UNIVERSITY OF MALAYA

IVC on Astrostatistics and Machine Learning (2-13 August 2021)

Introduction to Python

A walk through in learning Python effectively

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https://github.com/lizayusof/IVC_Astrostat_ML

The notes is adapted from course content SIF2007 (Norhasliza Yusof) and SQA7006 (Hasan Abu Kassim)

Basic info

- Python 3.X installed in your computer
- Libraries need to learn scientific computing or machine learning are :

✳ Matpotlib (library for visualisation - plotting graph)

✳ Numpy (numerical python library to call special mathematical function, handling arrays)

✳ Scipy (scientific computing library and utilised dumpy as its backbone)

✳ Seaborn (statistical data visualisation - based on Matplotlib)

✳ Pytorch (deep learning library)

✳ Tensorflow/Keras (machine learning library)

How to install Python in your computer

- python.org
- www.anaconda.com
- pycharm (www.jetbrains.com)

Integrated Graphic User Interface GUI + libraries automatically install

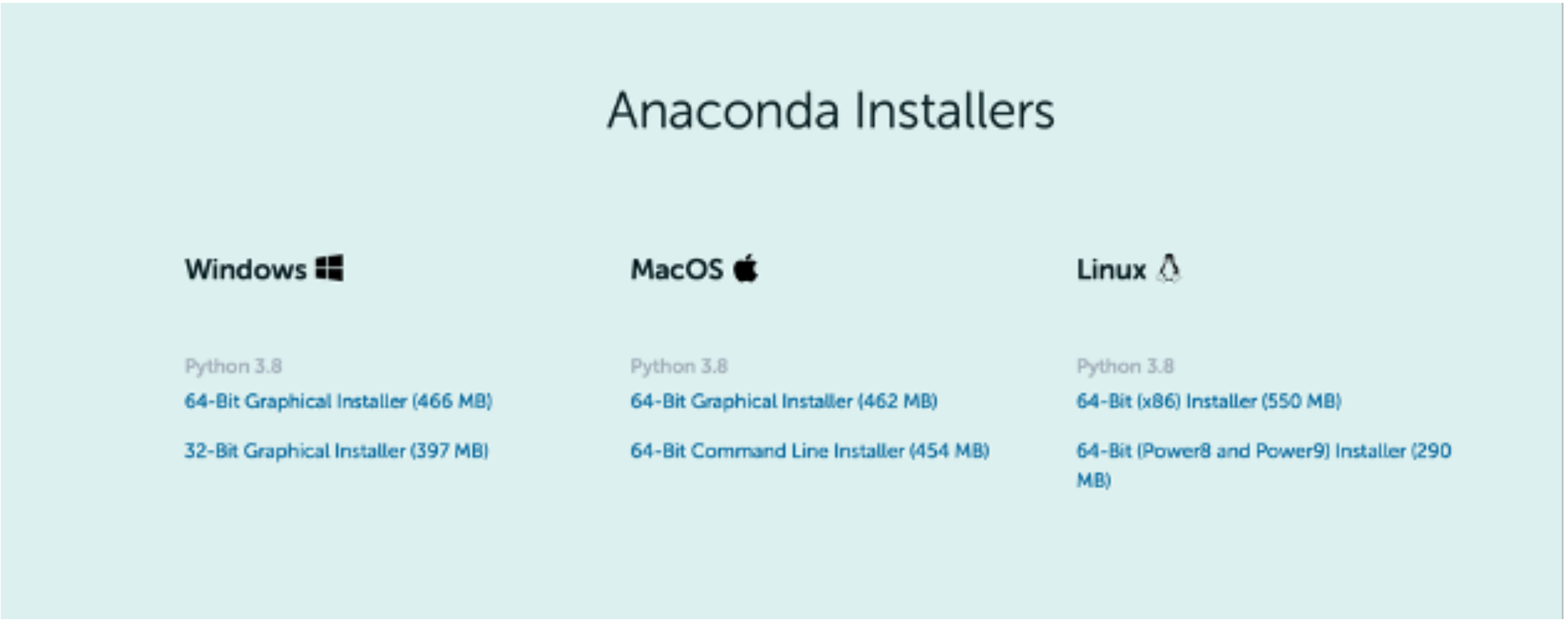
Or

If you are using Linux distro or MacOSX, popular option is via sudo apt-get install python3 or brew install python3 (in MacOSX)

Additional remarks:
anaconda uses conda -install command to install additional library
python.org or distribution via linux/Mac uses pip/pip3 -install command

Installation

https://www.anaconda.com/products/individual



Anaconda Installers

Windows

Python 3.8

64-Bit Graphical Installer (466 MB)

32-Bit Graphical Installer (397 MB)

MacOS

Python 3.8

64-Bit Graphical Installer (462 MB)

64-Bit Command Line Installer (454 MB)

