Applied Data Science with Python

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Python Libraries for Data Science

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Learning Objectives

By the end of this lesson, you will be able to:

- Explain the use of Python library
- List various Python libraries
- Identify the SciPy sub-packages
- Describe web scraping with BeautifulSoup

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Python Libraries for Data Science

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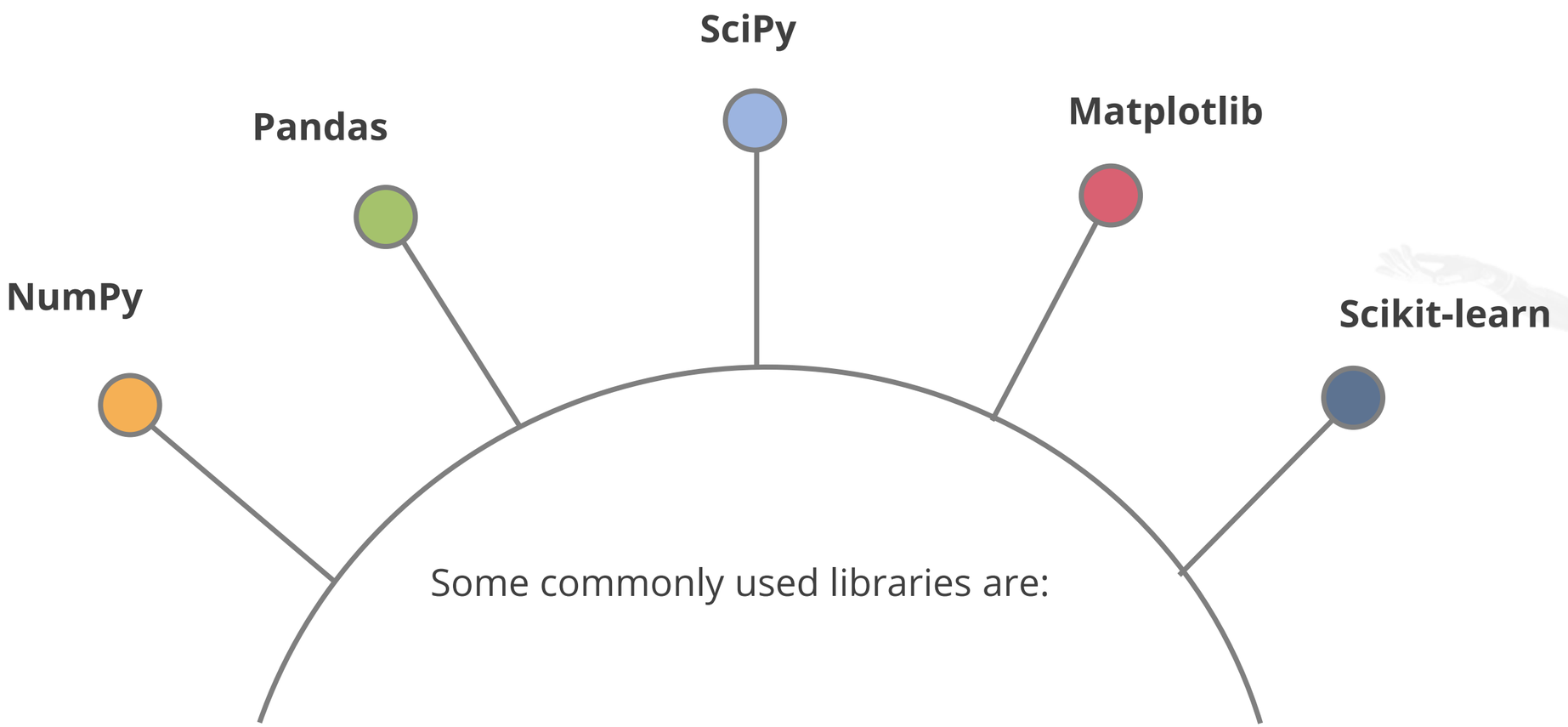
What Is Python Library?

A Python library is a group of interconnected modules. It contains code bundles that can be reused in different programs and apps.

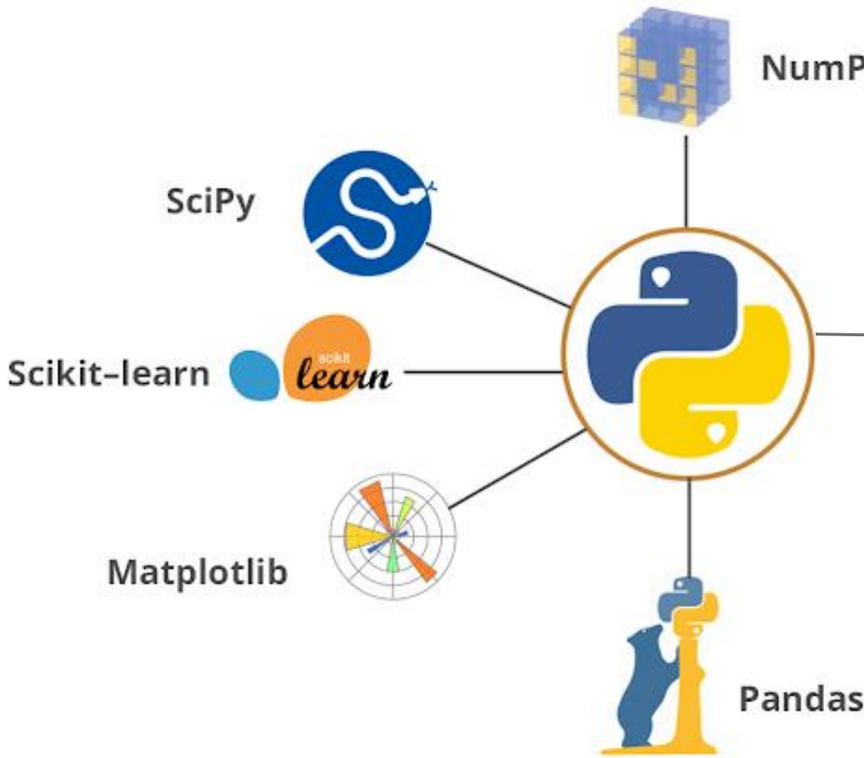
Python programming is made easier and more convenient for programmers due to its reusability.

Python Libraries

Various other Python libraries make programming easier.

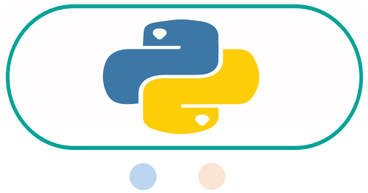


Benefits of Python Libraries



- Easy to learn
- Open source
- Efficient and multi-platform support
- Huge collection of libraries, functions, and modules
- Big open-source community
- Integrates well with enterprise apps and systems
- Great vendor and product support

Python Libraries: NumPy and Pandas



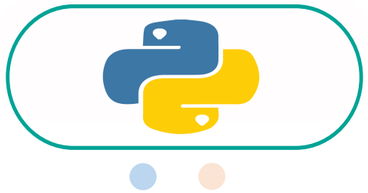
01

NumPy: Numerical Python is a machine learning library that can handle big matrices and multi-dimensional data.

02

Pandas: Pandas consist of a variety of analysis tools and configurable high-level data structures.

Python Libraries: SciPy and Matplotlib



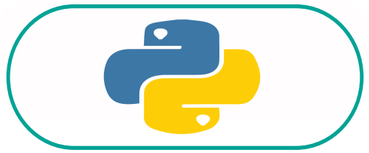
03

SciPy: Scientific Python is an open-source high-level scientific computation package. This library is based on a NumPy extension.

04

Matplotlib: It is also an open-source library that plots high-definition figures such as pie charts, histograms etc.

Python Libraries: Scikit-Learn



05

Scikit-learn: The library contains a lot of efficient tools for machine learning and statistical modeling including classification, regression, clustering, and dimensionality reduction.

Import Library into Python Program

Import Module in Python

In Python, a file is referred to as a module. The **import** keyword is used to utilize it.

Whenever we need to use a module, we import it from its library.

Example

Importing math library

import math

Example: Import Module in Python

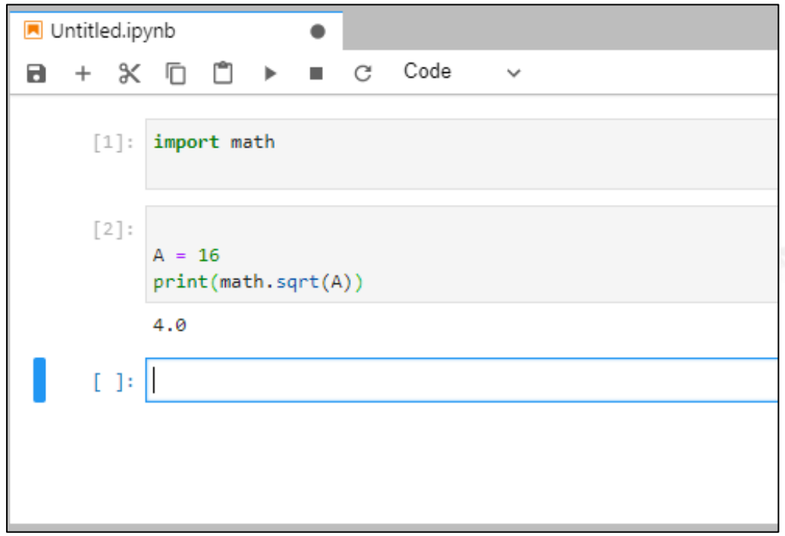
In this code, the math library is imported. One of its methods, that is sqrt(square root), is used without writing the actual code to calculate the square root of a number.

Example:

```
import math

A = 16
print(math.sqrt(A))
```

Output:



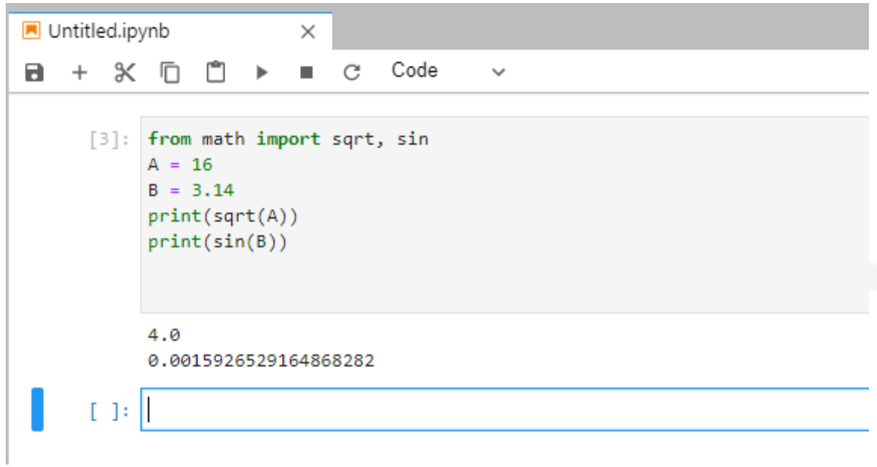
Example: Import Module in Python

As in the previous code, a complete library is imported to use one of its methods. However, only importing “sqrt” from the math library would have worked.

Example:

```
from math import
sqrt, sin
A = 16
B = 3.14
print(sqrt(A))
print(sin(B))
```

Output:



In the above code, only “sqrt” and “sin” methods from the math library are imported.

