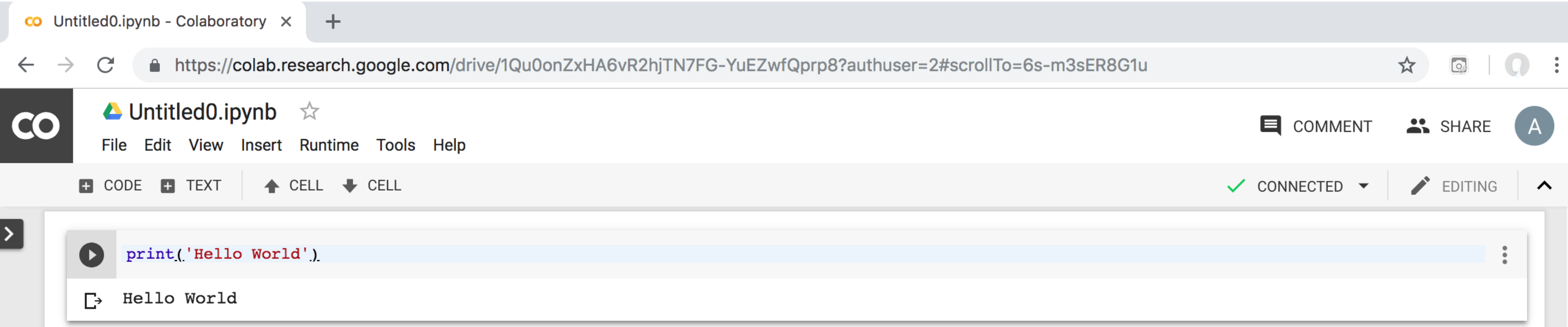
Google Colab



Run Jupyter Notebook Python3 GPU Google Colab

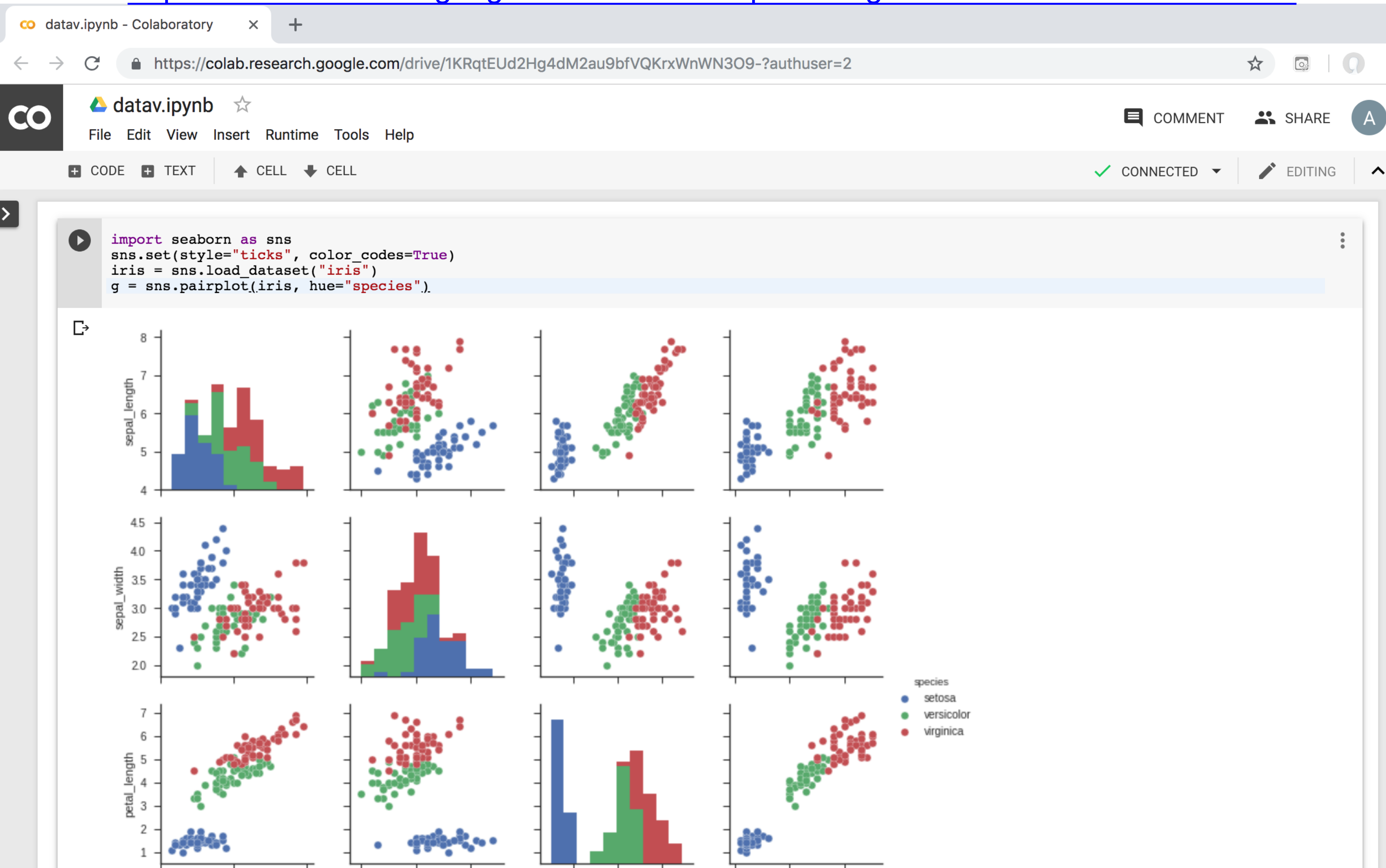


Google Colab Python Hello World
print('Hello World')



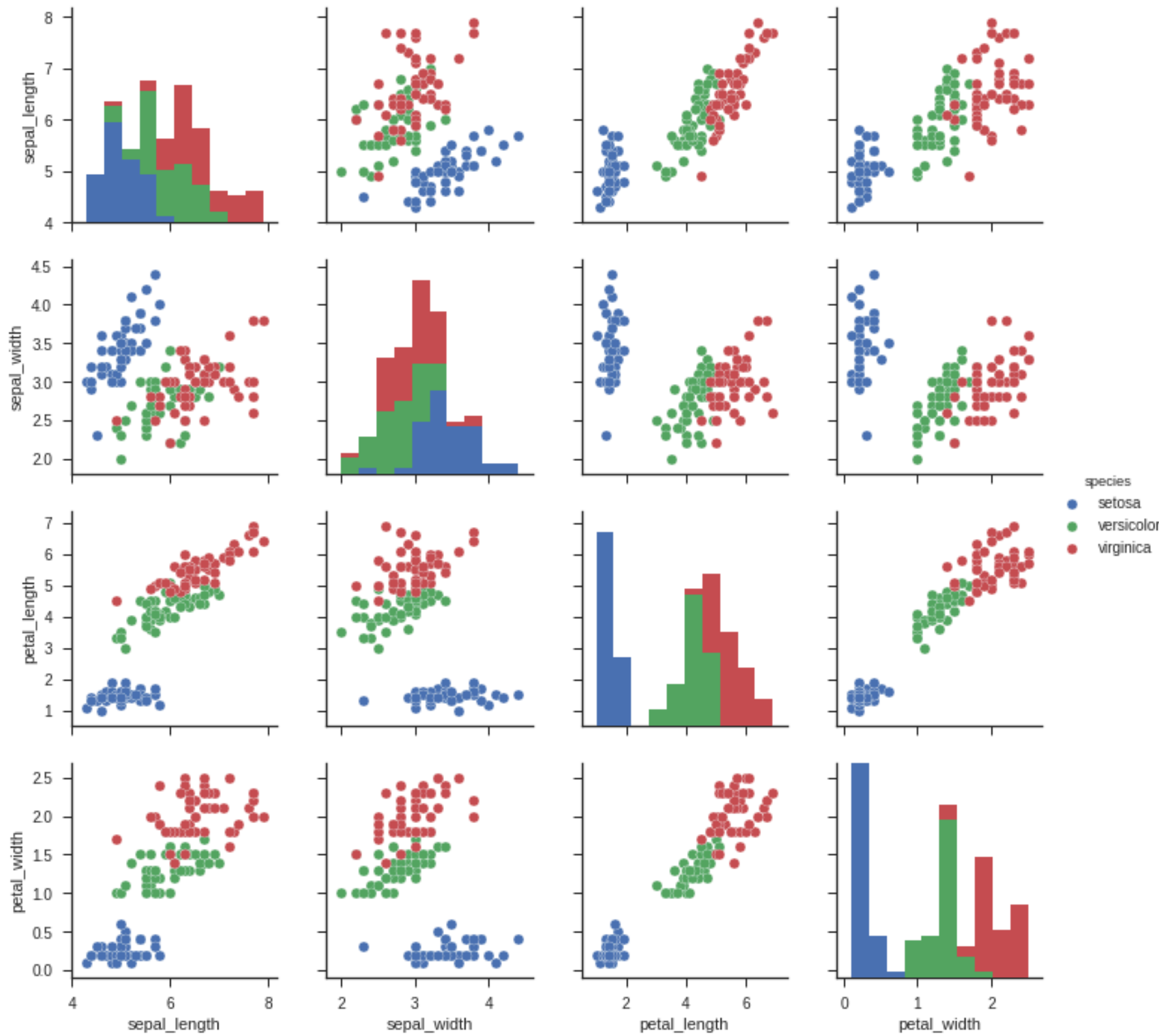
Data Visualization in Google Colab

https://colab.research.google.com/drive/1KRqtEUd2Hg4dM2au9bfVQKrxWnWN3O9-



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

```python
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

https://colab.research.google.com/drive/1KRqtEUd2Hg4dM2au9bfVQKrxWnWN3O9-

```
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

# 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))
print(df.tail(10))
print(df.describe())
print(df.info())
print(df.shape)
print(df.groupby('class').size())

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()

scatter_matrix(df)
plt.show()

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

Source: https://machinelearningmastery.com/machine-learning-in-python-step-by-step/

```
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
```

```python
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))
```

```python
# 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)
```