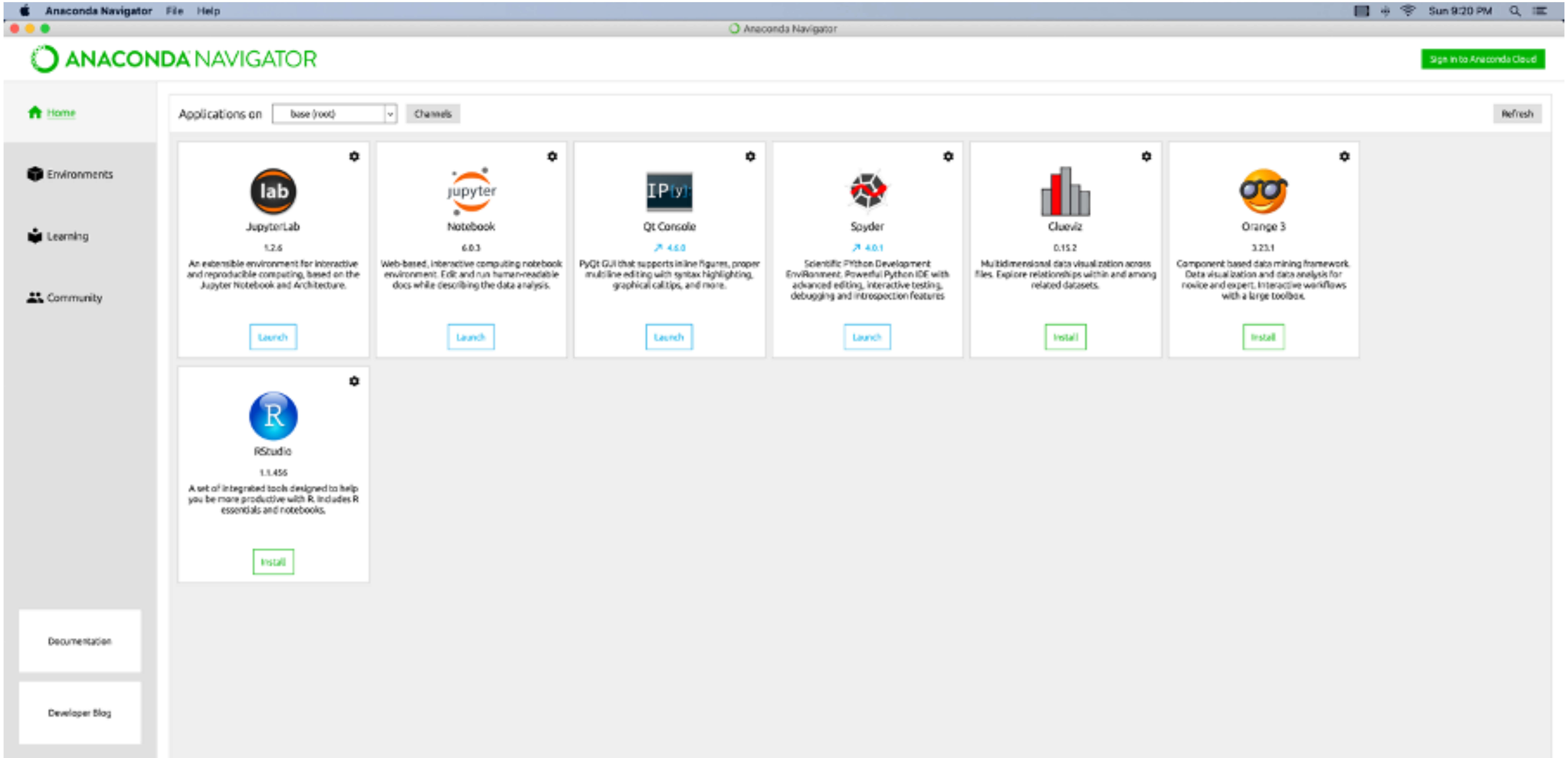
Linux

Python 3.8

64-Bit (x86) Installer (550 MB)

64-Bit (Power8 and Power9) Installer (290 MB)

Anaconda Navigation



JupyterLab
1.2.6
An extensible environment for interactive and reproducible computing, based on the Jupyter Notebook and Architecture.

Notebook
6.0.3
Web-based, interactive computing notebook environment. Edit and run human-readable docs while describing the data analysis.

Qt Console
↗ 4.6.0
PyQt GUI that supports inline figures, proper multiline editing with syntax highlighting, graphical calltips, and more.

Spyder
↗ 4.0.1
Scientific PYthon Development EnviRonment. Powerful Python IDE with advanced editing, interactive testing, debugging and introspection features

Glueviz
0.15.2
Multidimensional data visualization across files. Explore relationships within and among related datasets.

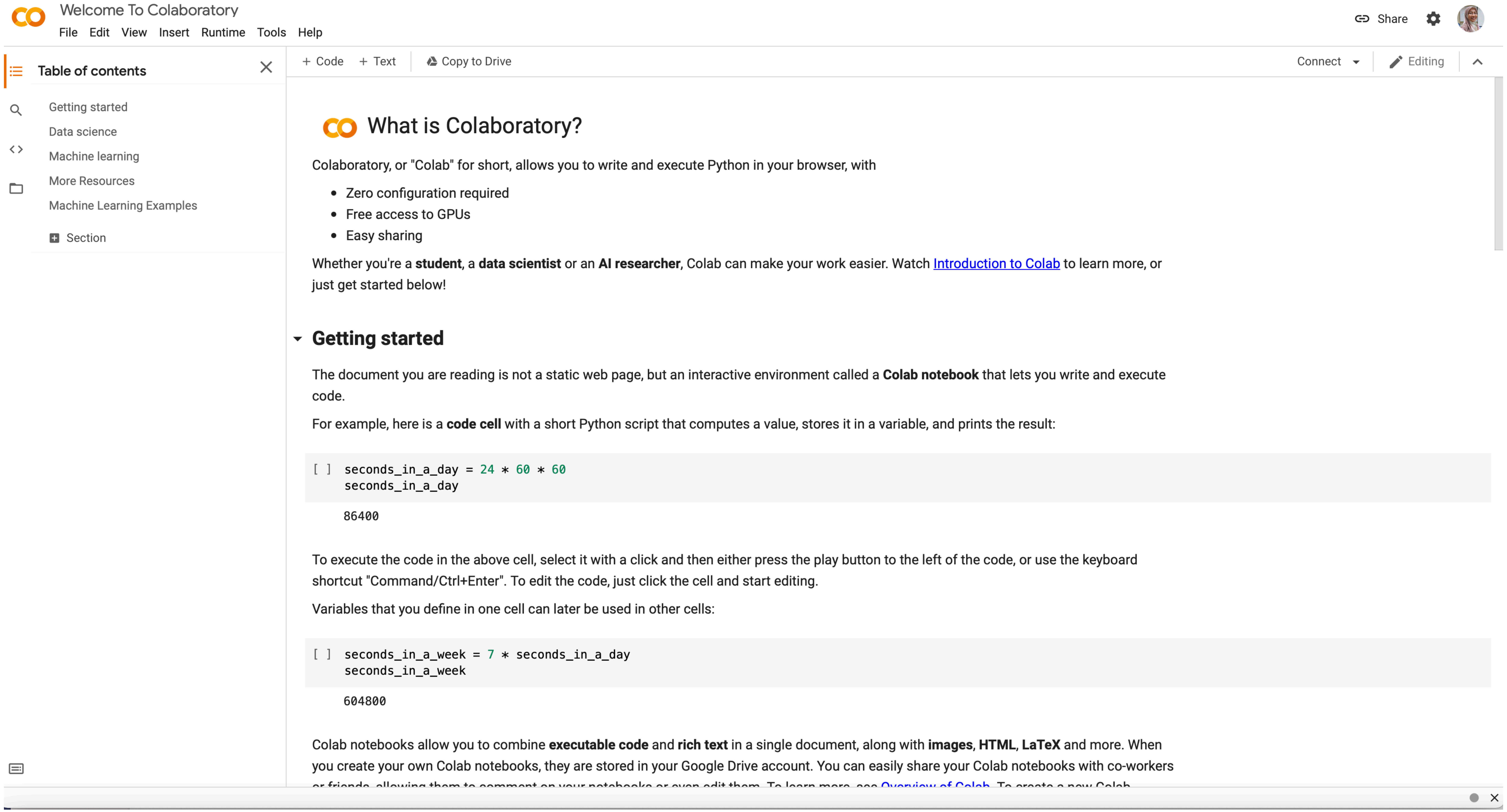
Orange 3
3.23.1
Component based data mining framework. Data visualization and data analysis for novice and expert. Interactive workflows with a large toolbox.