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NumPy

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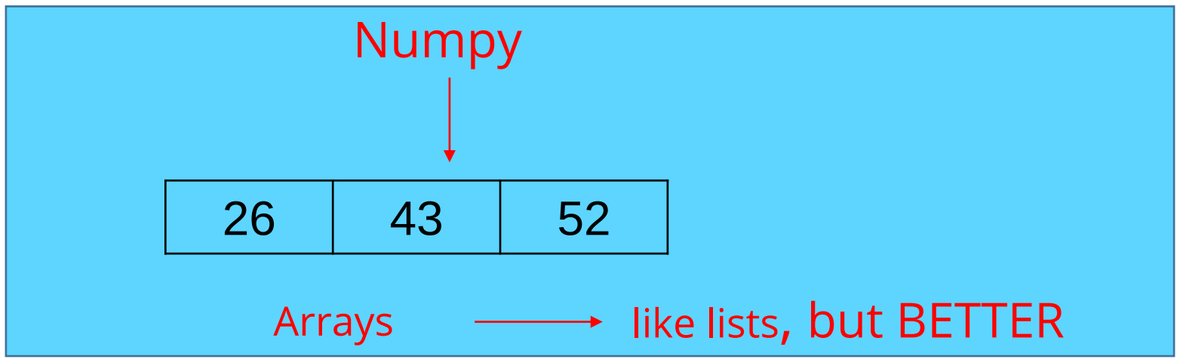
NumPy

NumPy (Numerical Python) is a library that consists of multidimensional array objects and a collection of functions for manipulating them.

NumPy conducts mathematical and logical operations on arrays.

Why NumPy

Numerical Python (NumPy) supports multidimensional arrays over which mathematical operations can be easily applied.




```
distance=[10,15,17,26]
time=[.30,.47,.55,1.20]
```

```
import numpy as np
```

Import NumPy

```
np_distance = np.array(distance)
np_time=np.array(time)
speed=np_distance/np_time
```

Create “distance” and “time” NumPy arrays

Mathematical function applied over the entire “distance” and “time” arrays

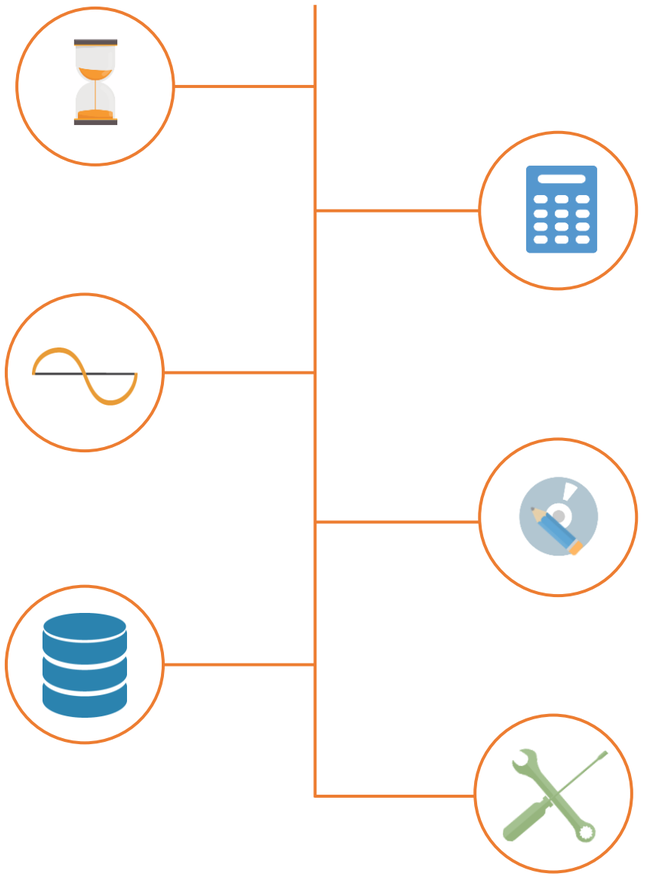
```
speed
```

```
array([ 33.33333333,  31.91489362,  30.90909091,  21.66666667])
```

NumPy Overview

NumPy is the foundational package for mathematical computing in Python.
It has the following properties:

- Supports fast and efficient multidimensional arrays (ndarray)
- Performs linear algebraic operations, Fourier transforms, and random number generation
- An efficient way of storing and manipulating data



- Executes element-wise computations and mathematical calculations
- Tools for reading/writing array-based datasets to disk
- Tools for integrating language codes (C, C++)

Functions of NumPy Module

S.No	NumPy Module	Functions
1	NumPy array manipulation functions	numpy.reshape() numpy.concatenate() numpy.shape()
2	NumPy string functions	numpy.char.add() numpy.char.replace() numpy.char.upper() and numpy.char.lower()
3	NumPy arithmetic functions	numpy.add() numpy.subtract() numpy.mod() and numpy.power()
4	NumPy statistical functions	numpy.median() numpy.mean() numpy.average()

There are three types of facts:

NumPy Function: Example 1

To access NumPy and its functions, import it in the Python code as shown below:

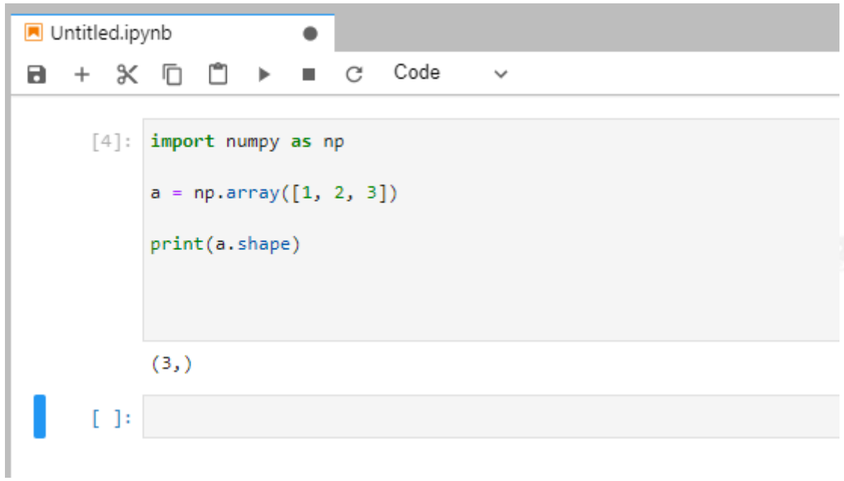
Example:

```
import numpy as np

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

print(a.shape)
```

Output:



In this example, the NumPy module is imported and the shape function is used.

NumPy Function: Example 2

To access NumPy and its functions, import it in the Python code as shown below:

Example:

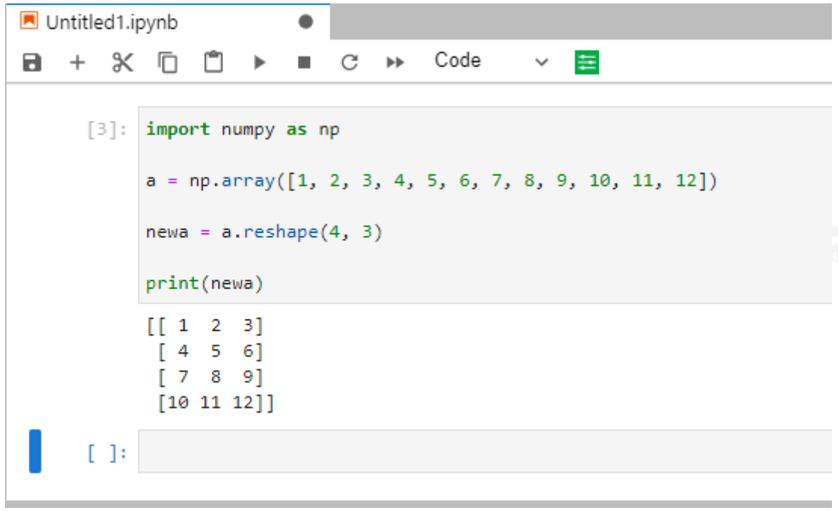
```
import numpy as np

a = np.array([1, 2, 3, 4, 5,
6, 7, 8, 9, 10, 11, 12])

newa = a.reshape(4, 3)

print(newa)
```

Output:



In this example, the NumPy module is imported and the reshape function is used.

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Pandas

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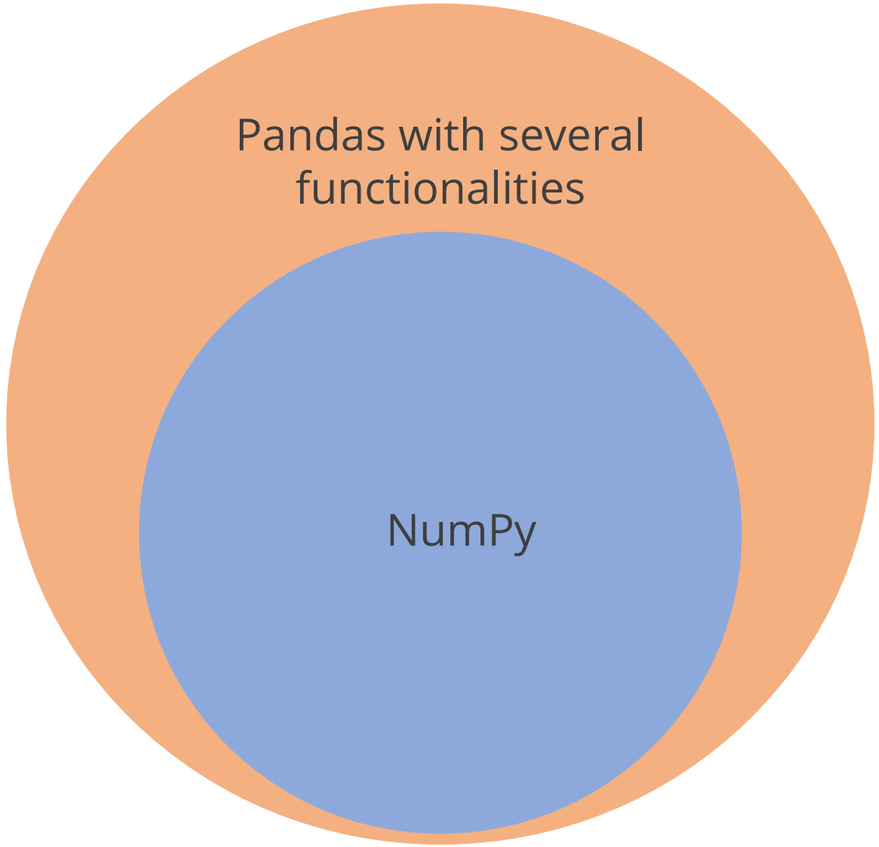
Pandas

Pandas is a Python package that allows you to work with large datasets.