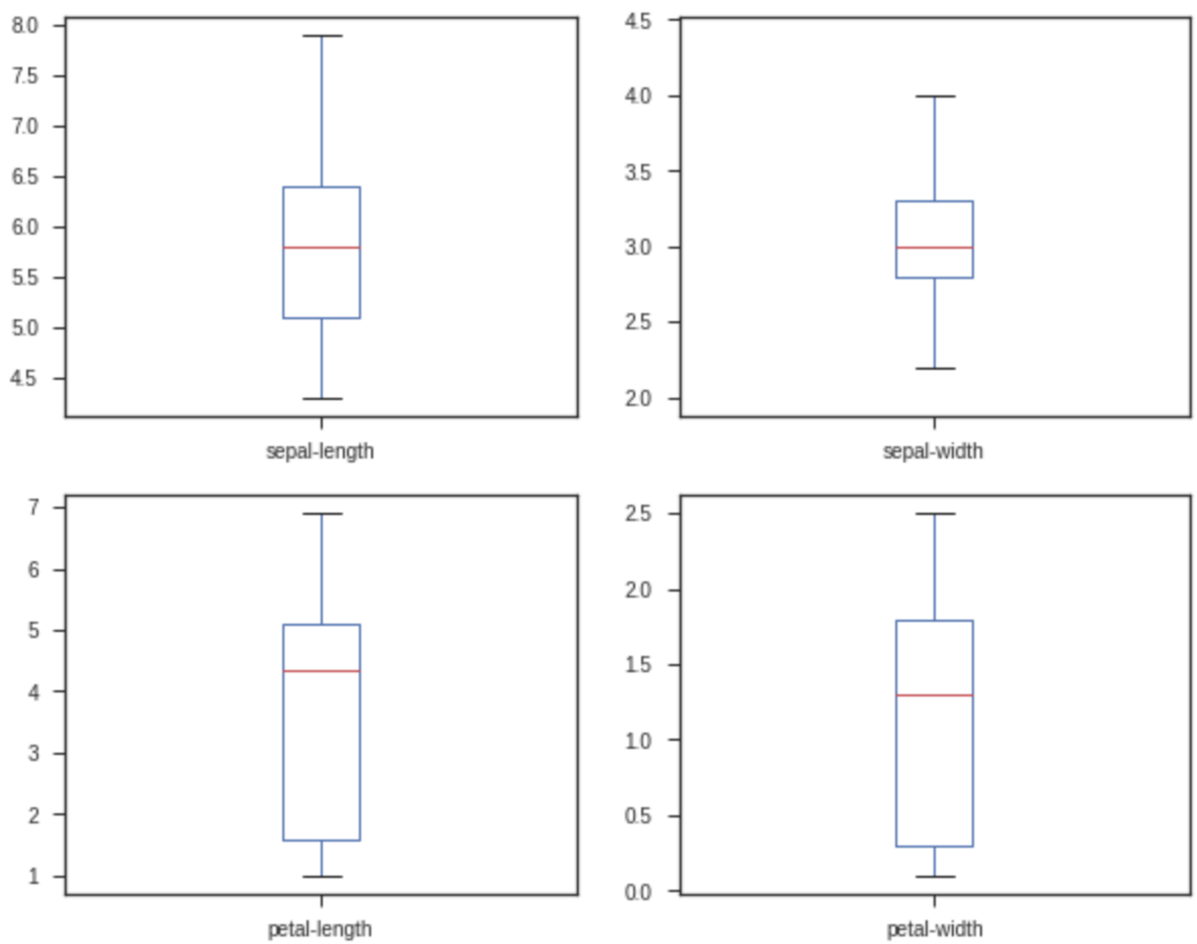
df.groupby('class').size()

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

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

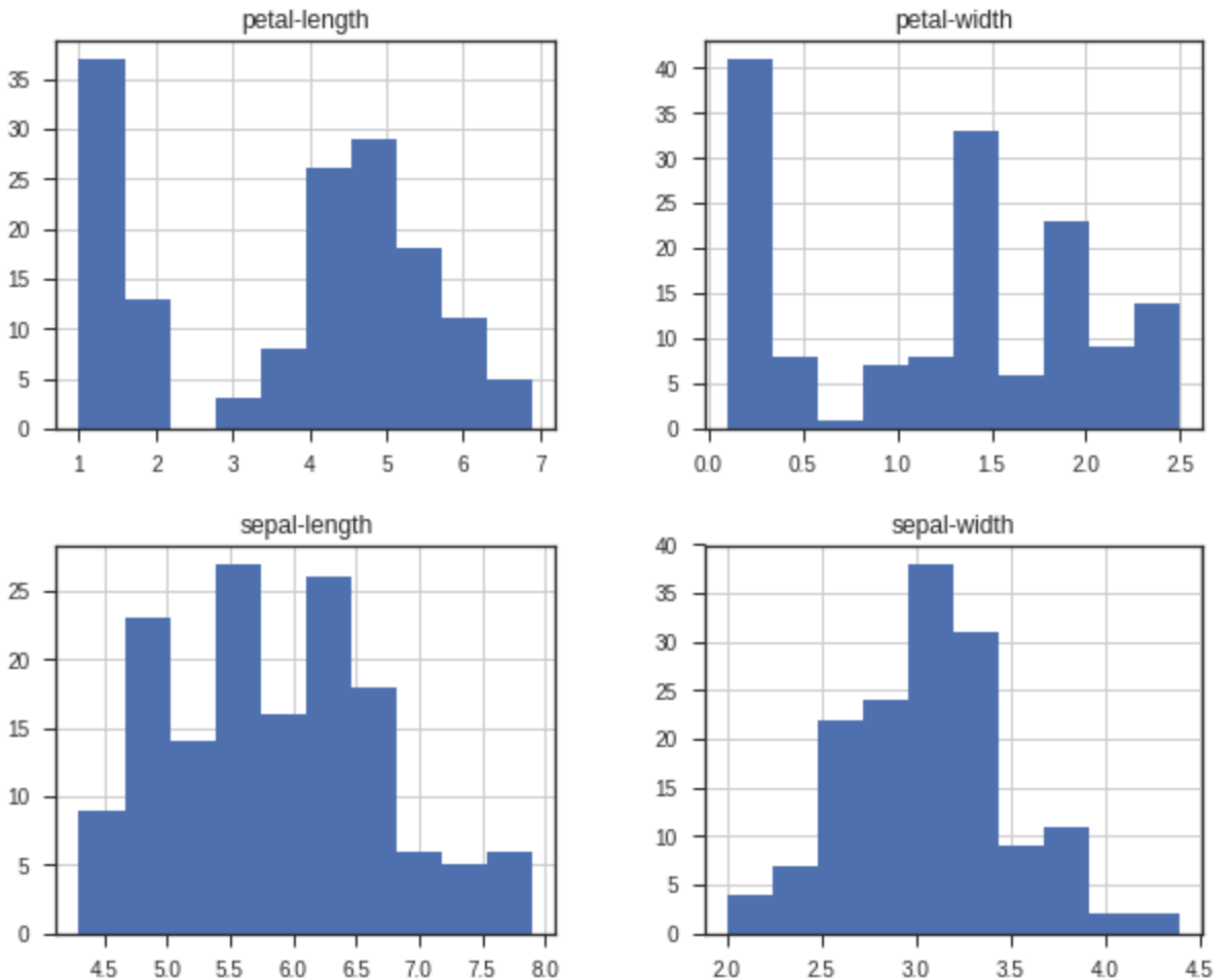
```
plt.rcParams["figure.figsize"] = (10,8)
df.plot(kind='box', subplots=True, layout=(2,2), sharex=False, sharey=False)
plt.show()
```