RStudio
1.1.456
A set of integrated tools designed to help you be more productive with R. Includes R essentials and notebooks.

Another solution to use Python without installation?

Google Colab (powered by Google)

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



What is Colaboratory?

Colaboratory, or "Colab" for short, allows you to write and execute Python in your browser, with

- Zero configuration required
- Free access to GPUs
- Easy sharing

Whether you're a **student**, a **data scientist** or an **AI researcher**, Colab can make your work easier. Watch Introduction to Colab to learn more, or just get started below!

Getting started

The document you are reading is not a static web page, but an interactive environment called a **Colab notebook** that lets you write and execute code.

For example, here is a **code cell** with a short Python script that computes a value, stores it in a variable, and prints the result:

```
[ ] seconds_in_a_day = 24 * 60 * 60
    seconds_in_a_day

    86400
```

To execute the code in the above cell, select it with a click and then either press the play button to the left of the code, or use the keyboard shortcut "Command/Ctrl+Enter". To edit the code, just click the cell and start editing.

Variables that you define in one cell can later be used in other cells:

```
[ ] seconds_in_a_week = 7 * seconds_in_a_day
    seconds_in_a_week

    604800
```

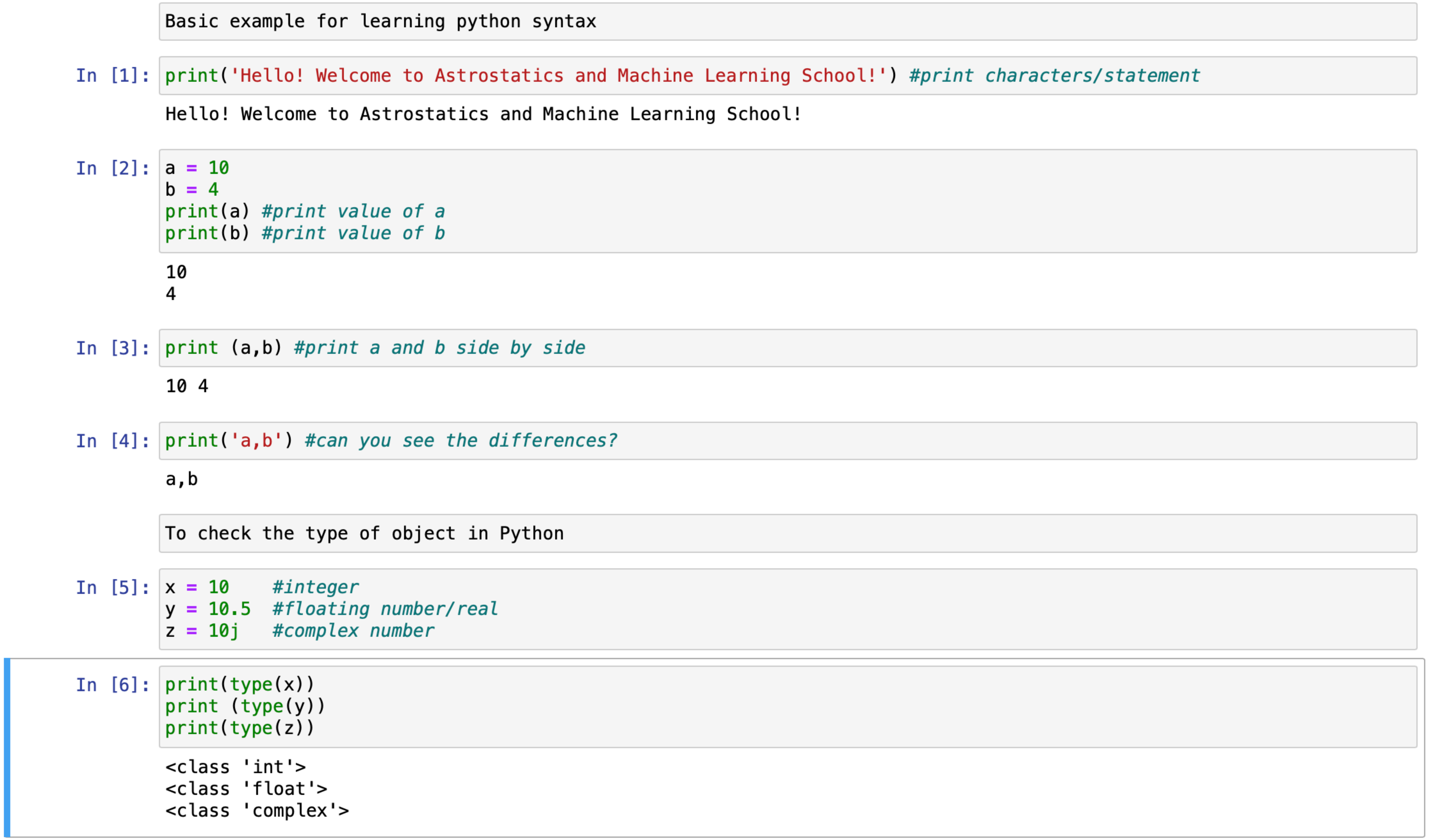
Colab notebooks allow you to combine **executable code** and **rich text** in a single document, along with **images**, **HTML**, **LaTeX** and more. When you create your own Colab notebooks, they are stored in your Google Drive account. You can easily share your Colab notebooks with co-workers or friends, allowing them to comment on your notebooks or even edit them. To learn more, see Overview of Colab. To create a new Colab