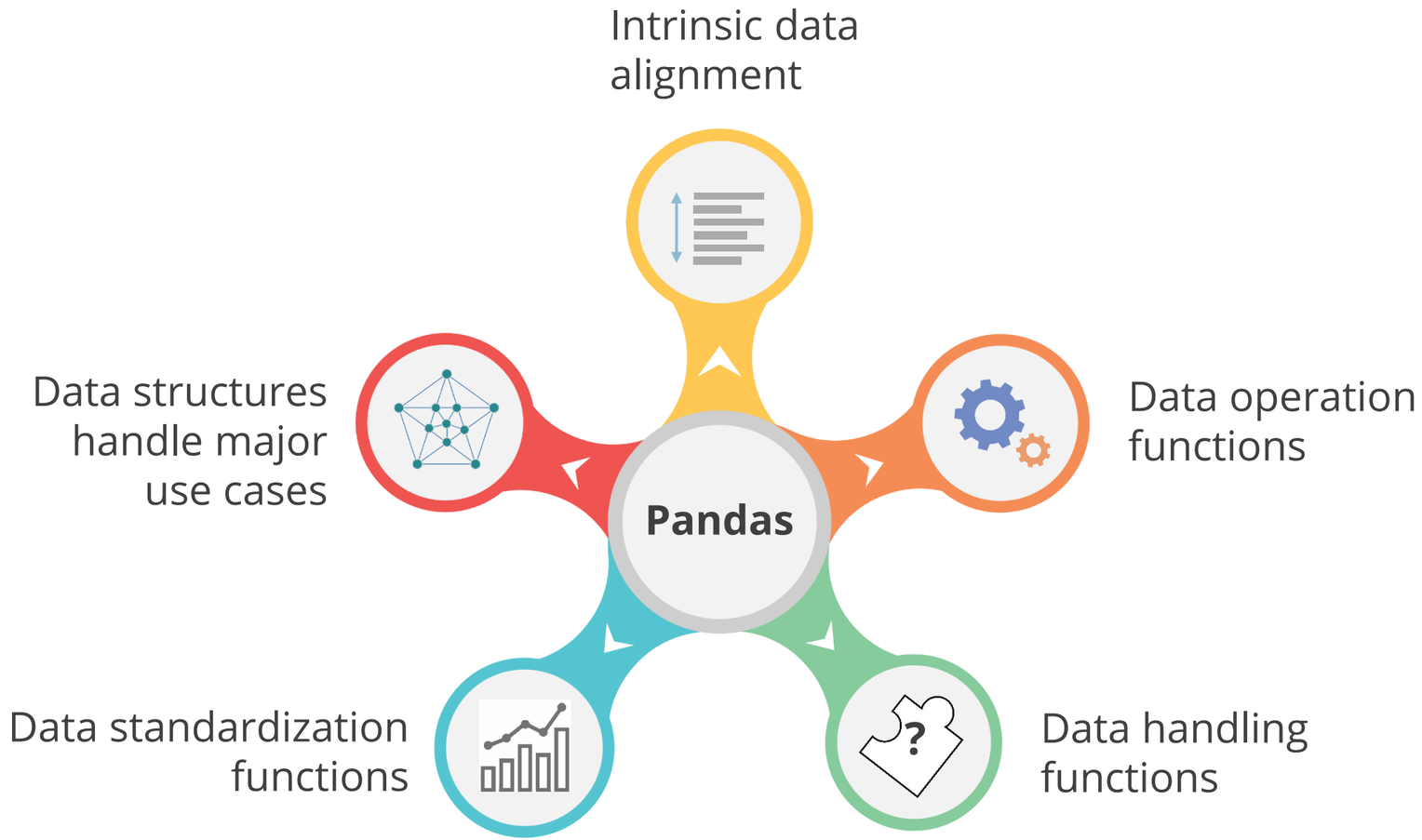
It offers tools for data analysis, cleansing, exploration, and manipulation.

Why Pandas

NumPy is great for mathematical computing, but why do we need pandas?

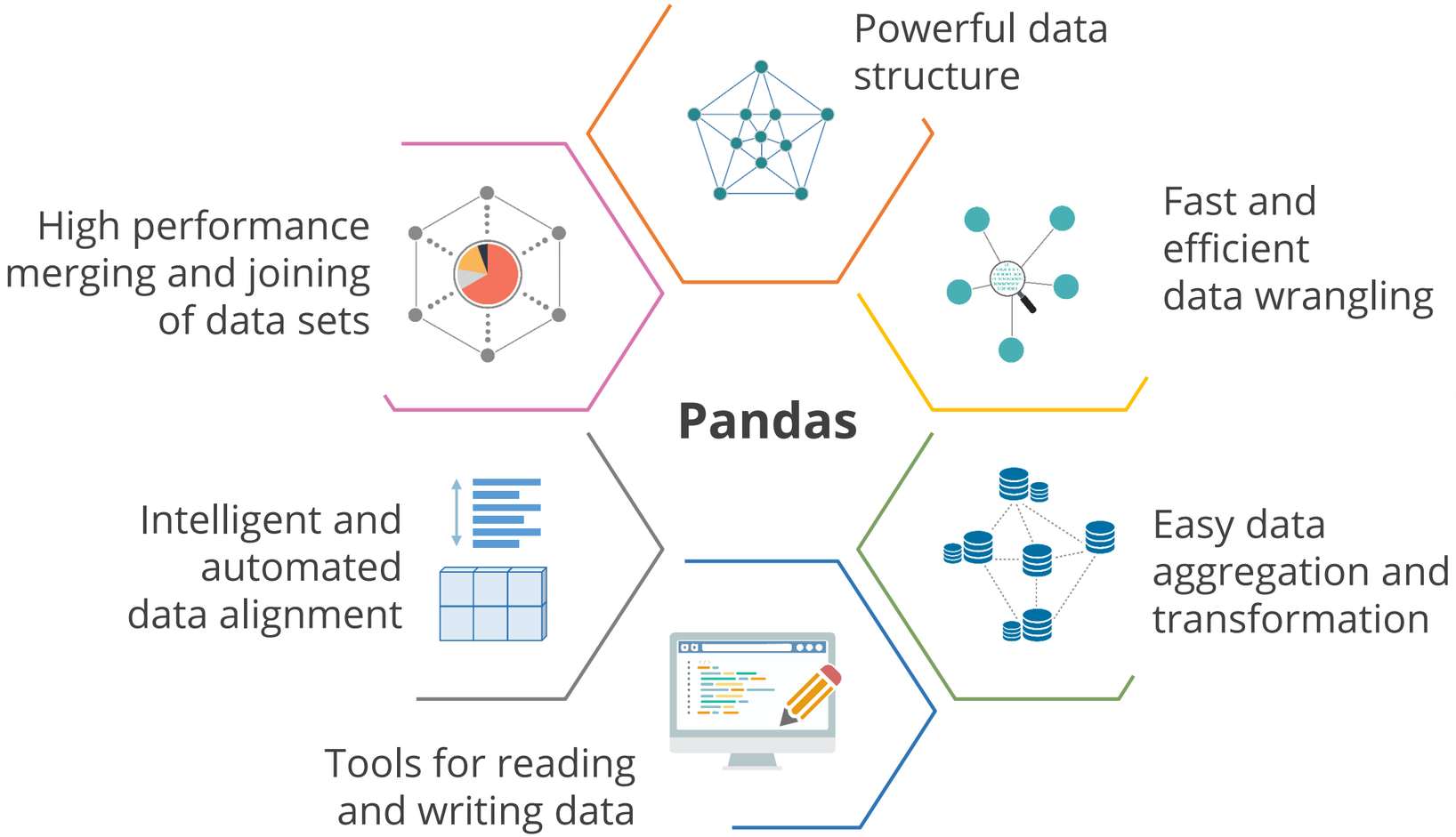


Why Pandas



Features of Pandas

The various features of pandas make it an efficient library for data scientists.



Data Structures

The four main libraries of pandas data structure are:

- **One**-dimensional labeled array
- Supports multiple data types

Series

Data Frame

- **Two**-dimensional labeled array
- Supports multiple data types
- Input can be a series
- Input can be another Data Frame

- **Three**-dimensional labeled array
- Supports multiple data types
- Items → axis 0
- Major axis → rows
- Minor axis → columns

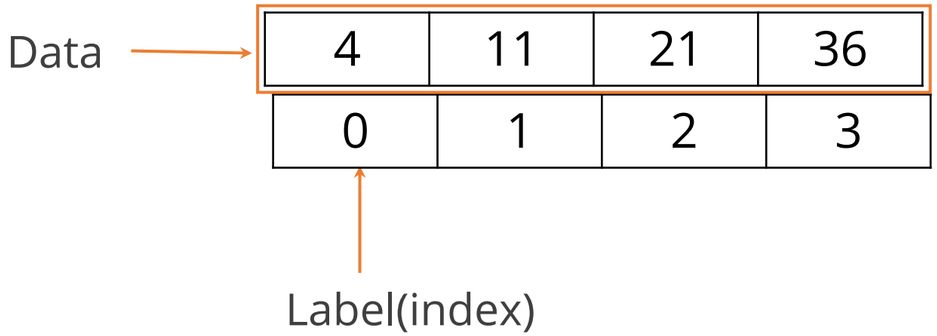
Panel

Panel 4D (Experimental)

- **Four-**dimensional labeled array
- Supports multiple data types
- Labels → axis 0
- Items → axis 1
- Major axis → rows
- Minor axis → columns

Understanding Series

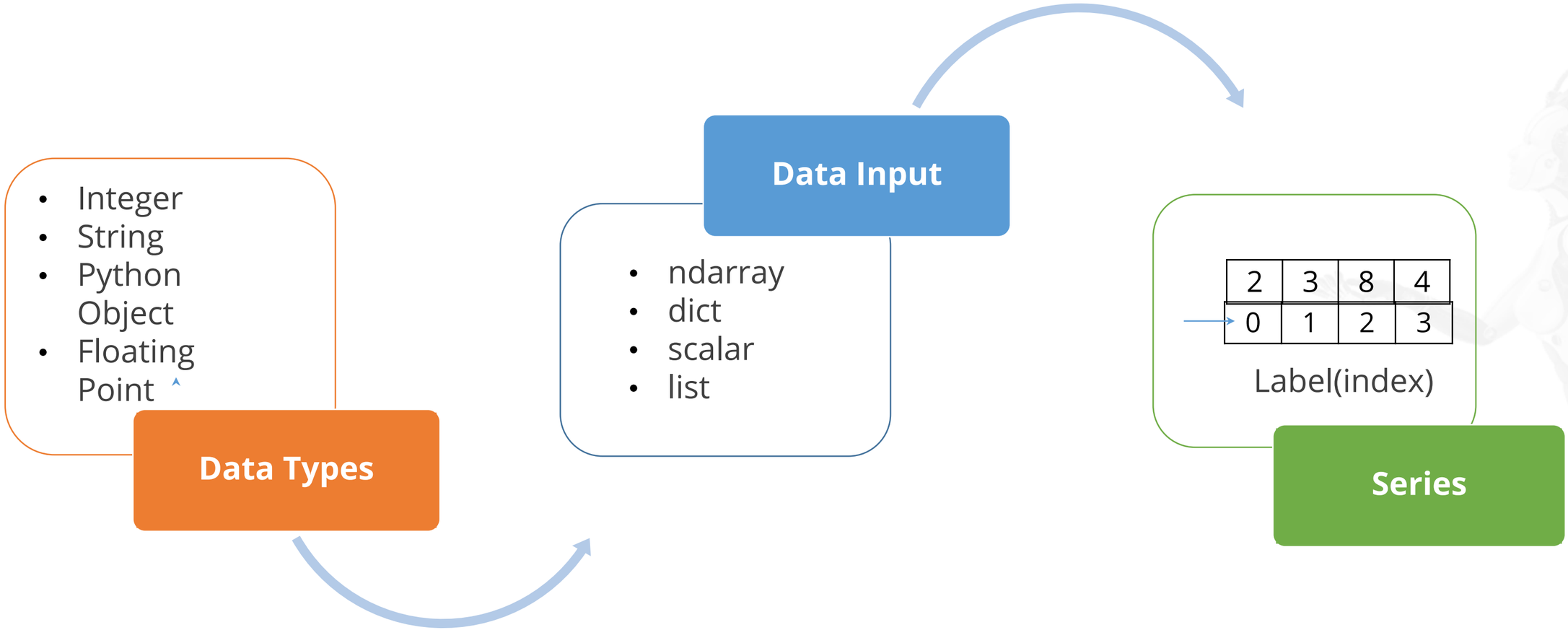
Series is a one-dimensional array-like object containing data and labels (or index).



Data alignment is intrinsic and will not be broken until changed explicitly by program.

Series

Series can be created with different data inputs:



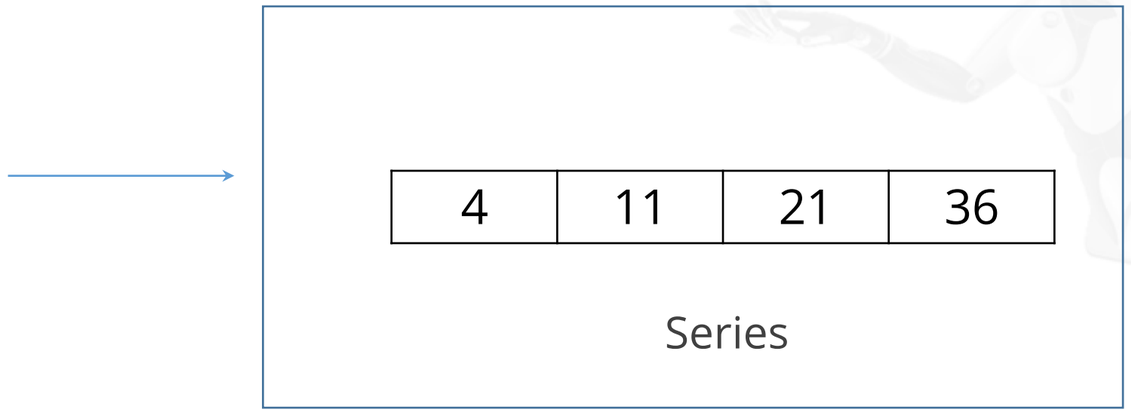
How to Create Series?