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

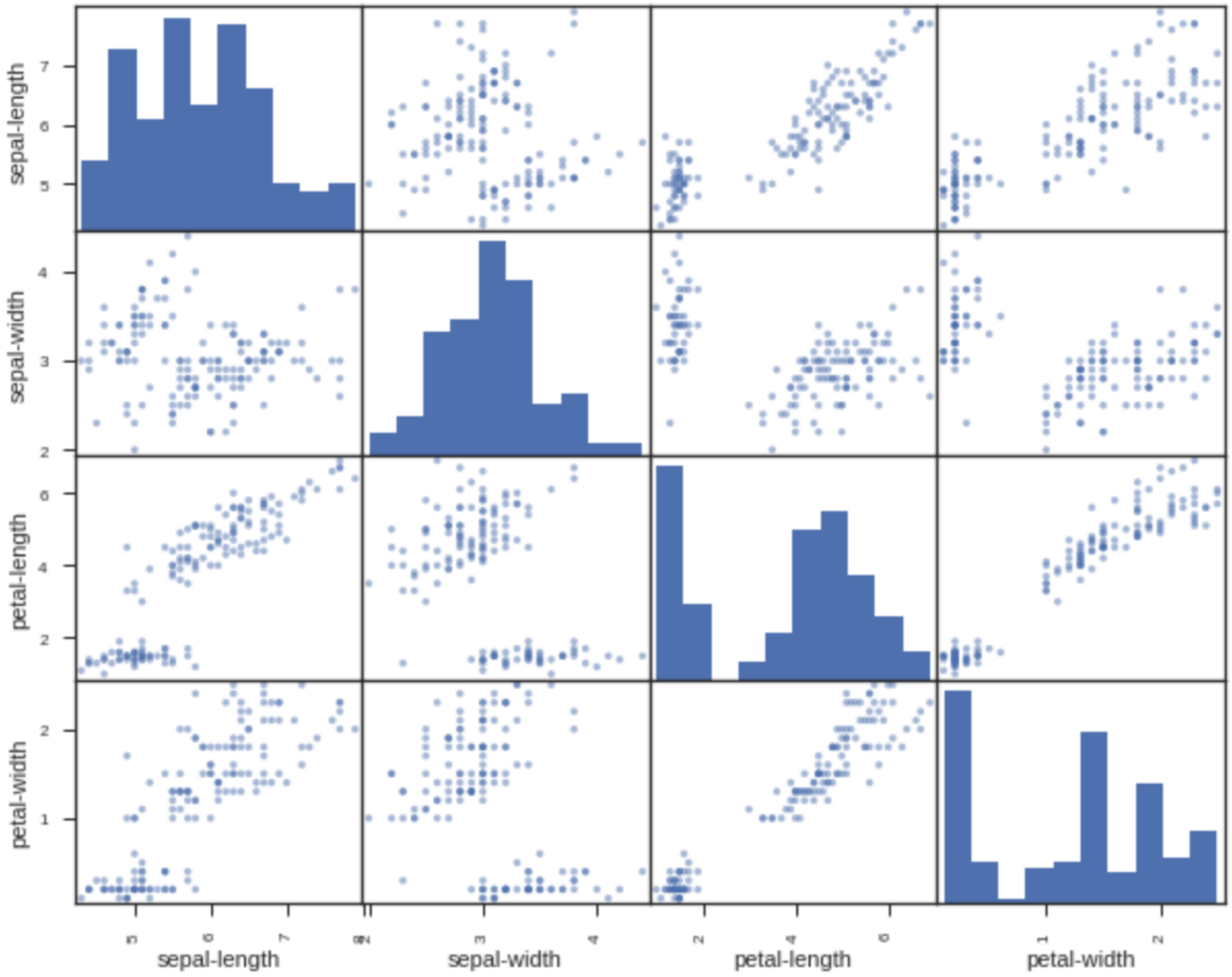
```
df.hist()
plt.show()
```

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



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

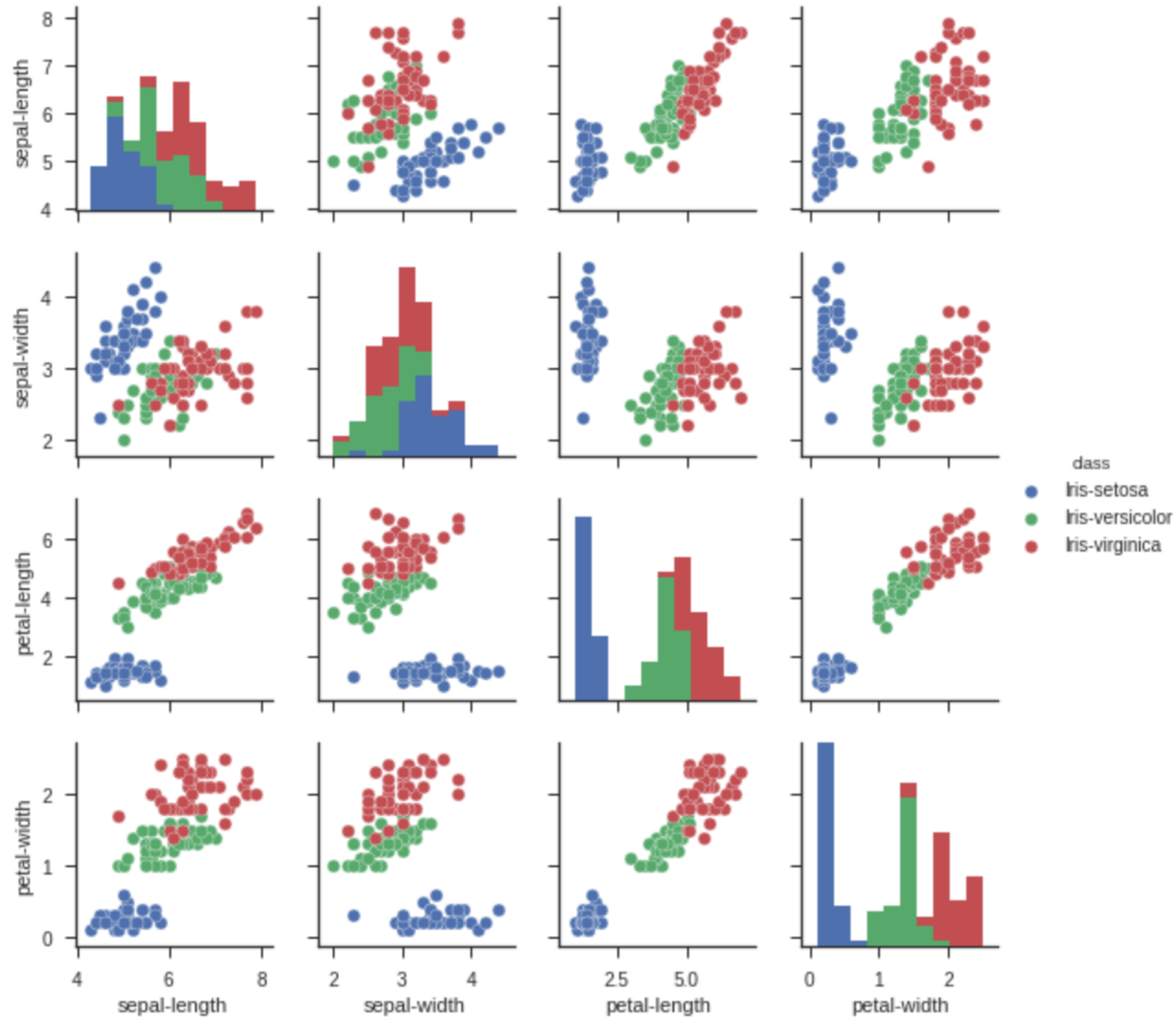
```
scatter_matrix(df)
plt.show()
```



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

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

<seaborn.axisgrid.PairGrid at 0x7f1d21267390>

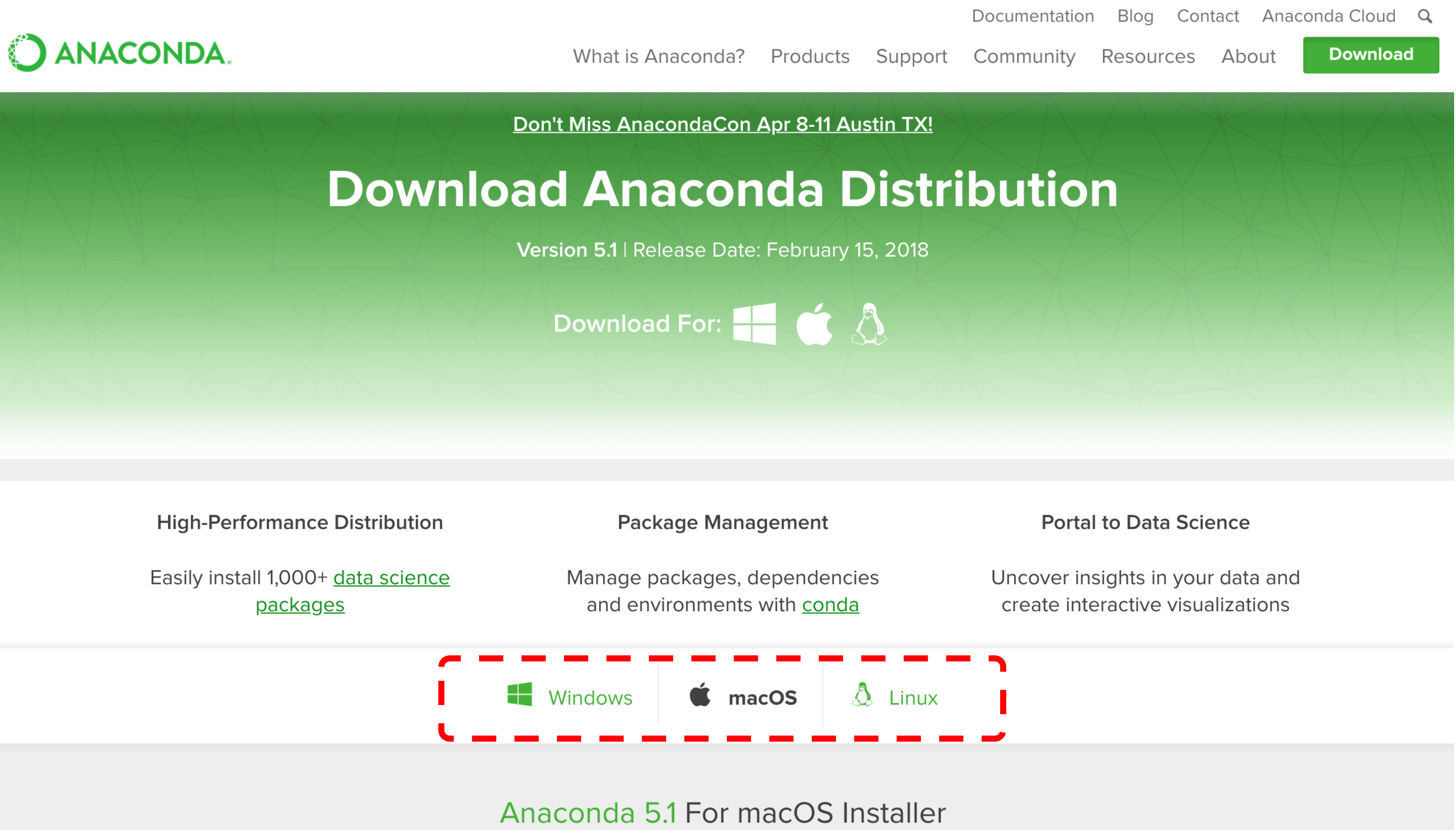


Anaconda

The Most Popular Python Data Science Platform

Source: https://www.anaconda.com/

Download Anaconda

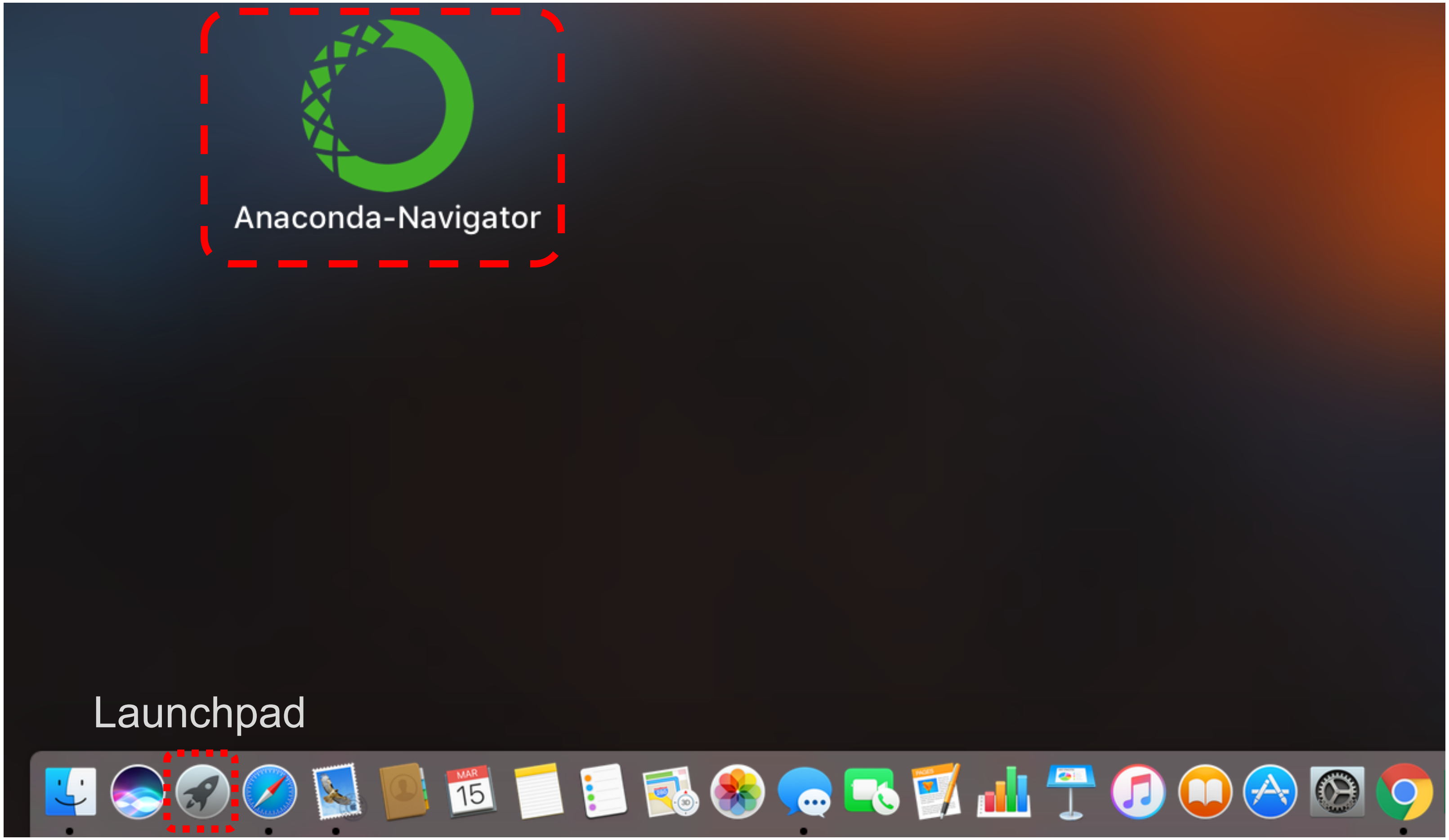


https://www.anaconda.com/download

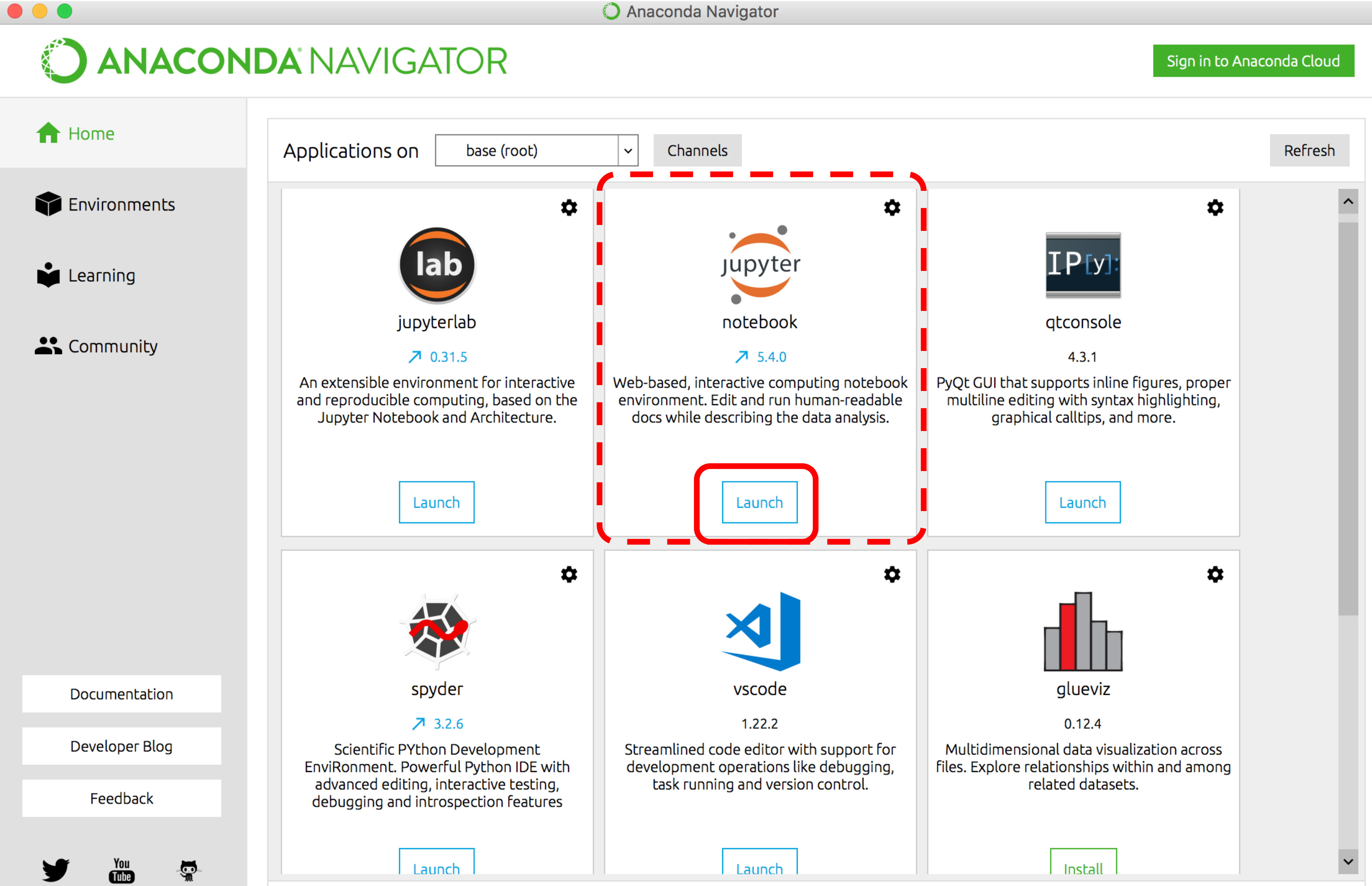
Python

HelloWorld

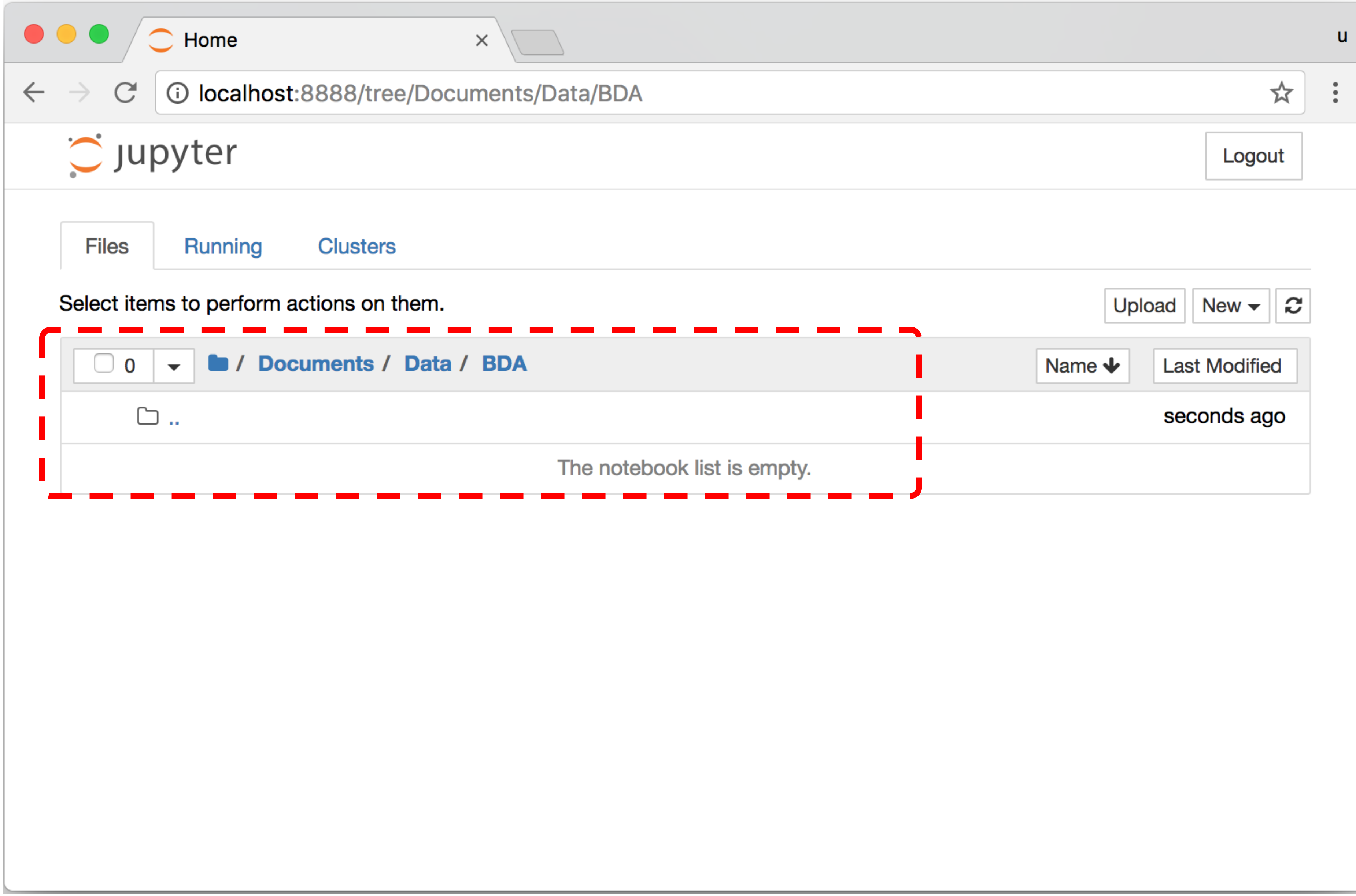
Anaconda-Navigator



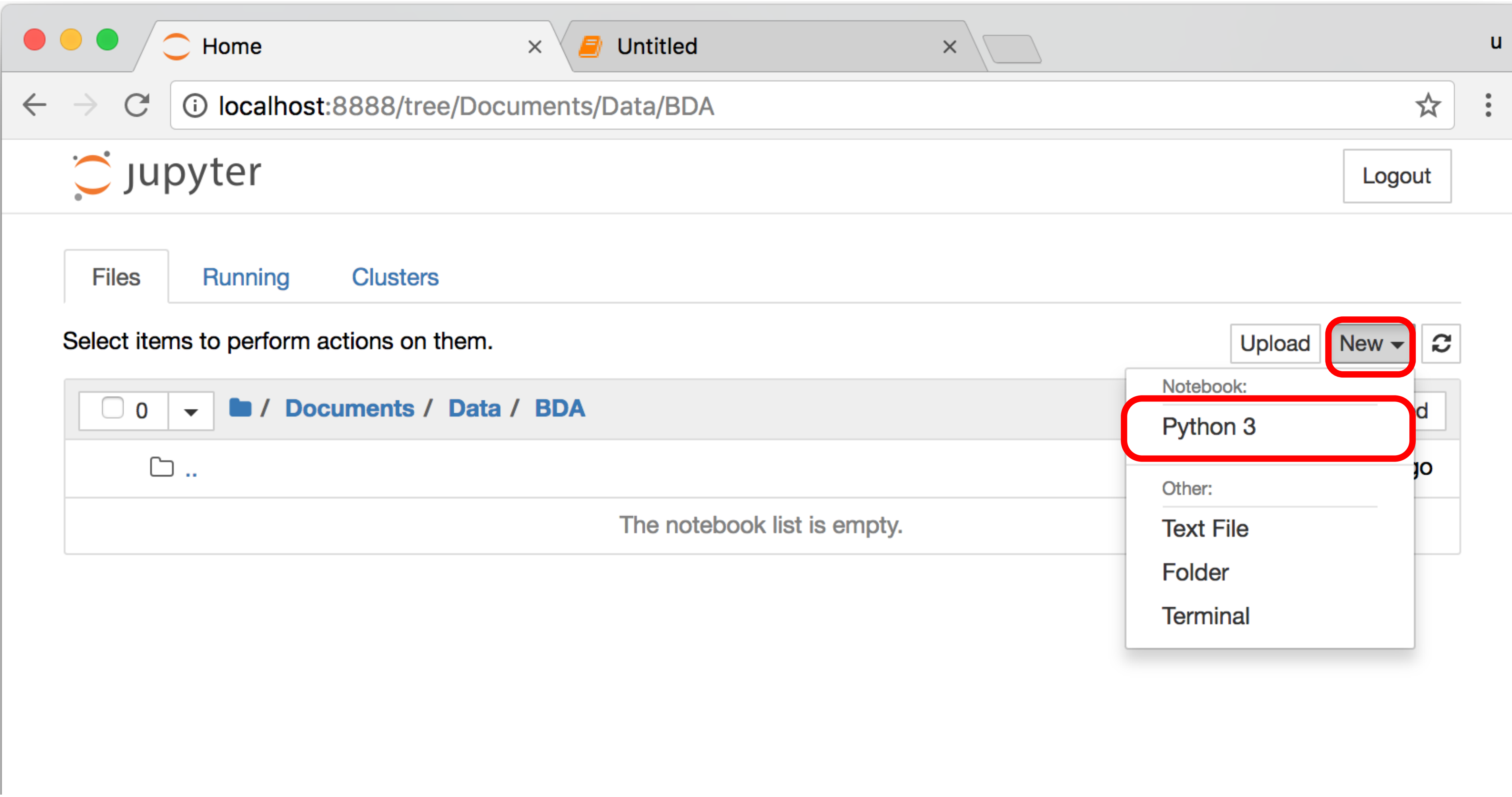
Anaconda Navigator



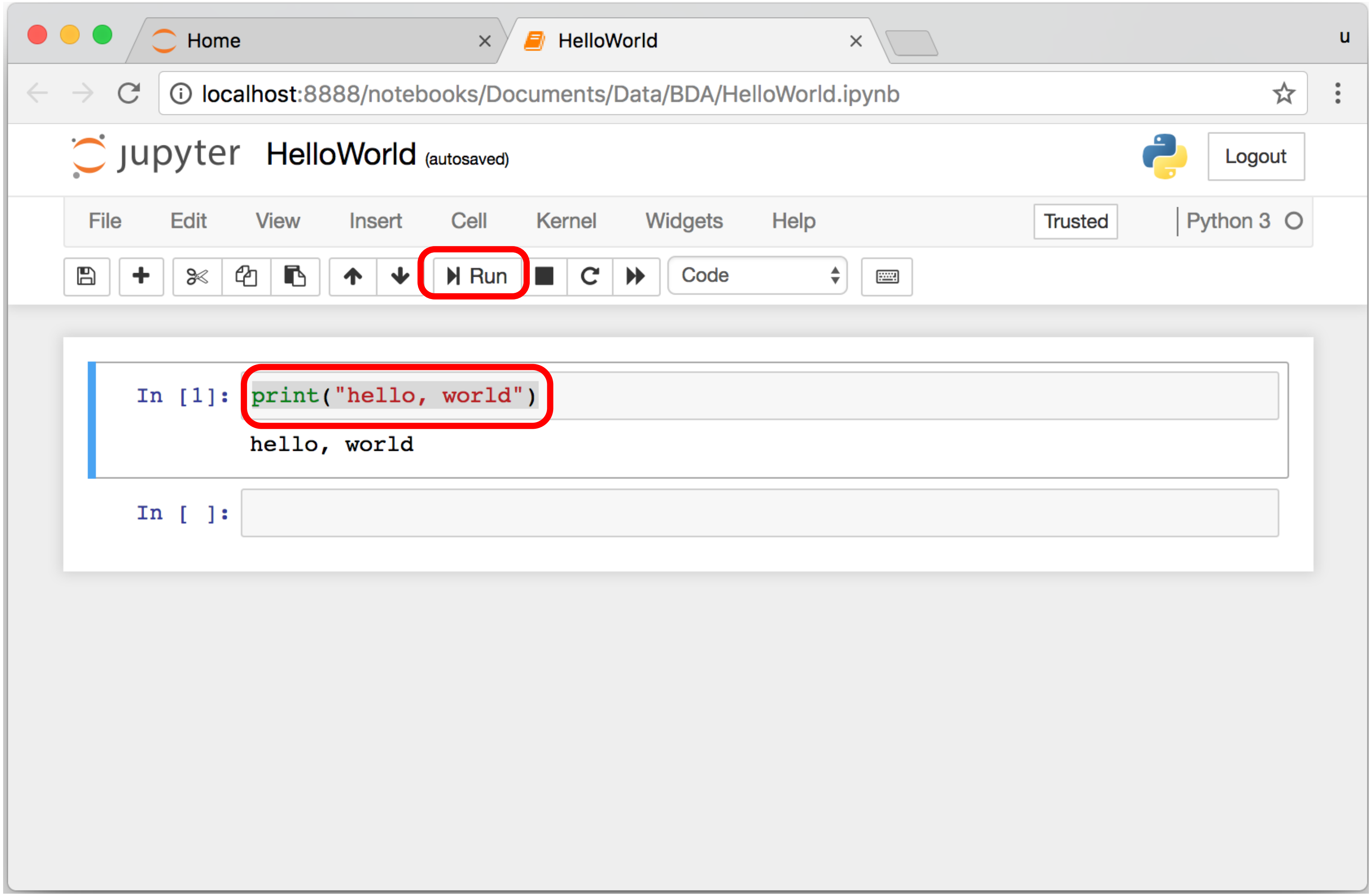
Jupyter Notebook



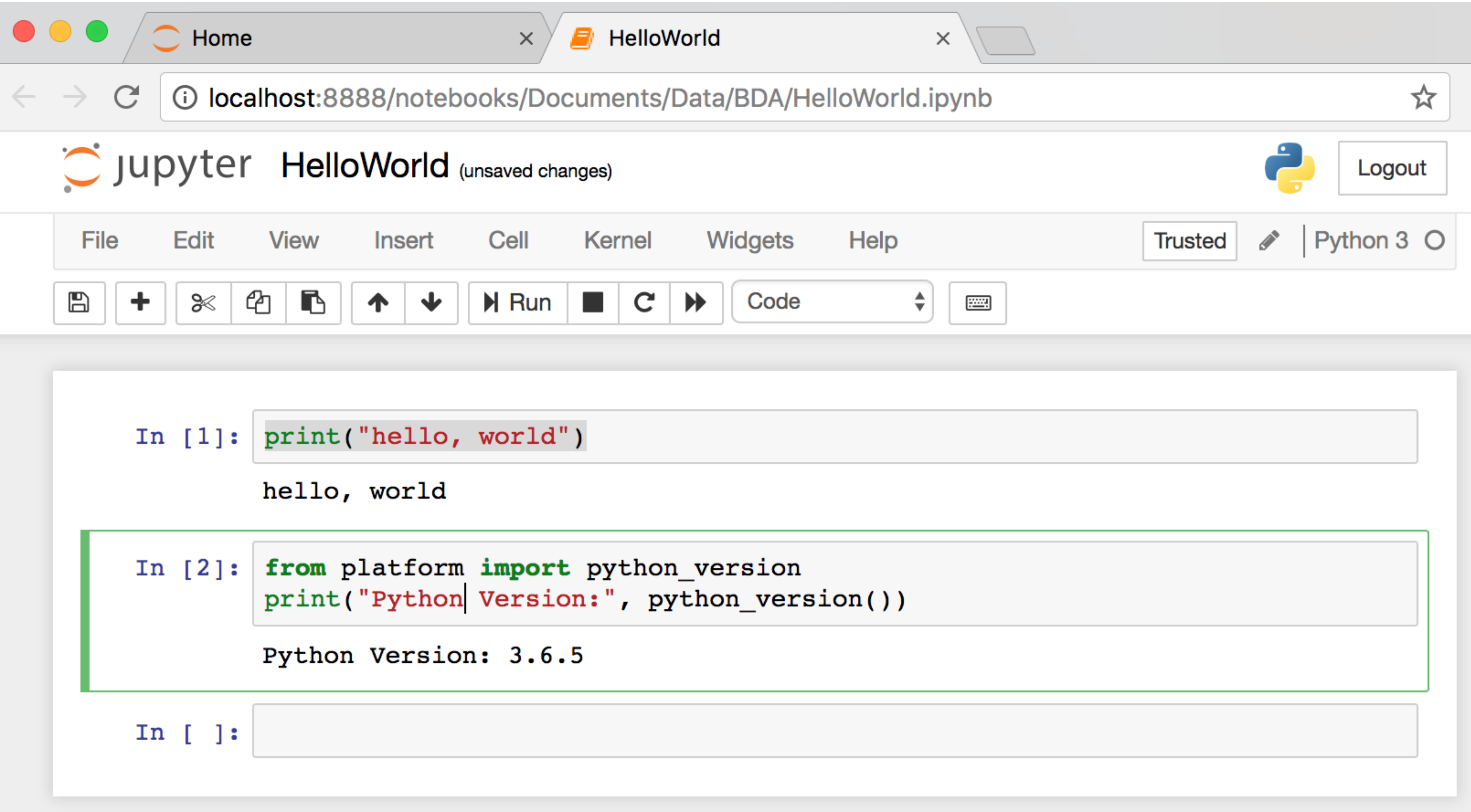
Jupyter Notebook
New Python 3



print("hello, world")



```python
from platform import python_version
print("Python Version:", python_version())
```

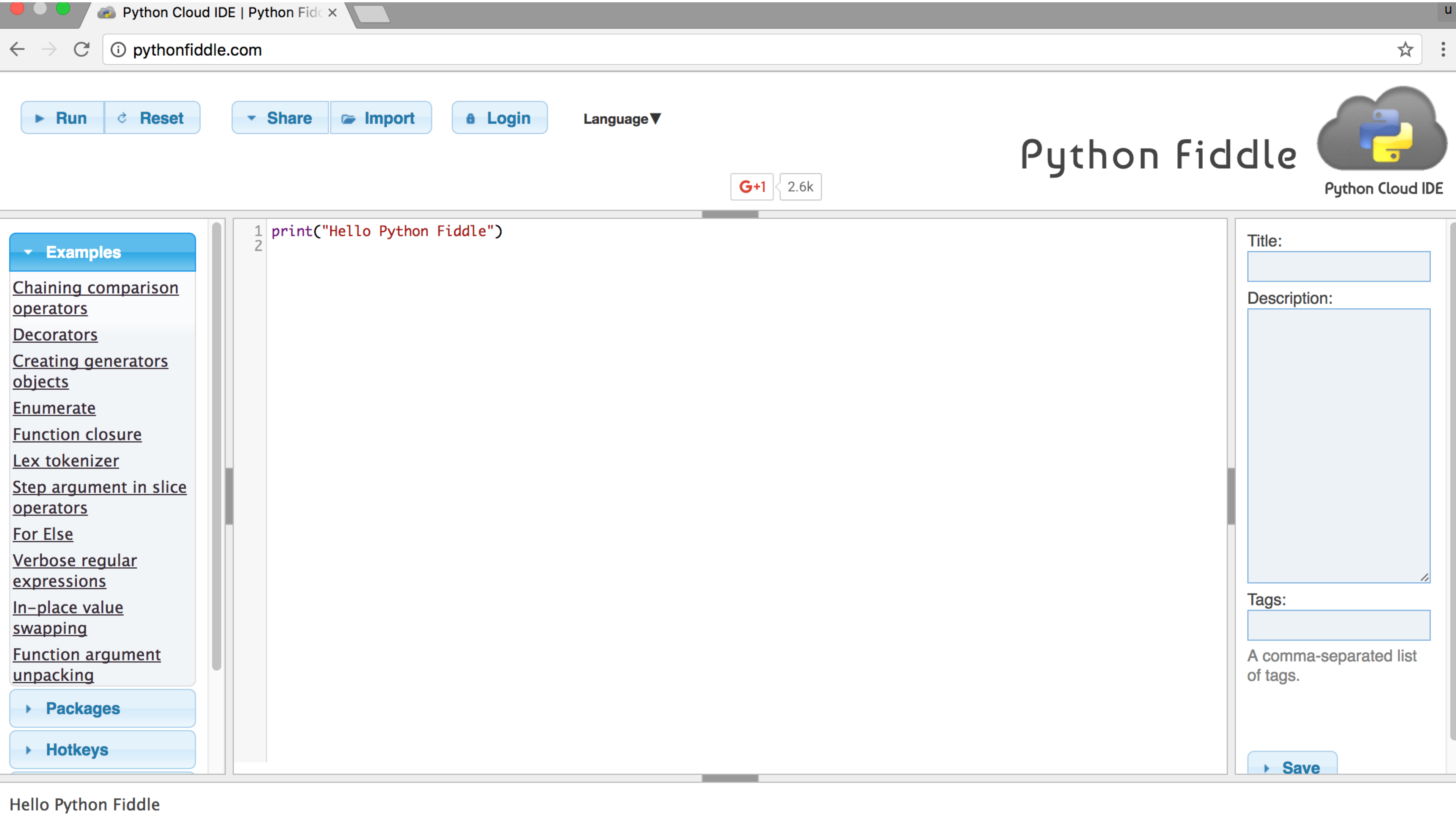