Introduction to Python

Basic information

- In programming numbers/values must be assigned by variable. We use “=” to connect values to a variable.
- Numbers/values can be either integer or real (floating number)
- In Python 3.0, all numbers are considered real unless we declared or set its identity.
- Python 3.0 can handle complex number and assign the complex number value as *j* instead of *i*.
- Python command for different type of numbers : integer (int), real (float), complex (complex)
- To produce output on your screen, use command print()

Introduction to Python



Basic example for learning python syntax

```
In [1]: print('Hello! Welcome to Astrostatics and Machine Learning School!') #print characters/statement
```

```
Hello! Welcome to Astrostatics and Machine Learning School!
```

```
In [2]: a = 10
        b = 4
        print(a) #print value of a
        print(b) #print value of b
```

```
10
4
```

```
In [3]: print (a,b) #print a and b side by side
```

```
10 4
```

```
In [4]: print('a,b') #can you see the differences?
```

```
a,b
```

To check the type of object in Python

```
In [5]: x = 10    #integer
        y = 10.5  #floating number/real
        z = 10j   #complex number
```

```
In [6]: print(type(x))
        print (type(y))
        print(type(z))
```

```
<class 'int'>
<class 'float'>
<class 'complex'>
```

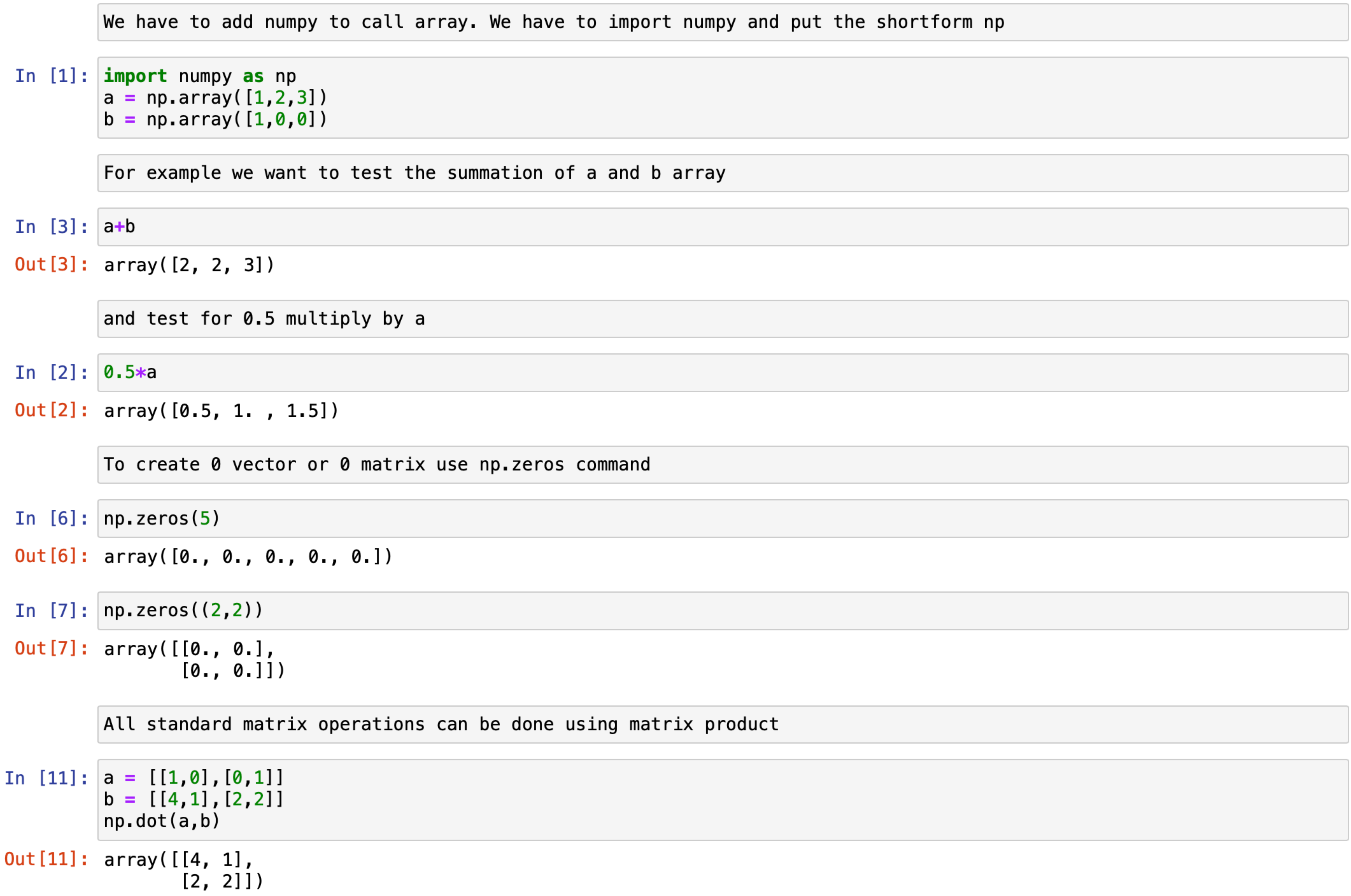
Introduction to Python

Basic Mathematical Operations

Operator	Description	Example
+	Addition	a+b
-	Substraction	a-b
*	Multiplication	a*b
/	Division	a/b
**	Power	a**b
>	Greater than	a>b
<	Lower than	a<b
>=	Equal and greater than	a>=b
<=	Less and less than	A<=b

