Chapter 3 : Introduction to Numpy

NumPy or Numerical Python is an open-source Python library that contains universal standard of numerical data. It is also handling matrix data structure and multiarray data which are often used in scientific computing. Numpy can be used simultaneously with other Python libraries like Matplotlib (for plotting), scipy (Scientific Python handles more complicated numerical calculation like integration routine) and pandas (data array library that can convert list of data into arrays).

Numpy Installation

If you have installed Python using Anaconda, Numpy should be part of the package. If there is no numpy in your Python distribution, you can install it using either pip or conda

```
pip install numpy
```

or

```
conda install numpy
```

How to use Numpy

To use Numpy, we need to import the library in our code:

```
import numpy as np
```

The short name of np is a universal term used to import numpy because it is easy to recognize if you are working in collaborative mode. In this chapter, I will introduce common numpy usage in scientific computing.

3.1 Mathematical function/operator

- Several mathematical function in python requires to call numpy library like trigonometry function, exponential function or square root function. Below shown in the table how we call these function in Python.

Operator/functions	Command
sin(x)	np.sin(x)
cos(x)	np.cos(x)
tan(x)	np.tan(x)
exp(x)	np.exp(x)
sqrt(x)	np.sqrt(x)
log(x)	np.log(x)
pi	np.pi

- Note that in Python, np.py is in radian not degree.

3.2 Code block

- One powerful usage in numpy is it can replace if block. One of the common commands to deal with code block using python is arange command.

- Example:

```
1 import numpy as np
2
3 x = np.arange(10)
4 print(x)
5
```

Output:

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

- Note that your output is now in square bracket, not in the list from top to bottom.
- The square bracket represents a list where the data can be expanded and more compact compared to list.
- If your data in normal bracket (), this is called tuple in Python.
- In Chapter 4, we shall learn that to plot any point using Matplotlib, the data must be in list form instead of tuple. Otherwise, no line will be plotted.
- We can find the length of x by using command np.len(x) to find the size of x. This is useful to check the length of your data consistent with the output.

- Another common command for code block is linspace.

```
1 import numpy as np
2
3 x = np.linspace(0,10,10)
4 print(x)
5
```

end point

number of points

starting point

This will produce an output:

```
[ 0.          1.11111111  2.22222222  3.33333333  4.44444444  5.55555556
  6.66666667  7.77777778  8.88888889 10.        ]
```

3.3 Arrays

- In scientific computing, arrays is important especially dealing with multi-dimensional data and in mathematics or physics, we used a lot of array function to solve linear equations.

- To define an array, command np.array is used. Example :

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

Output: `[1 2 3]`

- Numpy array can be illustrated like this:

source : https://numpy.org/doc/1.26/user/absolute_beginners.html

- We can try to solve simple 2 x 2 matrix addition using np.array

$$\begin{bmatrix} 1 & 2 \\ 3 & 4 \end{bmatrix} + \begin{bmatrix} 1 & 1 \\ 1 & 1 \end{bmatrix}$$

```
1  import numpy as np
2
3  a = np.array([[1, 2], [3, 4]])
4  b = np.array([[1, 1], [1, 1]])
5
6  x = a+b
7  print(x)
8
```

Output:

```
[[2 3]
 [4 5]]
```