Python

Programming

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

Python Fiddle



http://pythonfiddle.com/

Text input and output

```
print("Hello World")
```

```
print("Hello World\nThis is a message")
```

```
x = 3
print(x)
```

```
x = 2
y = 3
print(x, ' ', y)
```

```
name = input("Enter a name: ")
```

```
x = int(input("What is x? "))
```

```
x = float(input("Write a number "))
```

Source: http://pythonprogramminglanguage.com/text-input-and-output/

Python in Google Colab

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

python101.ipynb - Colaboratory

https://colab.research.google.com/drive/1FEG6DnGvwfUbeo4zJ1zTunjMqf2RkCrT?authuser=2#scrollTo=LSNfVqJO-7-U

python101.ipynb

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CODE TEXT CELL CELL CONNECTED EDITING

```
print("hello, world")
```

```
hello, world
```

[2]
```
# comment
from platform import python_version
print("Python Version:", python_version())
```

```
Python Version: 3.6.6
```

[3]
```
# https://www.learnpython.org/en/
# LearnPython.org interactive Python tutorial
print("Hello World")
print("Hello World\nThis is a message")
x = 3
print(x)
x = 2
y = 3
print(x, ' ', y)
```

```
Hello World
Hello World
This is a message
3
2   3
```

[4]
```
# Python Variables
x = 2
price = 2.5
word = 'Hello'

word = 'Hello'
word = "Hello"
word = '''Hello'''
```

https://tinyurl.com/aintpupython101

Text input and output

```
In [1]: print("Hello World")

        Hello World

In [2]: print("Hello World\nThis is a message")

        Hello World
        This is a message

In [3]: x = 3
        print(x)

        3

In [4]: x = 2
        y = 3
        print(x, ' ', y)

        2   3

In [5]: name = input("Enter a name: ")

        Enter a name: Myday

In [6]: x = int(input("What is x? "))

        What is x? 80

In [7]: x = float(input("Write a number "))

        Write a number 3.6
```

Source: http://pythonprogramminglanguage.com/text-input-and-output/

Variables

```
x = 2
price = 2.5
word = 'Hello'
```

```
word = 'Hello'
word = "Hello"
word = '''Hello'''
```

```
x = 2
x = x + 1
x = 5
```

Source: http://pythonprogramminglanguage.com/

Python Basic Operators

```
print('7 + 2 =', 7 + 2)
print('7 - 2 =', 7 - 2)
print('7 * 2 =', 7 * 2)
print('7 / 2 =', 7 / 2)
print('7 // 2 =', 7 // 2)
print('7 % 2 =', 7 % 2)
print('7 ** 2 =', 7 ** 2)
```

```
print('7 + 2 =', 7 + 2)