Example

Mathematical operations



We have to add numpy to call array. We have to import numpy and put the shortform np

```
In [1]: import numpy as np
        a = np.array([1,2,3])
        b = np.array([1,0,0])
```

For example we want to test the summation of a and b array

```
In [3]: a+b

Out[3]: array([2, 2, 3])
```

and test for 0.5 multiply by a

```
In [2]: 0.5*a

Out[2]: array([0.5, 1. , 1.5])
```

To create 0 vector or 0 matrix use np.zeros command

```
In [6]: np.zeros(5)

Out[6]: array([0., 0., 0., 0., 0.])

In [7]: np.zeros((2,2))

Out[7]: array([[0., 0.],
               [0., 0.]])
```

All standard matrix operations can be done using matrix product

```
In [11]: a = [[1,0],[0,1]]
         b = [[4,1],[2,2]]
         np.dot(a,b)

Out[11]: array([[4, 1],
                [2, 2]])
```

Introduction to Python

Mathematical function

- To call mathematical functions, we need numpy

- Numpy provides a high-performance multi-D array and basic tools to compute and manipulate array

- In python, all trigonometry values are in radian

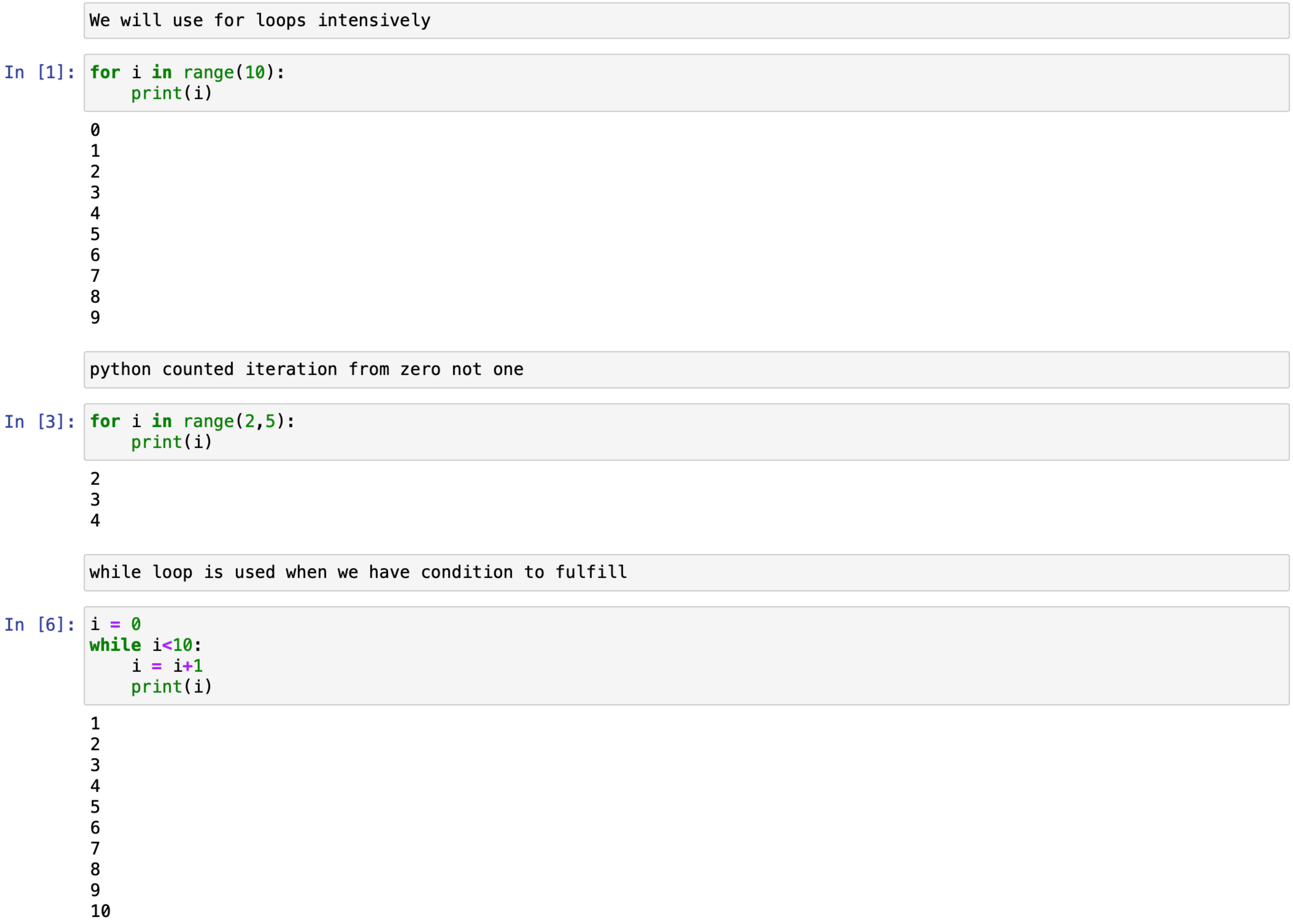
- Example to write $\sin(2\pi)$ using numpy

```
import numpy as np
A = np.sin(2*np.pi)
```

log()	sin()	cos()	tan()
pi	round	sqrt	truncate
absolute	exp	array	degree

Introduction to Python

Loops



```
We will use for loops intensively
```

In [1]:
```
for i in range(10):
    print(i)
```

```
0
1
2
3
4
5
6
7
8
9
```

```
python counted iteration from zero not one
```