Key points to note while creating a series are:

- Import Pandas as it is the main library (Import pandas as pd)
- Import NumPy while working with ndarrays (Import numpy as np)
- Apply the syntax and pass the data elements as arguments

Basic Method

S = pd.Series(data, index = [index])



Creating Series from a List

```
In [14]: import numpy as np
         import pandas as pd

In [15]: first_series = pd.Series(list('abcdef'))

In [16]: print (first_series)

0    a
1    b
2    c
3    d
4    e
5    f
dtype: object
```

Import libraries

Pass list as an argument

Index

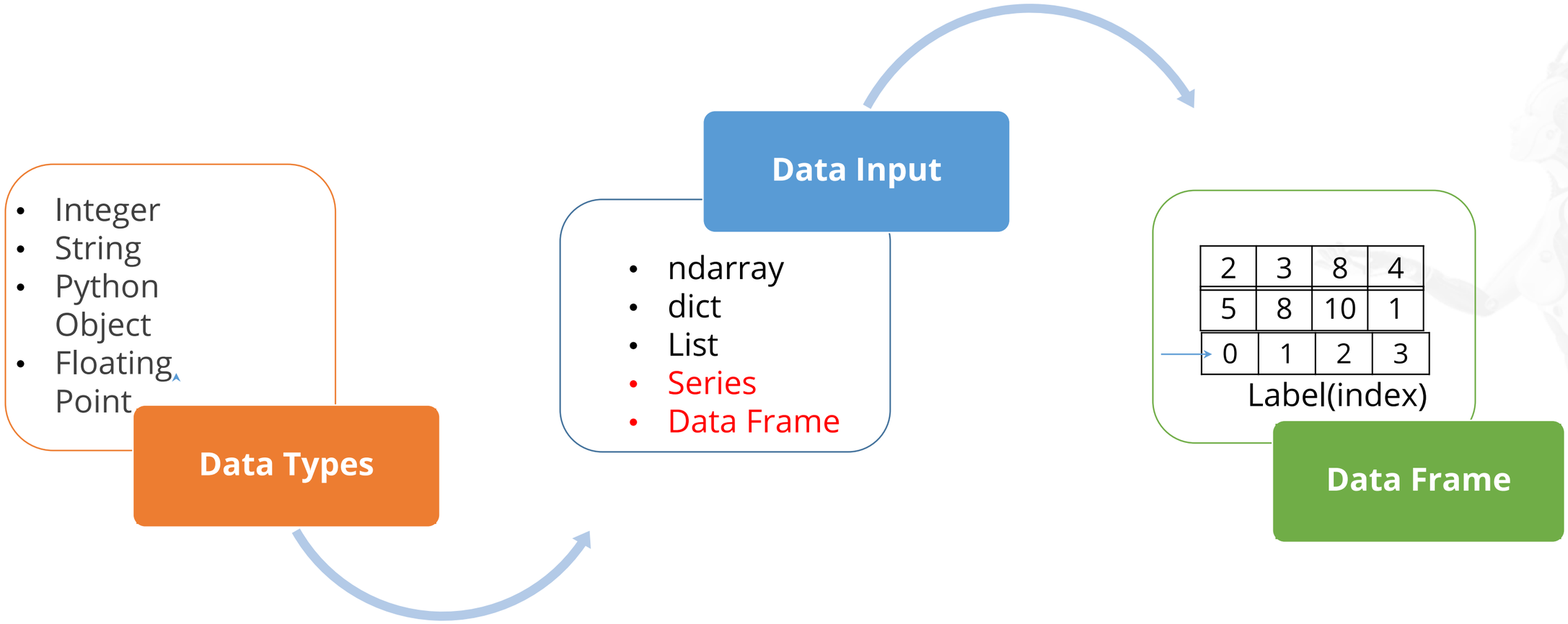
Data value

Data type

The index is not created for data but notices that data alignment is done automatically.

Data Frame

Data Frame is a two-dimensional labeled data structure with columns of potentially different types.



Creating Data Frame from Lists

```
In [1]: import pandas as pd
```

Create DataFrame from dict of equal length lists

```
In [2]: #last five olymnics data: place, year and number of countries participated
olympic_data_list = {'HostCity':['London','Beijing','Athens','Sydney','Atlanta'],
                     'Year':[2012,2008,2004,2000,1996],
                      'No. of Participating Countries':[205,204,201,200,197]
                     }
```

```
In [3]: df_olympic_data = pd.DataFrame(olympic_data_list)
```

Pass the list to the DataFrame

```
In [4]: df_olympic_data
```

Out[4]:

	HostCity	No. of Participating Countries	Year
0	London	205	2012
1	Beijing	204	2008
2	Athens	201	2004
3	Sydney	200	2000
4	Atlanta	197	1996

Creating Data Frame from dict

This example shows how to create a Data Frame from a series of dicts.

Create DataFrame from dict of dicts

dict one

dict two

```
In [5]: olympic_data_dict = {'London':{2012:205},'Beijing':{2008:204}}

In [6]: df_olympic_data_dict = pd.DataFrame(olympic_data_dict)

In [7]: df_olympic_data_dict
```

Entire dict

Out[7]:

	Beijing	London
2008	204	NaN
2012	NaN	205

Viewing Data Frame

A Data Frame can be viewed by referring to the column names or using the describe function.

```
In [8]: #select by City name
        df_olympic_data.HostCity
```

```
Out[8]: 0     London
        1    Beijing
        2     Athens
        3     Sydney
        4    Atlanta
        Name: HostCity, dtype: object
```

```
In [9]: #use describe function to display the content
        df_olympic_data.describe
```

```
Out[9]: <bound method DataFrame.describe of   HostCity  No. of Participating Countries  Year
        0   London                          205  2012
        1  Beijing                          204  2008
        2   Athens                          201  2004
        3   Sydney                          200  2000
        4  Atlanta                          197  1996>
```

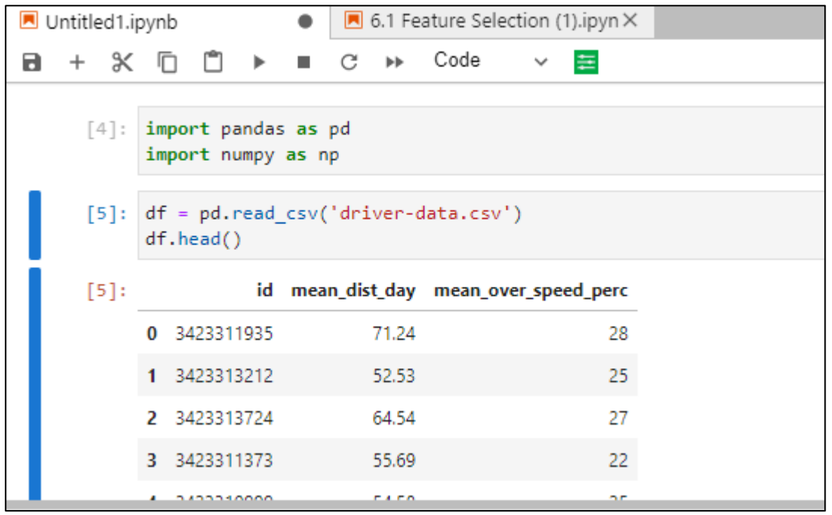
Pandas Functions: Example 1

The example shown uses two functions: the pd.read csv() function to import a dataset, and the df.head() function to output the first five rows of a dataset.

Example:

```
import pandas as pd
import numpy as np
df = pd.read_csv('driver-data.csv')
df.head()
```

Output:



	id	mean_dist_day	mean_over_speed_perc
0	3423311935	71.24	28
1	3423313212	52.53	25
2	3423313724	64.54	27
3	3423311373	55.69	22

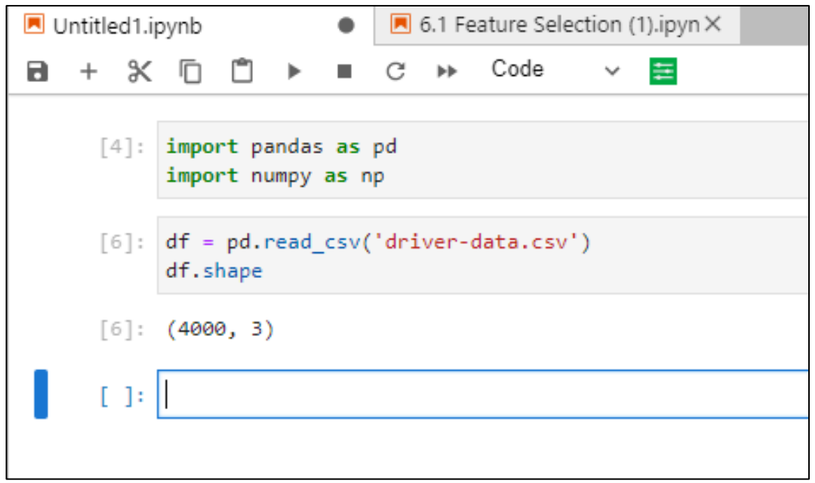
Pandas Functions: Example 2

The example uses df.shape() function to output the shape of the dataset.

Example:

```
import pandas as pd
import numpy as np
df = pd.read_csv('driver-data.csv')
df.shape
```

Output:



Pandas Functions: Example 3

The example uses df.info() function to output the information of the dataset.

Example:

```
import pandas as pd
import numpy as np
df = pd.read_csv('driver-data.csv')
df.info
```

Output:

```
[7]: <bound method DataFrame.info of              id  mean_dist_day  mean_over_speed_perc
     0     3423311935          71.24                    28
     1     3423313212          52.53                    25
     2     3423313724          64.54                    27
     3     3423311373          55.69                    22
     4     3423310999          54.58                    25
     ...          ...            ...                   ...
     3995  3423310685         160.04                    10
     3996  3423312600         176.17                     5
     3997  3423312921         170.91                    12
     3998  3423313630         176.14                     5
     3999  3423311533         168.03                     9

     [4000 rows x 3 columns]>
```