print('7 - 2 =', 7 - 2)
print('7 * 2 =', 7 * 2)
print('7 / 2 =', 7 / 2)
print('7 // 2 =', 7 // 2)
print('7 % 2 =', 7 % 2)
print('7 ** 2 =', 7 ** 2)
```

```
7 + 2 = 9
7 - 2 = 5
7 * 2 = 14
7 / 2 = 3.5
7 // 2 = 3
7 % 2 = 1
7 ** 2 = 49
```

BMI Calculator in Python

```python
height_cm = float(input("Enter your height in cm: "))
weight_kg = float(input("Enter your weight in kg: "))

height_m = height_cm/100
BMI = (weight_kg/(height_m**2))

print("Your BMI is: " + str(round(BMI,1)))
```

Source: http://code.activestate.com/recipes/580615-bmi-code/

BMI Calculator in Python

jupyter PythonTutorial Last Checkpoint: a minute ago (unsaved changes)

Logout

File Edit View Insert Cell Kernel Widgets Help Python 3

Code CellToolbar

In [1]:

```
height_cm = float(input("Enter your height in cm: "))
weight_kg = float(input("Enter your weight in kg: "))

height_m = height_cm/100
BMI = (weight_kg/(height_m**2))

print("Your BMI is: " + str(round(BMI,1)))
```

```
Enter your height in cm: 170
Enter your weight in kg: 60
Your BMI is: 20.8
```

In [ ]:

Source: http://code.activestate.com/recipes/580615-bmi-code/

Future value of a specified principal amount, rate of interest, and a number of years