In [3]:
```
for i in range(2,5):
    print(i)
```

```
2
3
4
```

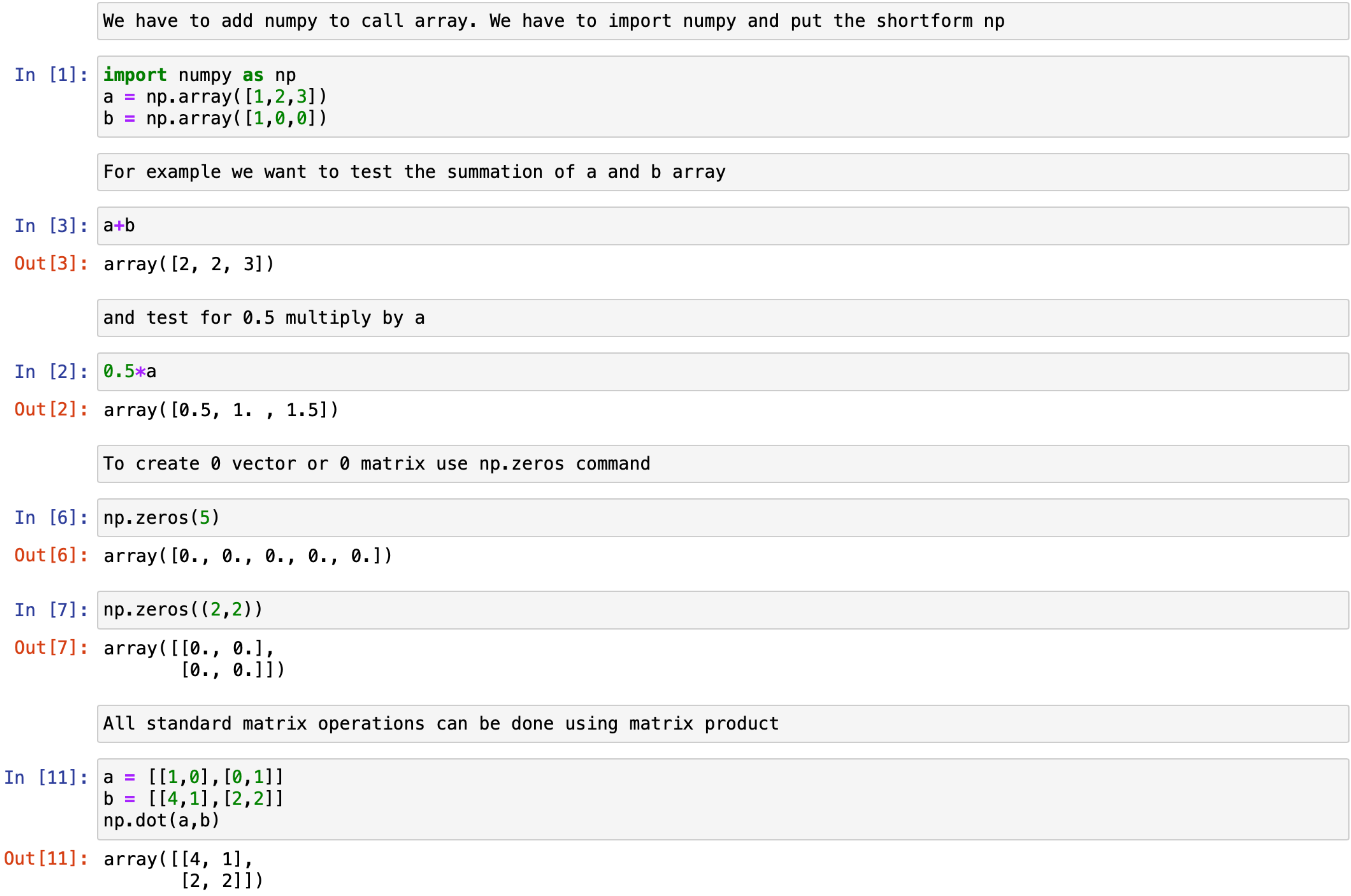
```
while loop is used when we have condition to fulfill
```

In [6]:
```
i = 0
while i<10:
    i = i+1
    print(i)
```

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

Introduction to Python

Arrays, Vectors and Matrices



We have to add numpy to call array. We have to import numpy and put the shortform np

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

For example we want to test the summation of a and b array

```
In [3]: a+b

Out[3]: array([2, 2, 3])
```

and test for 0.5 multiply by a

```
In [2]: 0.5*a

Out[2]: array([0.5, 1. , 1.5])
```

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In [7]: np.zeros((2,2))