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Matplotlib

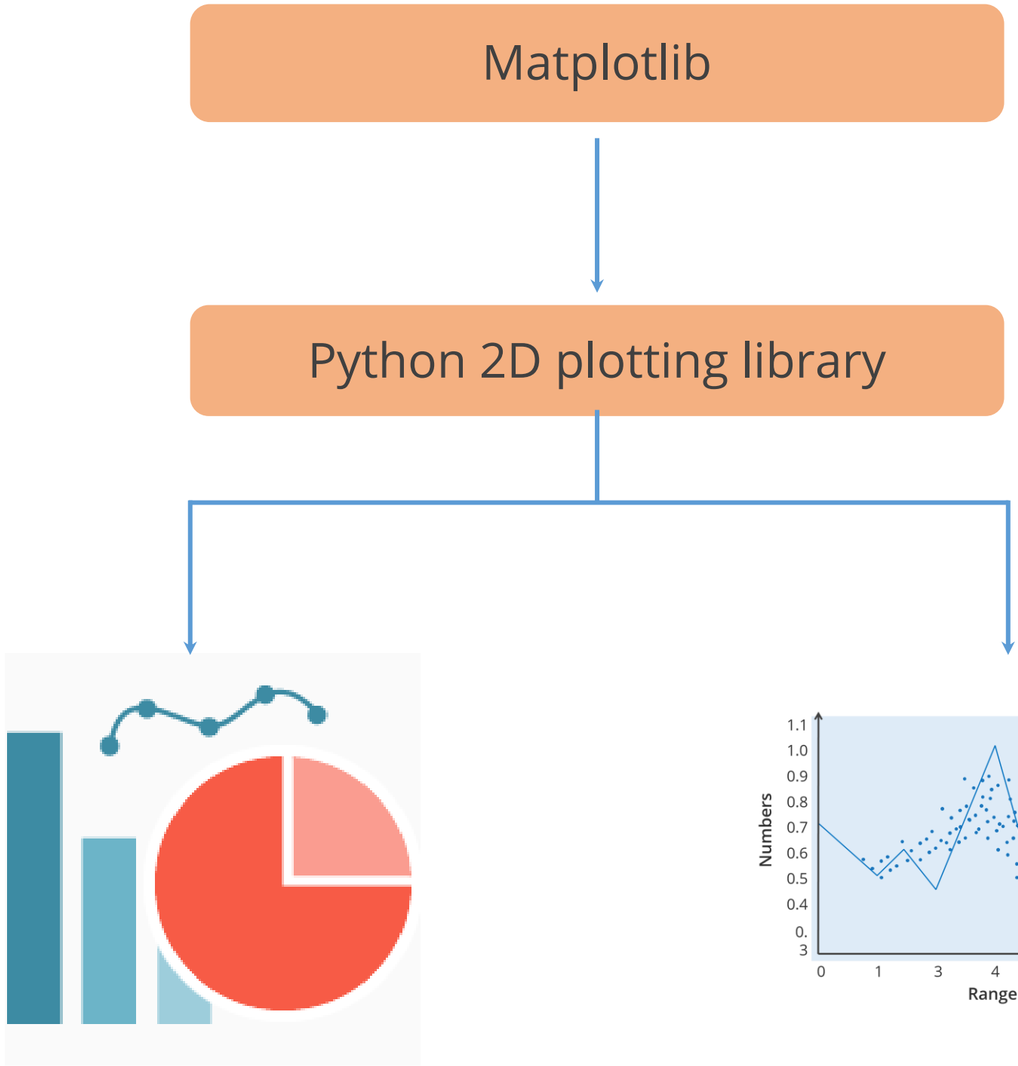
Matplotlib

Matplotlib is a visualization tool that uses a low-level graph plotting library written in Python.

Matplotlib is an open source and can be used freely.

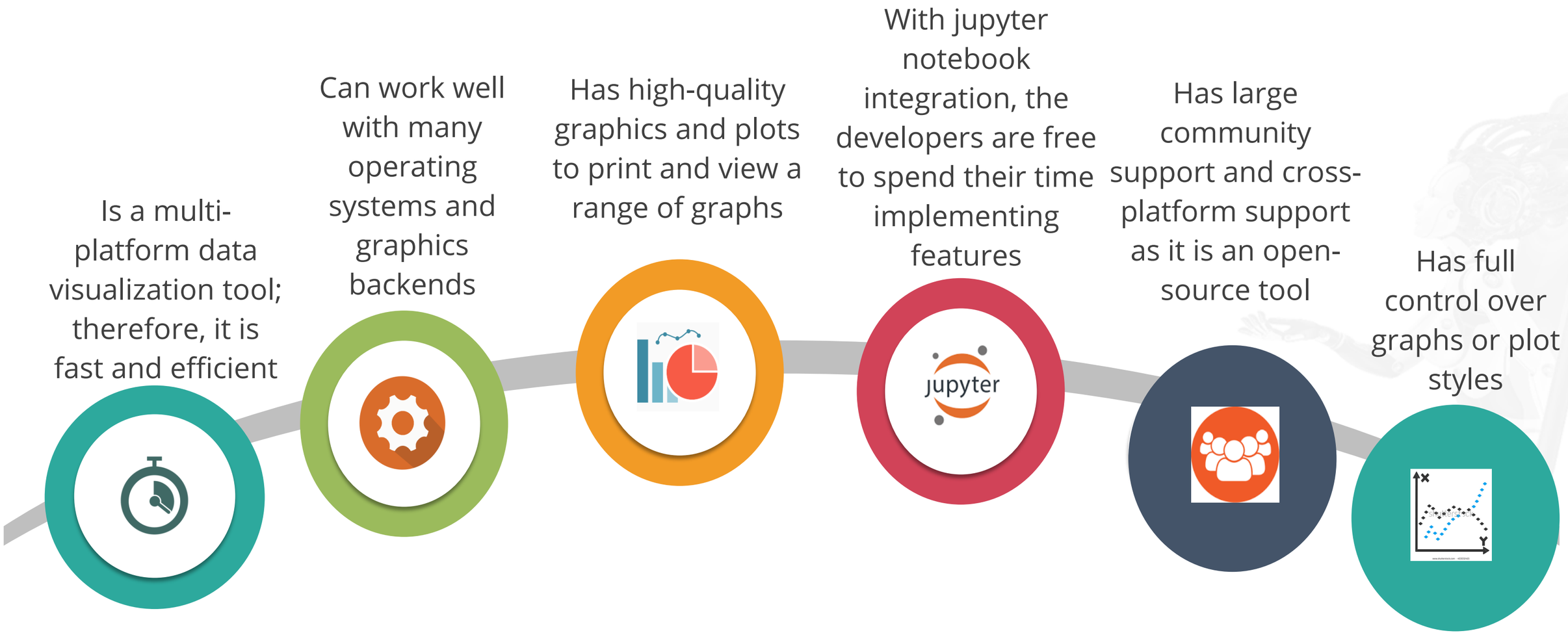
Matplotlib

Using Pythons' matplotlib makes data visualization of large and complex data easy.



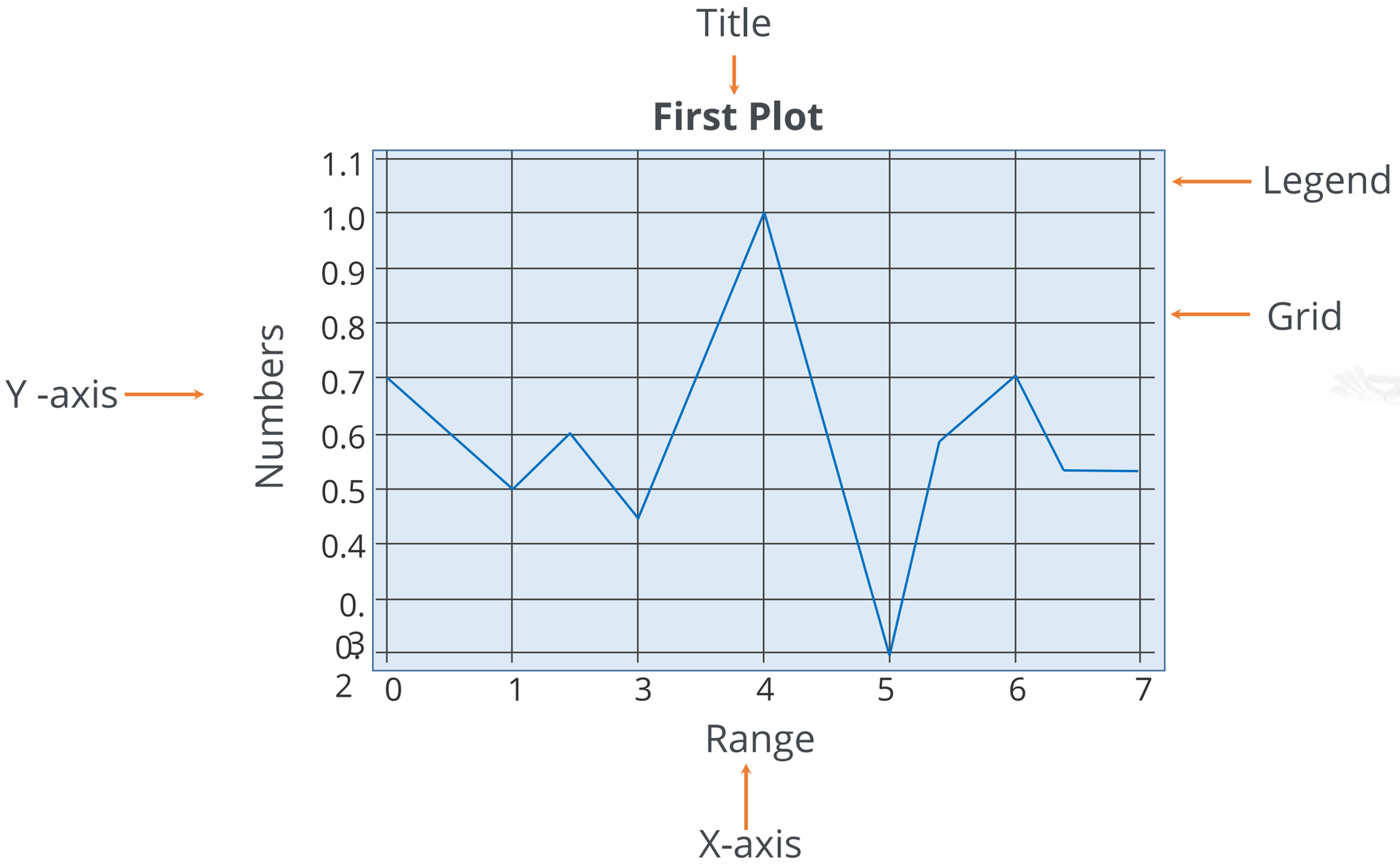
Matplotlib: Advantages

There are several advantages of using matplotlib to visualize data. They are as follows:



The Plot

A plot is a graphical representation of data, which shows the relationship between two variables or the distribution of data.



Steps to Create a Plot

You can create a plot using four simple steps.

Step 01: Import the required libraries

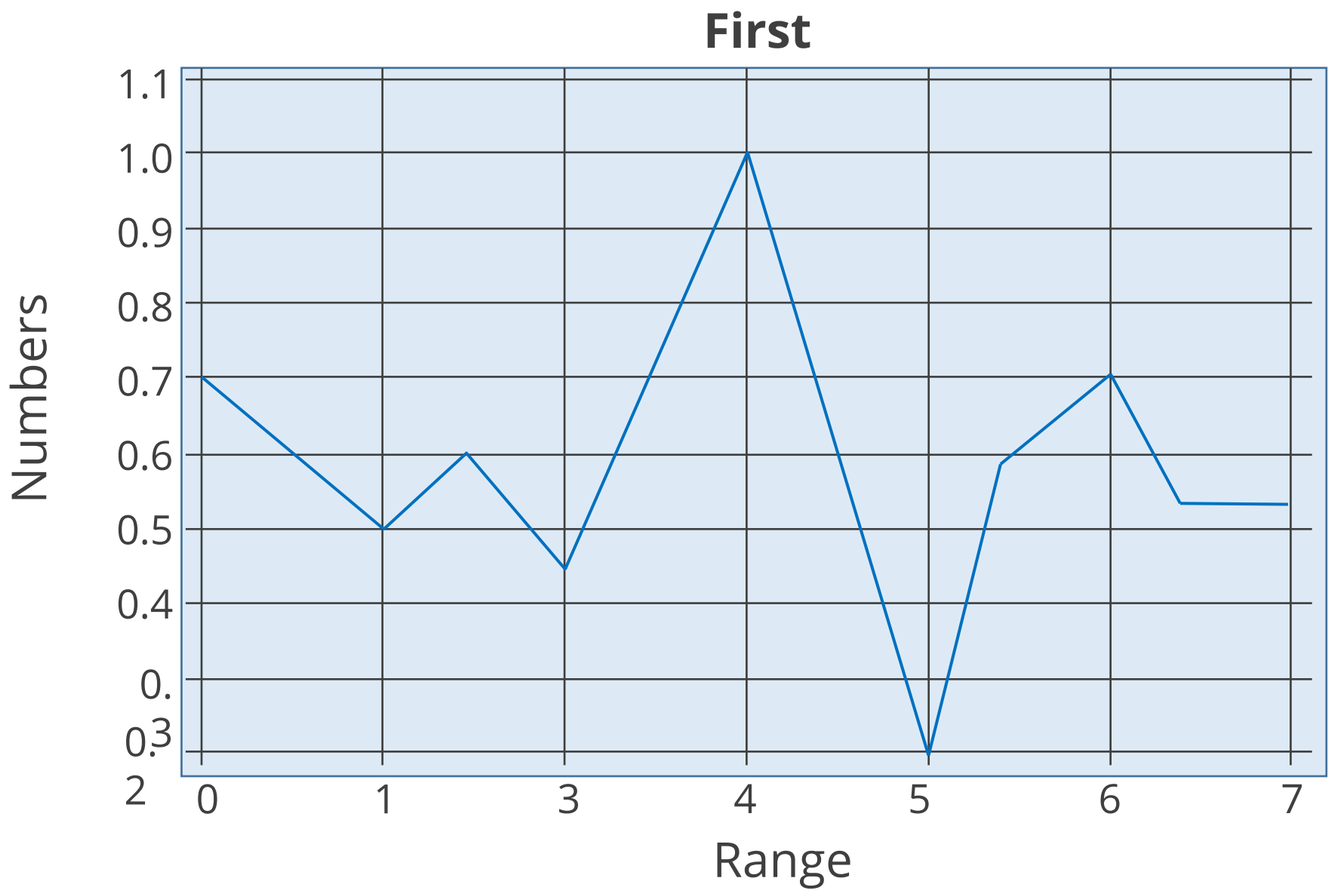
Step 02: Define or import the required dataset

Step 03: Set the plot parameters

Step 04: Display the created plot

Steps to Create Plot: Example

Let us consider the same example plot used earlier.