Source: https://www.w3resource.com/python-exercises/python-basic-exercise-39.php

Future Value (FV)

```
# How much is your $100 worth after 7 years?
print(100 * 1.1 ** 7)
# output = 194.87
```

```
print(100 * 1.1 ** 7)
```

```
194.87171000000012
```

Source: https://www.w3resource.com/python-exercises/python-basic-exercise-39.php

Future Value (FV)

```python
pv = 100
r = 0.1
n = 7

fv = pv * ((1 + (r)) ** n)
print(round(fv, 2))
```


```python
pv = 100
r = 0.1
n = 7

fv = pv * ((1 + (r)) ** n)
print(round(fv, 2))
```


```
194.87
```

Future Value (FV)

```
amount = 100
interest = 10 #10% = 0.01 * 10
years = 7

future_value = amount * ((1 + (0.01 * interest)) ** years)
print(round(future_value, 2))
```

```
amount = 100
interest = 10 #10% = 0.01 * 10
years = 7

future_value  = amount * ((1 + (0.01 * interest)) ** years)
print(round(future_value, 2))
```

```
194.87
```

Source: https://www.w3resource.com/python-exercises/python-basic-exercise-39.php

if statements

```
>   greater than
<   smaller than
==  equals
!=  is not
```

```
score = 80
if score >=60 :
    print("Pass")
else:
    print("Fail")
```

```
Pass
```

```
score = 80
if score >=60 :
    print("Pass")
else:
    print("Fail")
```

Source: http://pythonprogramminglanguage.com/

if elif else

```
score = 90
grade = ""
if score >=90:
    grade = "A"
elif score >= 80:
    grade = "B"
elif score >= 70:
    grade = "C"
elif score >= 60:
    grade = "D"
else:
    grade = "E"
print(grade)
# grade = ”A”
```

```
A
```

http://pythontutor.com/visualize.html
https://goo.gl/E6w5ph

Source: http://pythonprogramminglanguage.com/

for loops

```
for i in range(1,11):
    print(i)
```

```
1
2
3
4
5
6
7
8
9
10
```

Source: http://pythonprogramminglanguage.com/

for loops

```
for i in range(1,10):
    for j in range(1,10):
        print(i, ' * ' , j , ' = ', i*j)
```

```
9 * 1 = 9
9 * 2 = 18
9 * 3 = 27
9 * 4 = 36
9 * 5 = 45
9 * 6 = 54
9 * 7 = 63
9 * 8 = 72
9 * 9 = 81
```

Source: http://pythonprogramminglanguage.com/

while loops

```python
age = 10

while age < 20:
    print(age)
    age = age + 1
```

```
10
11
12
13
14
15
16
17
18
19
```

Source: https://learnpython.trinket.io/learn-python-part-8-loops#/while-loops/about-while-loops

Functions

```
def convertCMtoM(xcm):
    m = xcm/100
    return m

cm = 180
m = convertCMtoM(cm)
print(str(m))
```

```
1.8
```

python™

Lists

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

```
4
60
70
90
```

Tuples

A tuple in Python is a collection that cannot be modified.
A tuple is defined using parenthesis.

```
x = (10, 20, 30, 40, 50)
print(x[0])
print(x[1])
print(x[2])
print(x[-1])
```

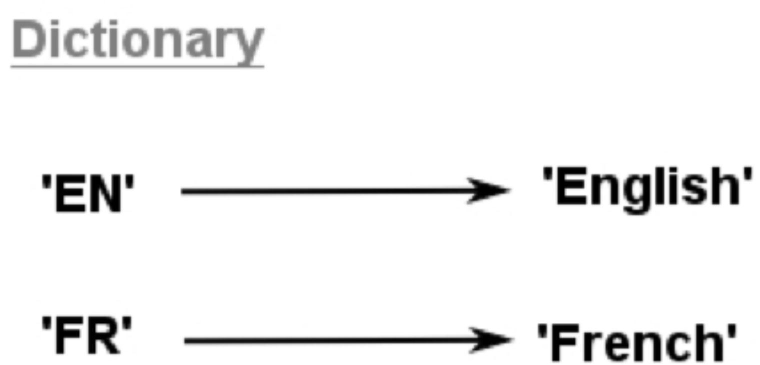
```
10
20
30
50
```

Source: http://pythonprogramminglanguage.com/tuples/

python™

Dictionary

```
k = { 'EN':'English', 'FR':'French' }
print(k['EN'])
```




```
English
```

Source: http://pythonprogramminglanguage.com/dictionary/

Sets

```
animals = {'cat', 'dog'}
```

```
animals = {'cat', 'dog'}
print('cat' in animals)   # Check if an element is in a set; prints "True"
print('fish' in animals)  # prints "False"
animals.add('fish')       # Add an element to a set
print('fish' in animals)  # Prints "True"
print(len(animals))       # Number of elements in a set; prints "3"
animals.add('cat')        # Adding an element that is already in the set does nothing
print(len(animals))       # Prints "3"
animals.remove('cat')     # Remove an element from a set
print(len(animals))       # Prints "2"
```

```
True
False
True
3
3
2
```

```
animals = {'cat', 'dog'}
print('cat' in animals)
print('fish' in animals)
animals.add('fish')
print('fish' in animals)
print(len(animals))
animals.add('cat')
print(len(animals))
animals.remove('cat')
print(len(animals))
```

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

python™

File Input / Output

```
with open('myfile.txt', 'w') as file:
    file.write('Hello World\nThis is Python File Input Output')

with open('myfile.txt', 'r') as file:
    text = file.read()
print(text)
```

```
with open('myfile.txt', 'w') as file:
    file.write('Hello World\nThis is Python File Input Output')
```

```
with open('myfile.txt', 'r') as file:
    text = file.read()
print(text)
```

```
Hello World
This is Python File Input Output
```

```
text
```

```
'Hello World\nThis is Python File Input Output'
```

Source: https://github.com/TiesdeKok/LearnPythonforResearch/blob/master/0_python_basics.ipynb

File Input / Output

```python
with open('myfile.txt', 'a+') as file:
    file.write('\n' + 'New line')

with open('myfile.txt', 'r') as file:
    text = file.read()
print(text)
```

```python
with open('myfile.txt', 'a+') as file:
    file.write('\n' + 'New line')
```

```python
with open('myfile.txt', 'r') as file:
    text = file.read()
print(text)
```

```
Hello World
This is Python File Input Output
New line
```

Source: https://github.com/TiesdeKok/LearnPythonforResearch/blob/master/0_python_basics.ipynb

Big Data Analytics
with
Numpy
in Python

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.

NumPy

NumPy

Scipy.org

About NumPy
License
Old array packages

NumPy

NumPy is the fundamental package for scientific computing with Python. It contains among other things:

- a powerful N-dimensional array object
- sophisticated (broadcasting) functions
- tools for integrating C/C++ and Fortran code
- useful linear algebra, Fourier transform, and random number capabilities

Besides its obvious scientific uses, NumPy can also be used as an efficient multi-dimensional container of generic data. Arbitrary data-types can be defined. This allows NumPy to seamlessly and speedily integrate with a wide variety of databases.

NumPy is licensed under the *BSD license*, enabling reuse with few restrictions.

Getting Started

- Getting NumPy
- Installing the SciPy Stack
- NumPy and SciPy documentation page
- NumPy Tutorial
- NumPy for MATLAB© Users
- NumPy functions by category
- NumPy Mailing List

For more information on the SciPy Stack (for which NumPy provides the fundamental array data structure), see scipy.org.

http://www.numpy.org/

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

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

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

```
2 * v
```

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

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

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

```
2 * v
```

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

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/

Numpy Quickstart Tutorial

SciPy.org Sponsored By ENTHOUGHT

Quickstart tutorial

Prerequisites

Before reading this tutorial you should know a bit of Python. If you would like to refresh your memory, take a look at the Python tutorial.

If you wish to work the examples in this tutorial, you must also have some software installed on your computer. Please see http://scipy.org/install.html for instructions.

The Basics

NumPy's main object is the homogeneous multidimensional array. It is a table of elements (usually numbers), all of the same type, indexed by a tuple of positive integers. In NumPy dimensions are called *axes*. The number of axes is *rank*.

For example, the coordinates of a point in 3D space `[1, 2, 1]` is an array of rank 1, because it has one axis. That axis has a length of 3. In the example pictured below, the array has rank 2 (it is 2-dimensional). The first dimension (axis) has a length of 2, the second dimension has a length of 3.

```
[[ 1., 0., 0.],
 [ 0., 1., 2.]]
```

NumPy's array class is called `ndarray`. It is also known by the alias `array`. Note that `numpy.array` is not the same as the Standard Python Library class `array.array`, which only handles one-dimensional arrays and offers less functionality. The more important attributes of an `ndarray` object are:

ndarray.ndim

the number of axes (dimensions) of the array. In the Python world, the number of dimensions is referred to as *rank*.

ndarray.shape

Table Of Contents

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

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

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

```python
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]])
```

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

```
(3, 5)
```

```python
a.ndim
```