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```

All standard matrix operations can be done using matrix product

```
In [11]: a = [[1,0],[0,1]]
         b = [[4,1],[2,2]]
         np.dot(a,b)

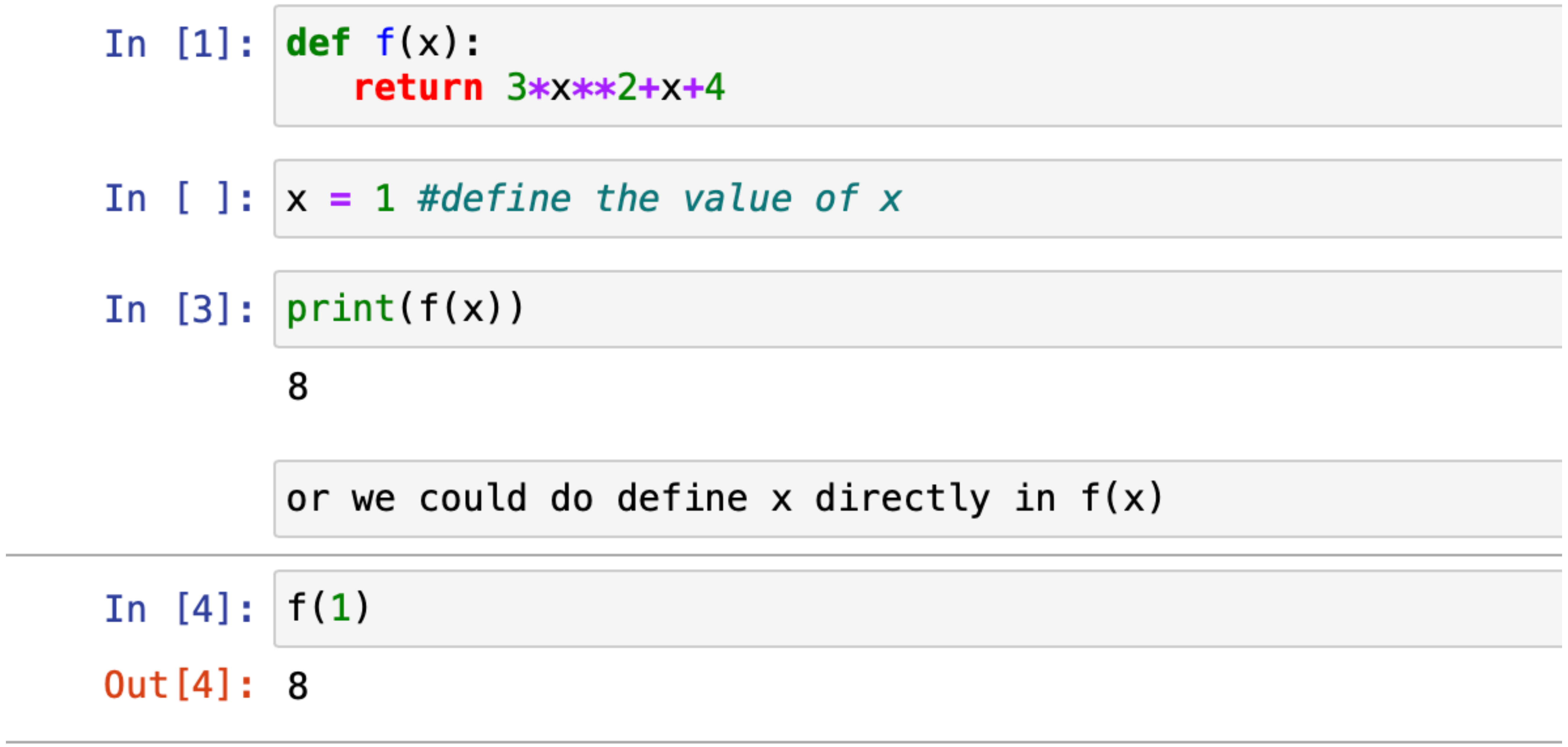
Out[11]: array([[4, 1],
                [2, 2]])
```

Introduction to Python

User defined function

We have to define our own functions. For example let us define a function :

$$f(x) = 3x^2 + x + 4$$



```
In [1]: def f(x):
            return 3*x**2+x+4

In [ ]: x = 1 #define the value of x

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

        8
```

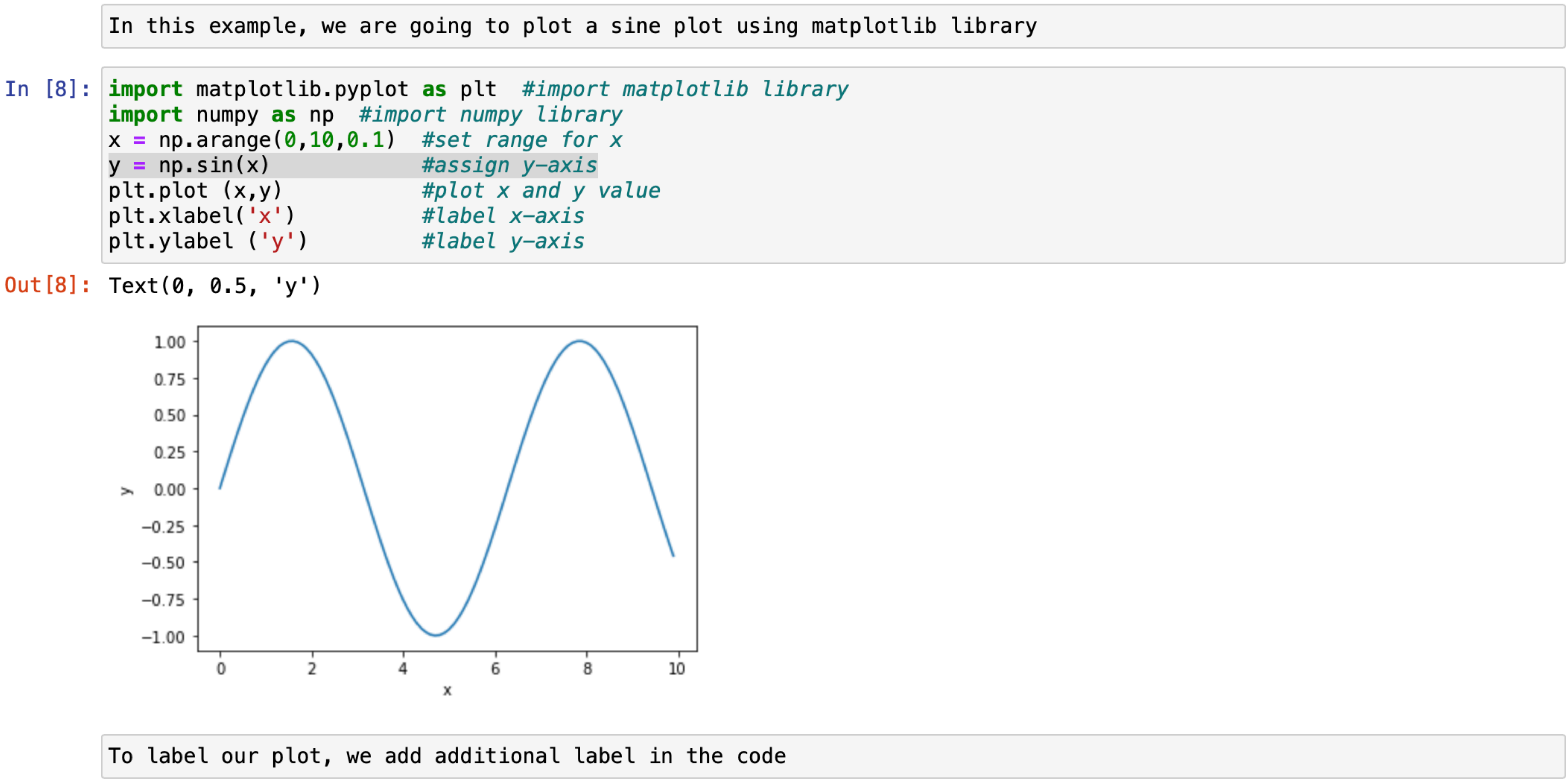
or we could do define x directly in f(x)

```
In [4]: f(1)

Out[4]: 8
```