Follow the steps to obtain this plot.

Steps to Create Plot: Example

```
In [1]: #import numpy for generating random numbers
        import numpy as np
        #import matplotib library
        import matplotlib.pyplot as plt
        from matplotlib import style
        %matplotlib inline
```

Generate random numbers — numpy

Plot the numbers — pyplot

set the grid style — style

```
In [21]: #generate random numbers (total 10)
         randomNumber = np.random.rand(10)
```

used numpy random method — Defined the dataset

```
In [22]: #view them
         print(randomNumber)
```

view the created random numbers — Print method

```
[ 0.71892609  0.49065612  0.61092193  0.43397501  0.94771363  0.31505178
  0.58568599  0.6929941   0.4288734   0.43774794]
```

```
In [23]: #select the style of the plot
         style.use('ggplot')
         #plot the random number
         plt.plot(randomNumber,'g',label='line one',linewidth=2)
         #x axis is number of random numbers (index)
         plt.xlabel('Range')
         #y axis is actual random number
         plt.ylabel('Numbers')
         #Title of the plot
         plt.title('First Plot')
```

ggplot — Set the style

Set the legend

Set line width

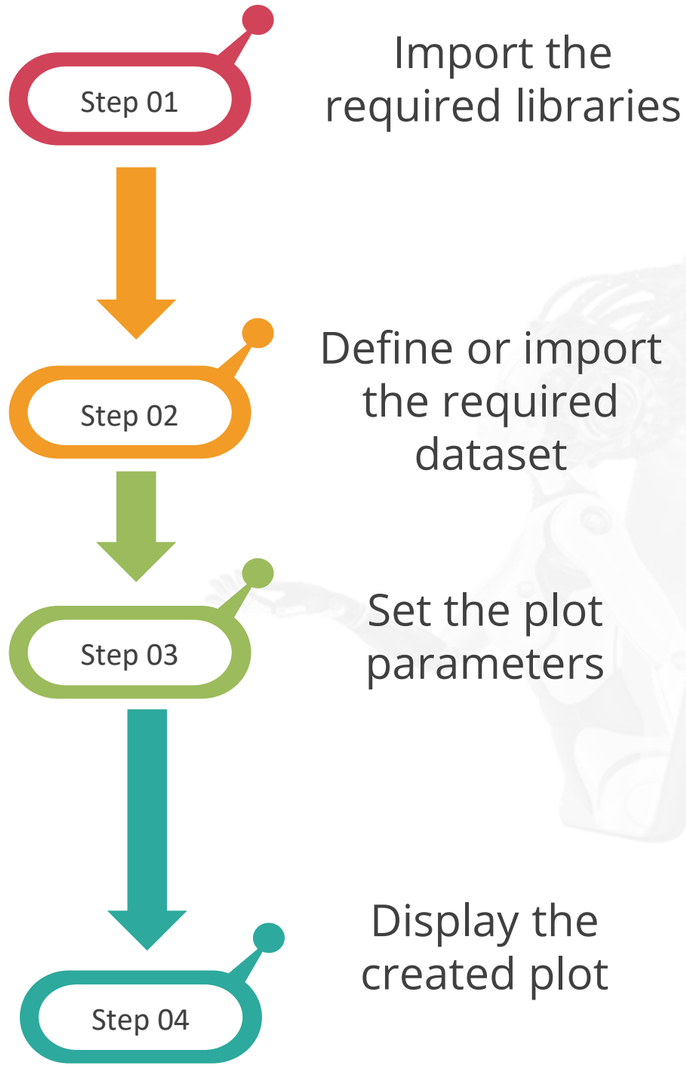
Set coordinates labels

Set the title

```
plt.legend()
plt.show()
```

Plot the graph

Display the created plot



SciPy

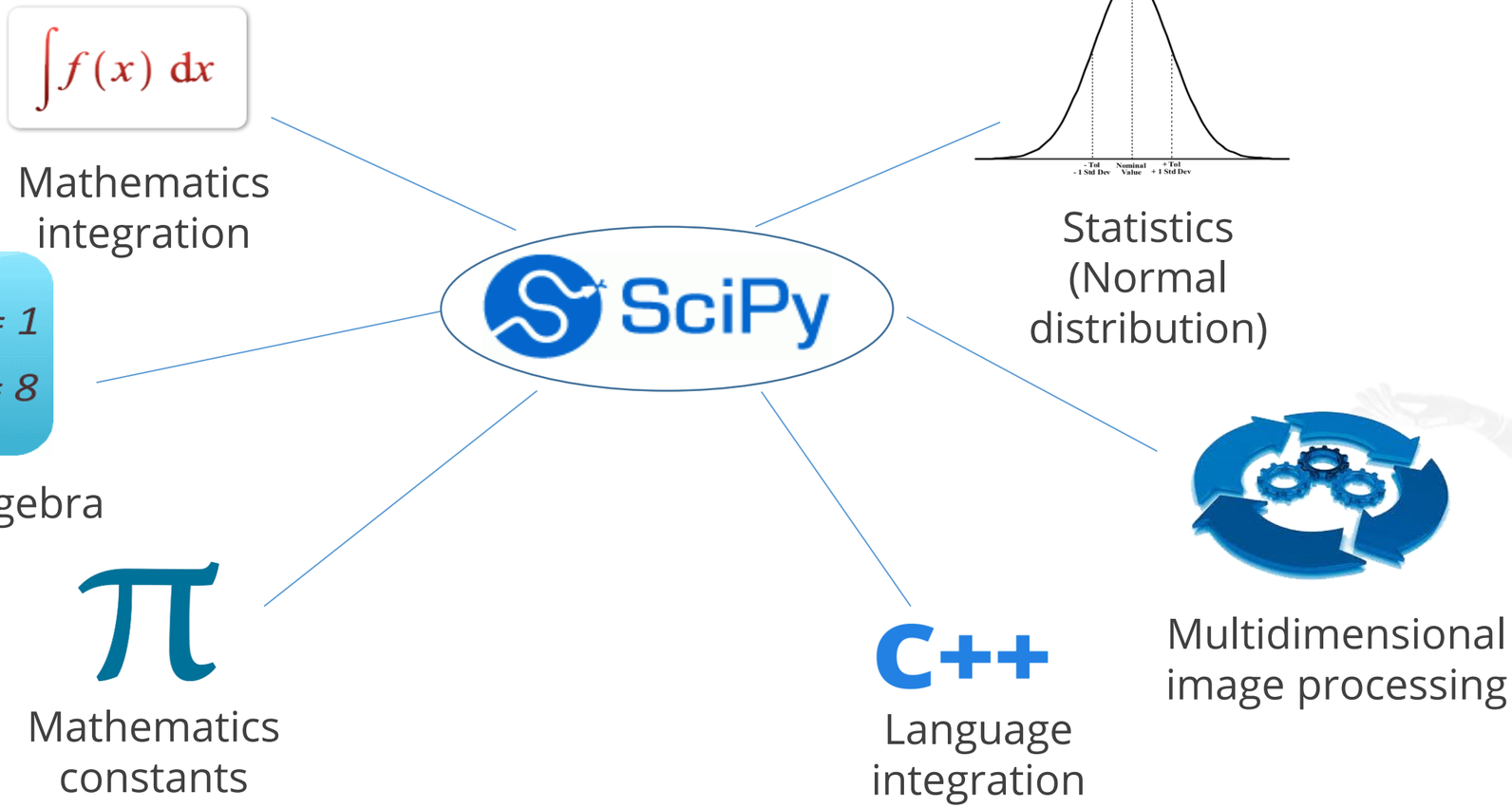
SciPy

SciPy is a free and open-source Python library used for scientific and technical computing.

It has greater optimization, statistics, and signal processing functions.

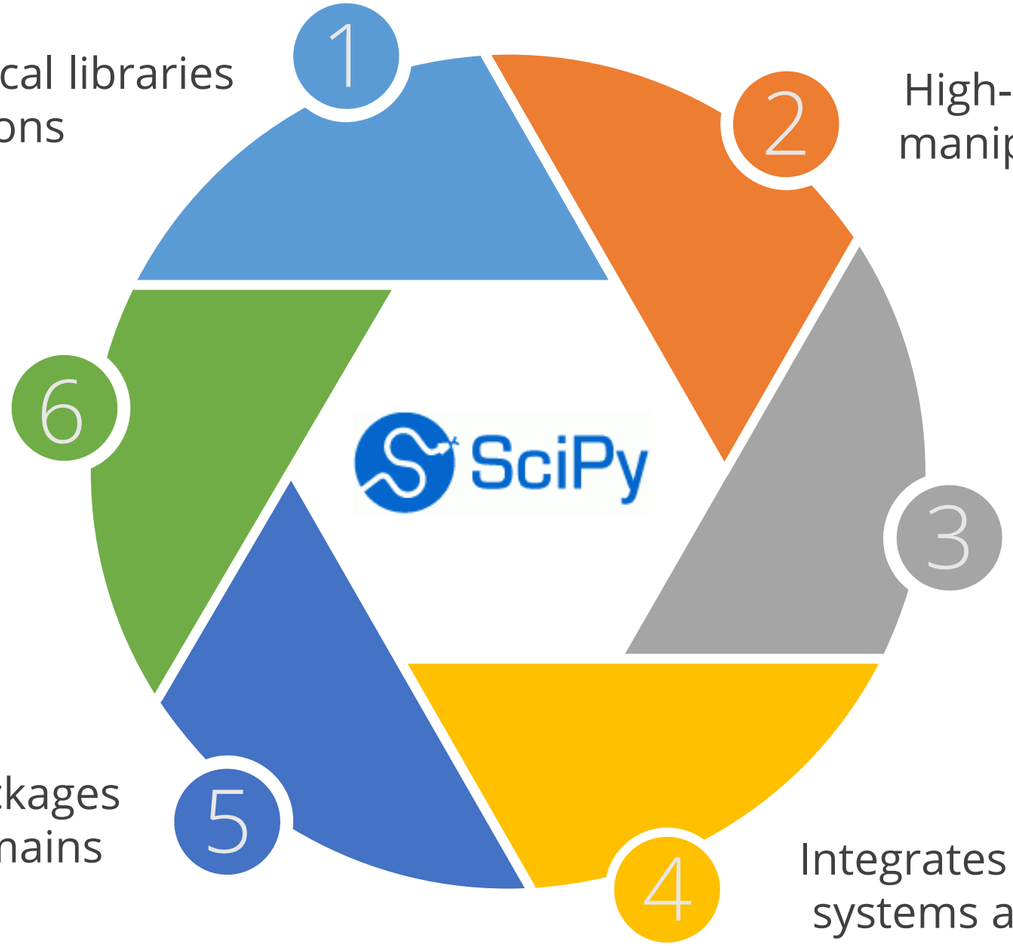
SciPy

SciPy has built-in packages that help in handling the scientific domains.