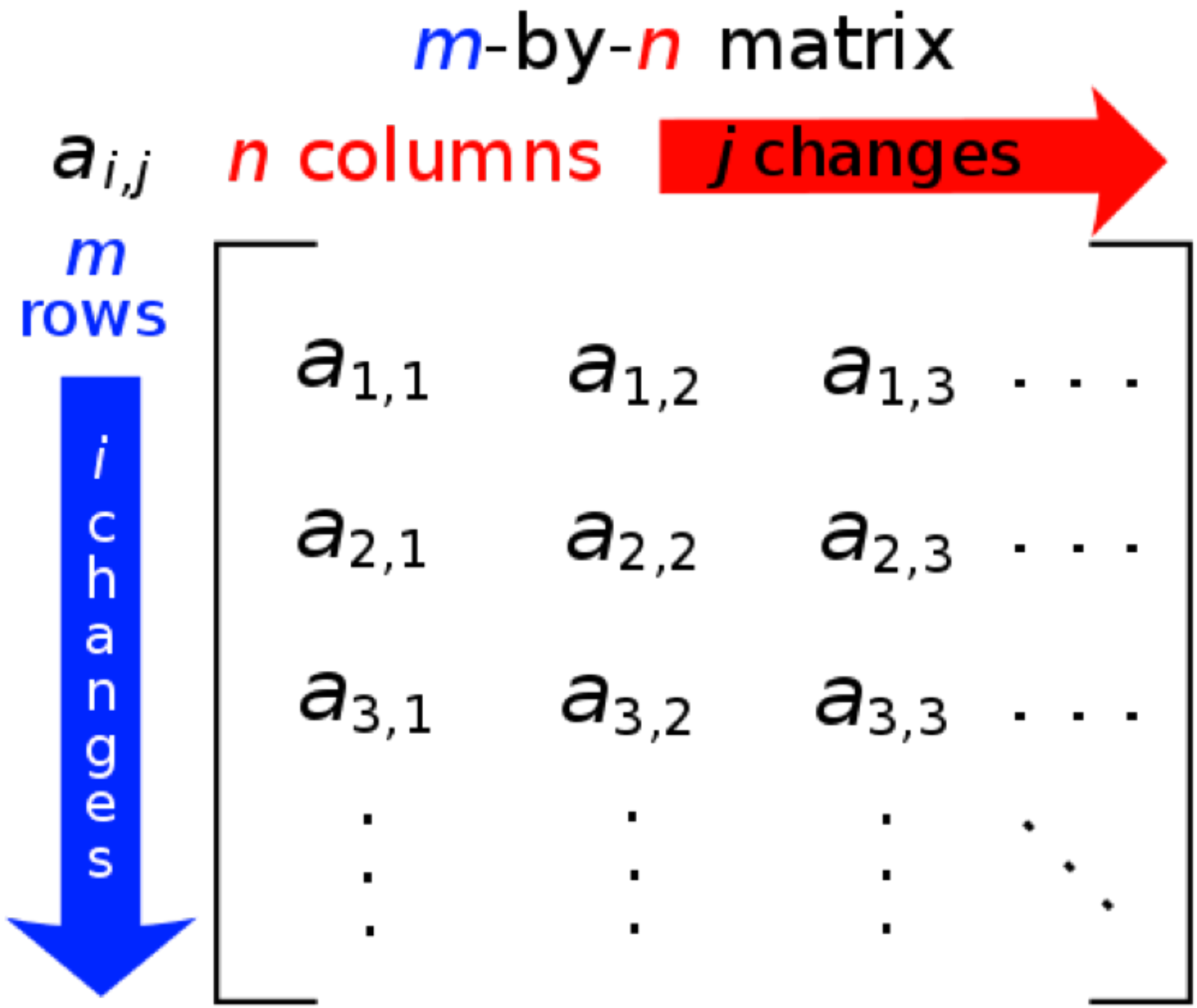
```
2
```

```python
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**

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

One-dimensional Array (1-D Array)

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

```python
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)
```

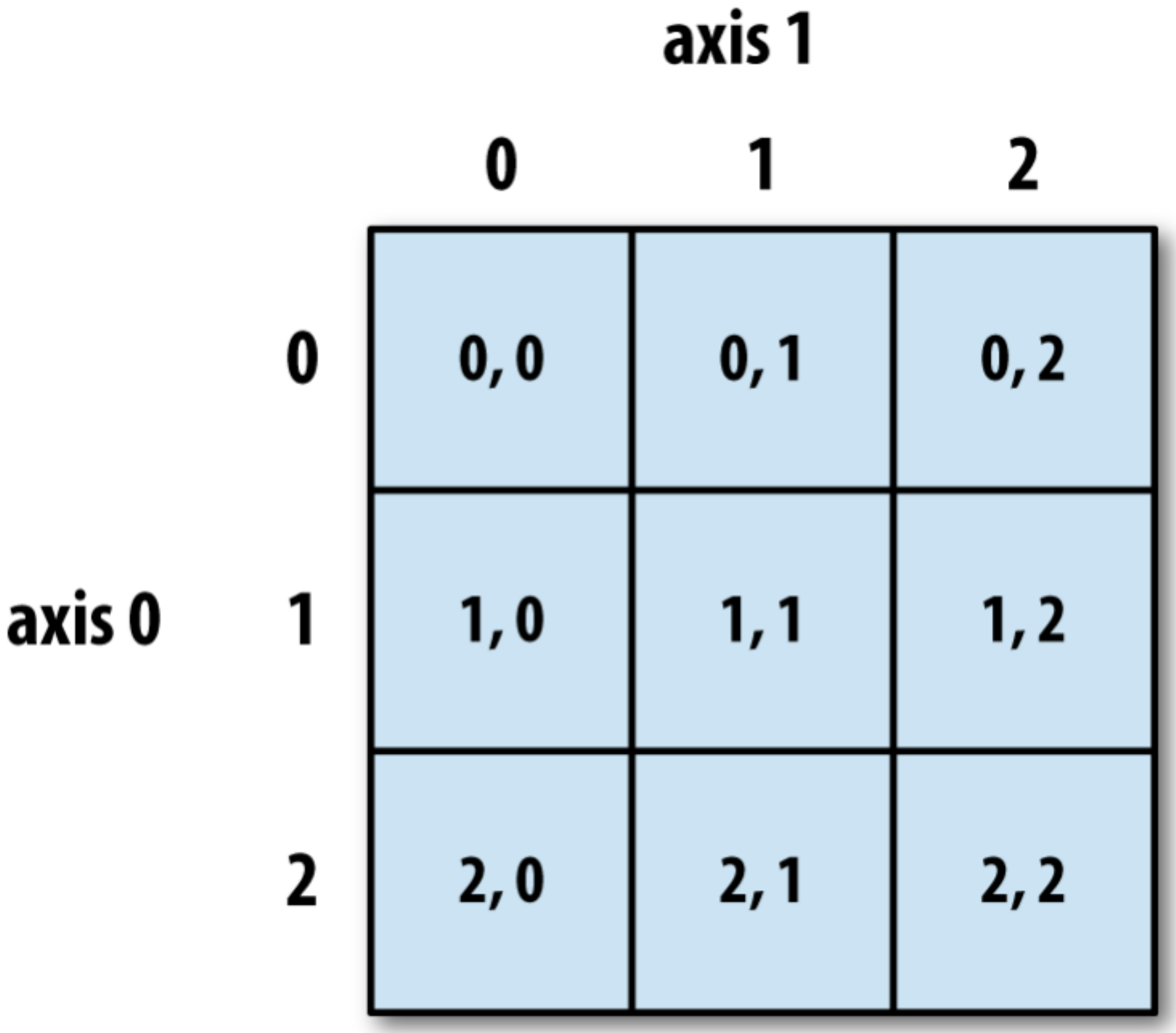
```
(3, 4)
```

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

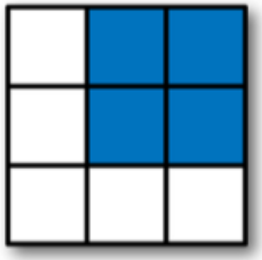
NumPy Array



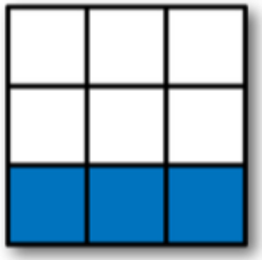
Source: https://www.safaribooksonline.com/library/view/python-for-data/9781449323592/ch04.html

Numpy Array

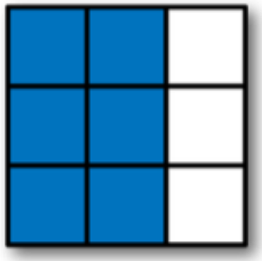
Expression	Shape



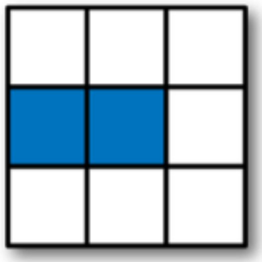
arr[:2, 1:]	(2, 2)



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

Wes McKinney (2017), "Python for Data Analysis: Data Wrangling with Pandas, NumPy, and IPython", 2nd Edition, O'Reilly Media.

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

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betatim committed with wesm Add requirements (#71) — Latest commit ea47998 5 days ago

datasets	Add Kaggle titanic dataset	5 months ago
examples	Remove sex column from tips dataset	4 months ago
.gitignore	Add gitignore	2 years ago
COPYING	Use MIT license for code examples	a month ago
README.md	Add launch in Azure Notebooks button (#70)	19 days ago
appa.ipynb	Make more cells markdown instead of raw	a month ago
ch02.ipynb	Make more cells markdown instead of raw	a month ago
ch03.ipynb	Make more cells markdown instead of raw	a month ago
ch04.ipynb	Convert all notebooks to v4 format	a month ago
ch05.ipynb	Make more cells markdown instead of raw	a month ago
ch06.ipynb	Make more cells markdown instead of raw	a month ago
ch07.ipynb	Convert all notebooks to v4 format	a month ago
ch08.ipynb	Make more cells markdown instead of raw	a month ago
ch09.ipynb	Make more cells markdown instead of raw	a month ago
ch10.ipynb	Make more cells markdown instead of raw	a month ago

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

Wes McKinney (2017), "Python for Data Analysis: Data Wrangling with Pandas, NumPy, and IPython", 2nd Edition, O'Reilly Media.

wesm / pydata-book

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Branch: 2nd-edition ▾ pydata-book / ch04.ipynb

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wesm Convert all notebooks to v4 format c2780a0 on Sep 27

2 contributors

1857 lines (1856 sloc) | 32.6 KB

Raw | Blame | History

NumPy Basics: Arrays and

In [ ]:

```python
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 [ ]:

```python
import numpy as np
my_arr = np.arange(1000000)
my_list = list(range(1000000))
```

In [ ]:

```python
%time for _ in range(10): my_arr2 = my_arr * 2
%time for _ in range(10): my_list2 = [x * 2 for x in my_list]
```

The NumPy ndarray: A Multidimensional Array Object

In [ ]:

```python
import numpy as np
# Generate some random data
data = np.random.randn(2, 3)
data
```

Source: https://github.com/wesm/pydata-book/blob/2nd-edition/ch04.ipynb

Summary

- **Foundations of Big Data Analysis in Python**
  - **Python**
    - Programming language
  - **Numpy**
    - Scientific computing

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