Visualisation/Making plots

We will use Matplotlib package to create plots



In this example, we are going to plot a sine plot using matplotlib library

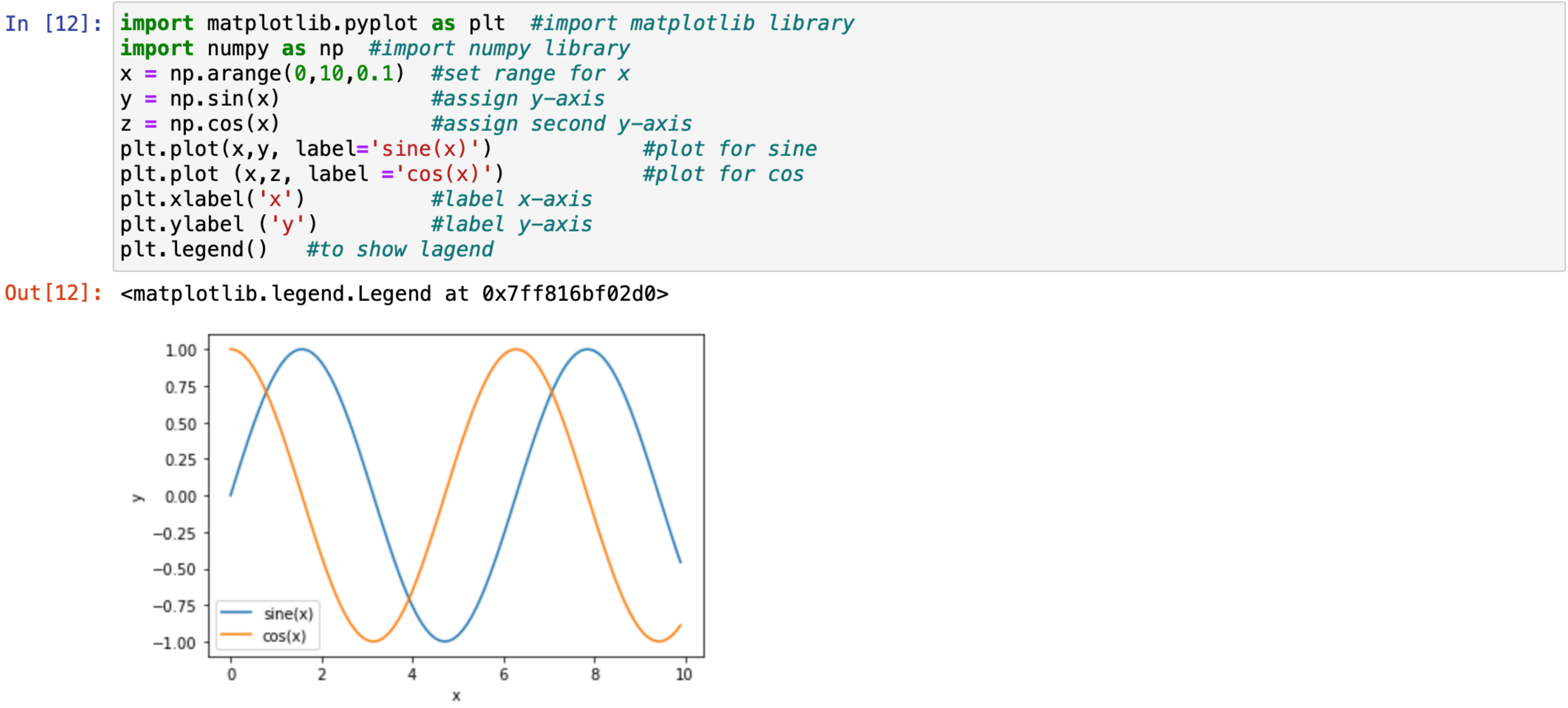
```
In [8]: import matplotlib.pyplot as plt  #import matplotlib library
        import numpy as np  #import numpy library
        x = np.arange(0,10,0.1)  #set range for x
        y = np.sin(x)            #assign y-axis
        plt.plot (x,y)           #plot x and y value
        plt.xlabel('x')          #label x-axis
        plt.ylabel ('y')         #label y-axis
```

```
Out[8]: Text(0, 0.5, 'y')
```

To label our plot, we add additional label in the code

Introduction to Python

Plotting two function in one graph



```
In [12]: import matplotlib.pyplot as plt  #import matplotlib library
         import numpy as np  #import numpy library
         x = np.arange(0,10,0.1)  #set range for x
         y = np.sin(x)            #assign y-axis
         z = np.cos(x)            #assign second y-axis
         plt.plot(x,y, label='sine(x)')            #plot for sine
         plt.plot (x,z, label ='cos(x)')           #plot for cos
         plt.xlabel('x')          #label x-axis
         plt.ylabel ('y')         #label y-axis
         plt.legend()  #to show lagend

Out[12]: <matplotlib.legend.Legend at 0x7ff816bf02d0>
```

All codes available in https://github.com/lizayusof/IVC_Astrostat_ML