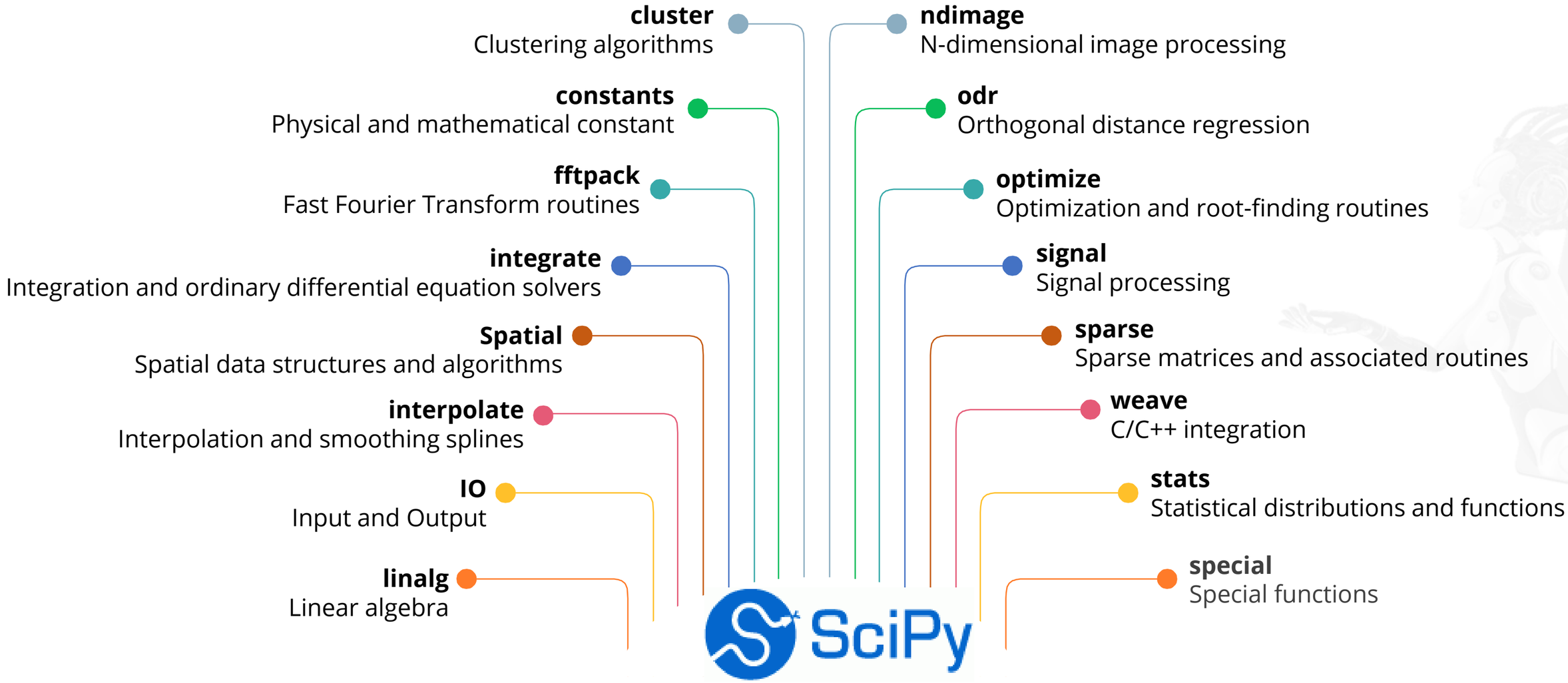
SciPy and Its Characteristics

1. Built-in mathematical libraries and functions
2. High-level commands for data manipulation and visualization
3. Efficient and fast data processing
4. Integrates well with multiple systems and environments
5. Large collection of sub-packages for different scientific domains
6. Simplifies scientific application development



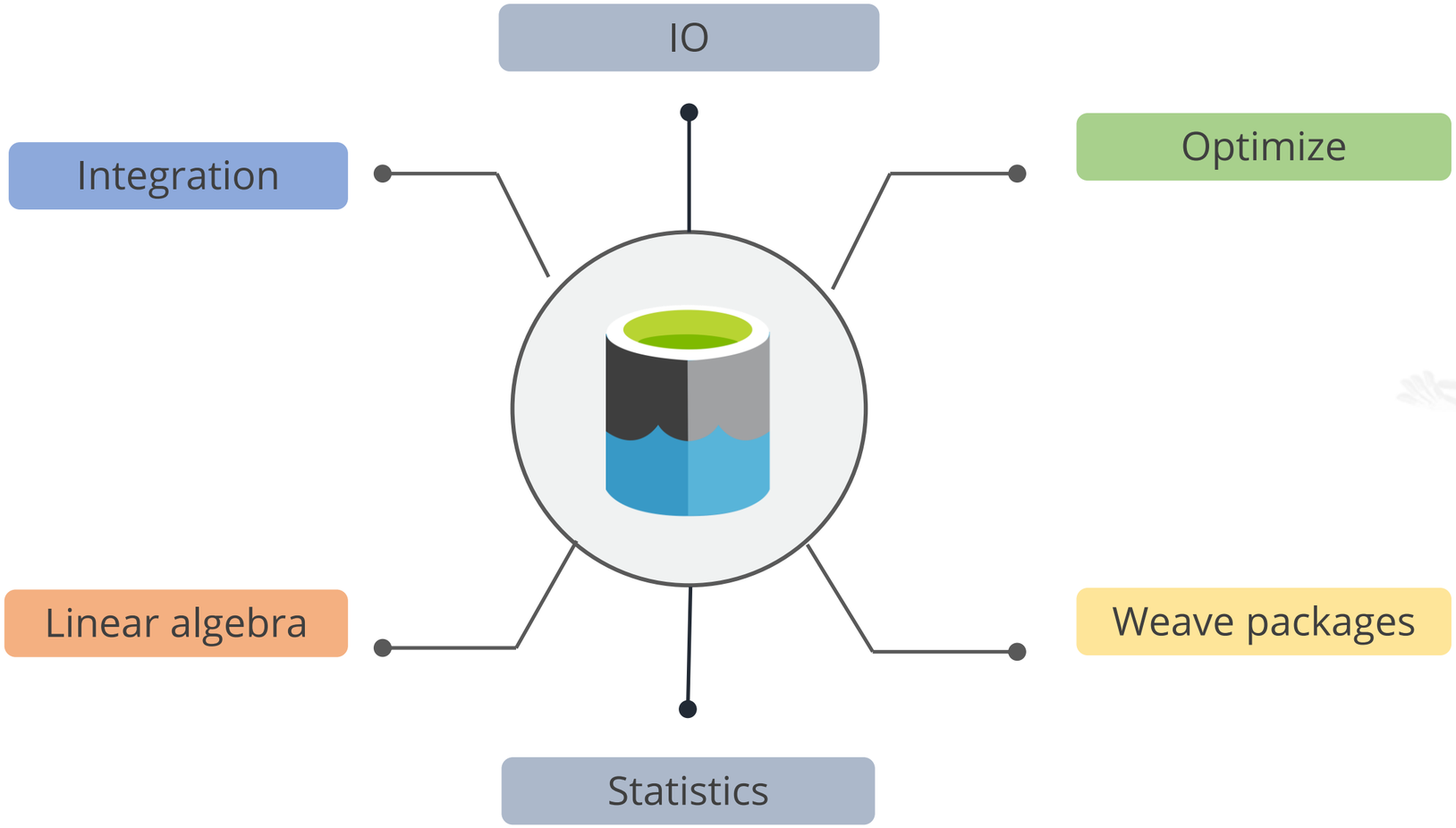
SciPy Sub-Package

SciPy has multiple sub-packages which handle different scientific domains.



SciPy Packages

Some widely used packages are:



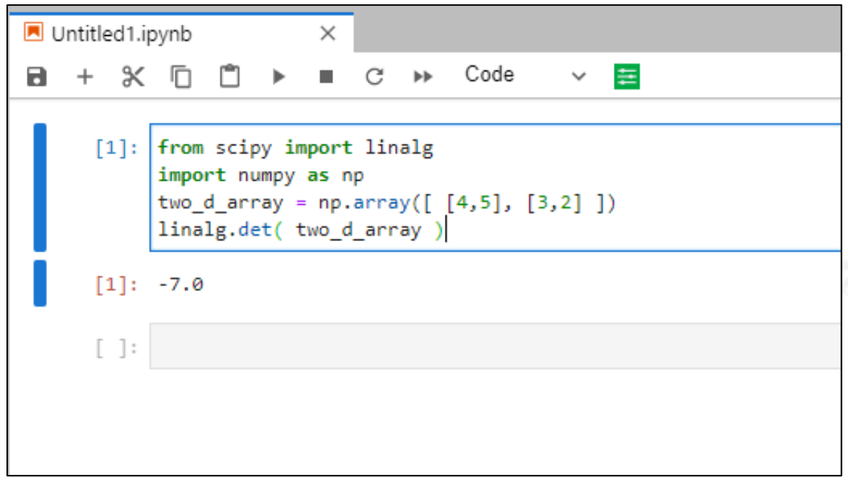
SciPy Packages: Example 1

Let's look at SciPy with scipy.linalg as an example.

Example:

```
from scipy import linalg
import numpy as np

two_d_array = np.array([ [4,5], [3,2] ])

linalg.det( two_d_array )
```

Output:



The example above calculates the determinant of a two-dimensional matrix.

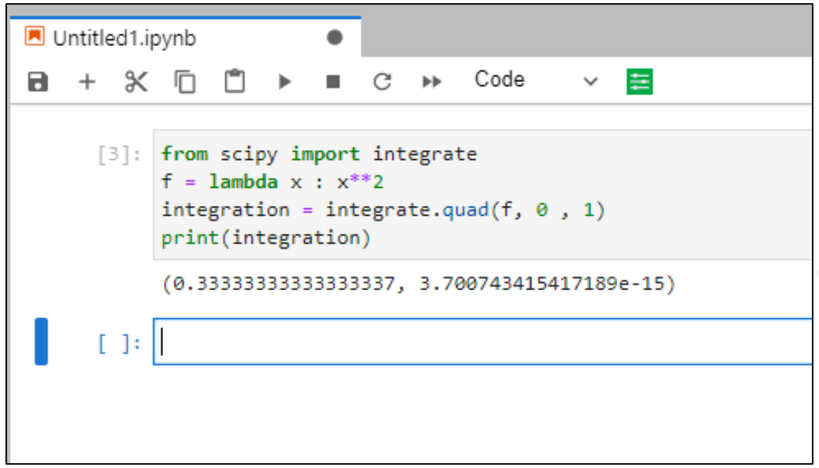
SciPy Packages: Example 2

Let's look at SciPy with scipy.integrate as an example.

Example:

```
from scipy import integrate
f = lambda x : x**2
integration = integrate.quad(f, 0 , 1)
print(integration)
```

Output:



In this example, the function returns two values in which the first value is integration, and the second value is the estimated error in integral.

Scikit-Learn

Scikit-Learn

Scikit is a powerful and modern machine learning Python library. It is used for fully- and semi-automated data analysis and information extraction.

Allows many tools to identify, organize, and solve real-life problems

Provides a collection of free downloadable datasets

Consists of many libraries to learn and predict

Scikit-Learn

Scikit is a powerful and modern machine learning Python library. It is used for fully- and semi-automated data analysis and information extraction.

Provides model support for every problem type

Maintains model persistence

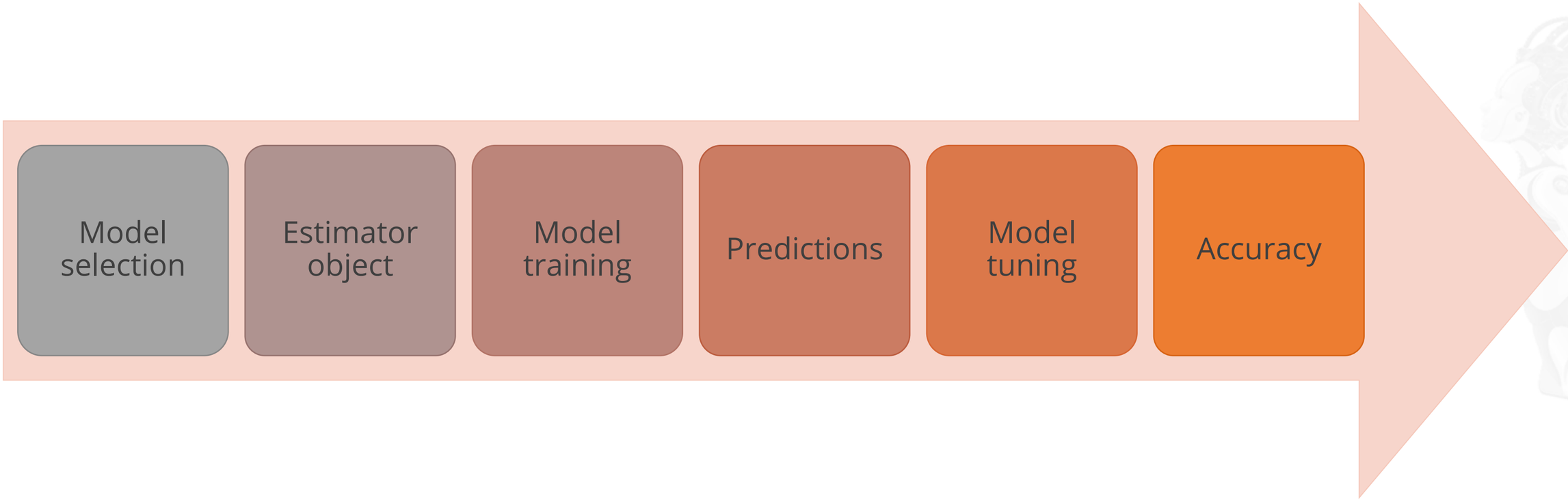
Provides open-source community and vendor support

Scikit-Learn

- It is also known as sklearn.
- It is used to build a machine learning model that has various features such as classification, regression, and clustering.
- It includes algorithms such as k-means, k-nearest neighbors, support vector machine (SVM), and decision tree.

Scikit-Learn: Problem-Solution Approach

Scikit-learn helps data scientists and machine learning engineers to solve problems using the problem-solution approach.



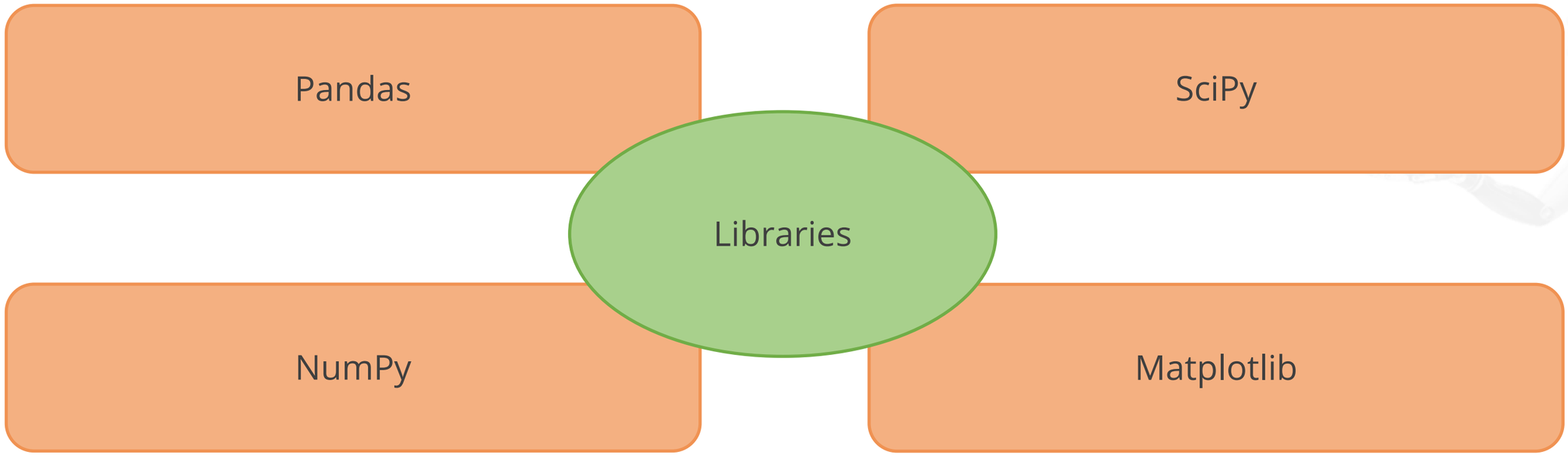
Scikit-Learn: Problem-Solution Considerations

Points to be considered while working with a scikit-learn dataset or loading the data to scikit-learn:

- Create separate objects for features and responses
- Ensure features and responses only have numeric values
- Verify that the features and responses are in the form of a NumPy ndarray
- Check features and responses have the same shape and size as the array
- Ensure features are always mapped as *x,* and responses as *y*

Scikit-Learn: Prerequisite for Installation

The libraries that must be installed before installing Scikit-learn are:



Scikit-Learn: Installation

To install scikit-learn in Jupyter notebook via pip, enter the code:
pip install scikit-learn

To install scikit-learn via command prompt, enter the code:
conda install scikit-learn

```
conda install scikit-learn
```

Scikit-Learn: Models

Some popular groups of models provided by scikit-learn are:

1. Clustering
2. Cross validation
3. Ensemble methods
4. Feature extraction
5. Feature selection
6. Parameter tuning
7. Supervised models
8. Dimensionality reduction

DATA AND
ARTIFICIAL INTELLIGENCE

Web Scraping with BeautifulSoup

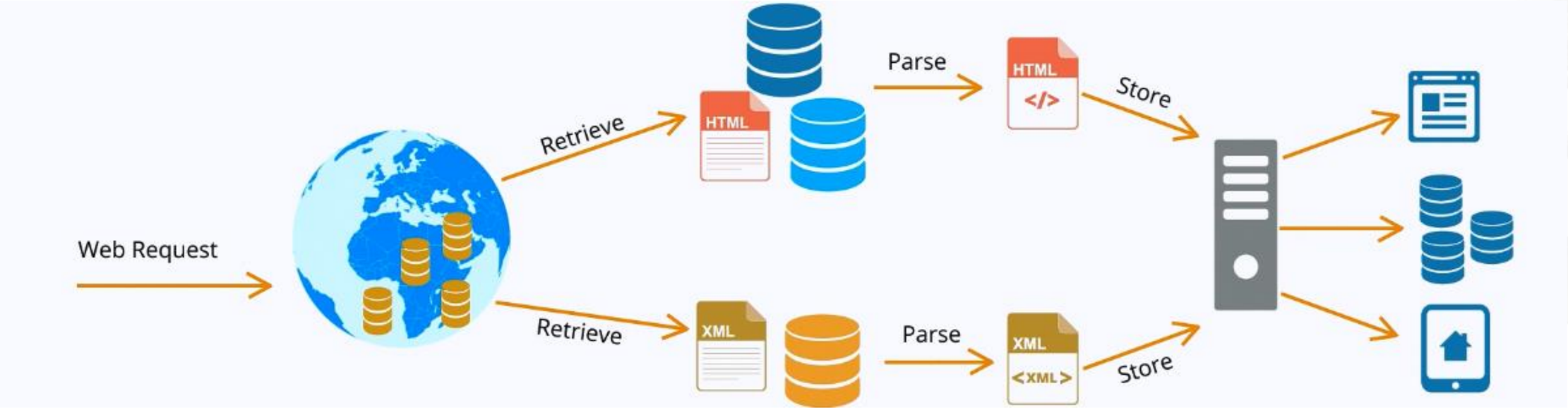
simplilearn

Web Scraping

Web scraping is the process of constructing an algorithm that can extract, parse, download, and organize useful information from the web automatically.

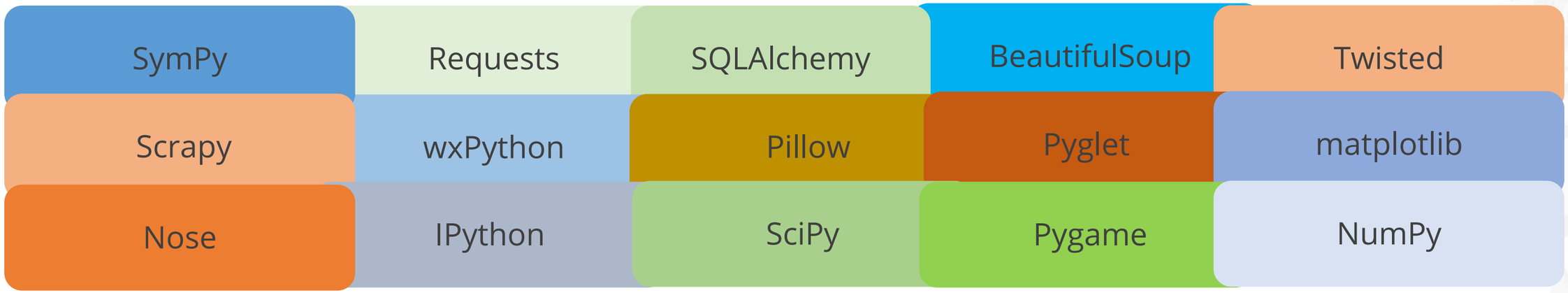
Web Scraping: Process

The four processes followed in web scraping are web requesting, retrieving, parsing, and storing the desired data format.



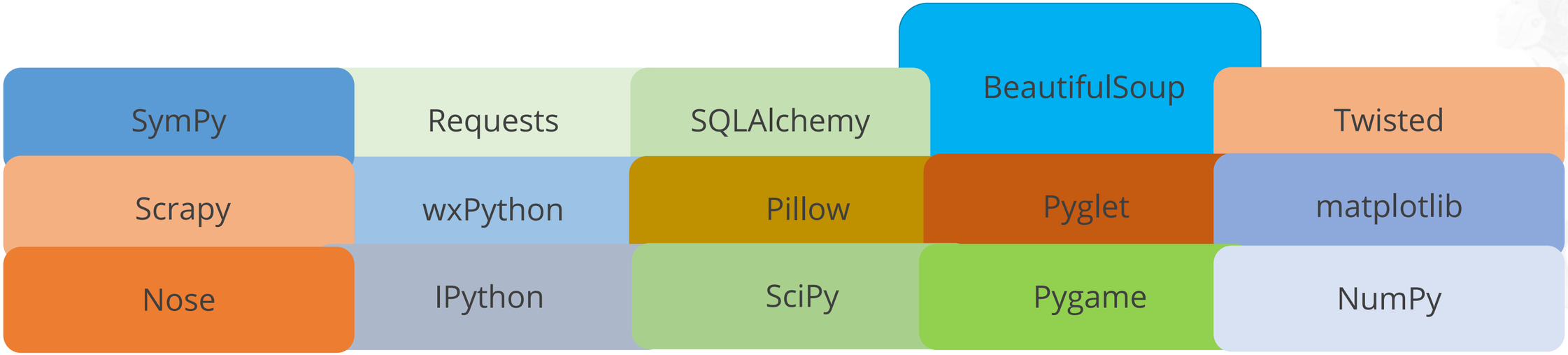
Web Scraping: Tools

There are many tools used for web scraping.



Web Scraping Tools: BeautifulSoup

BeautifulSoup is an easy, intuitive, and robust Python library designed for web scraping.



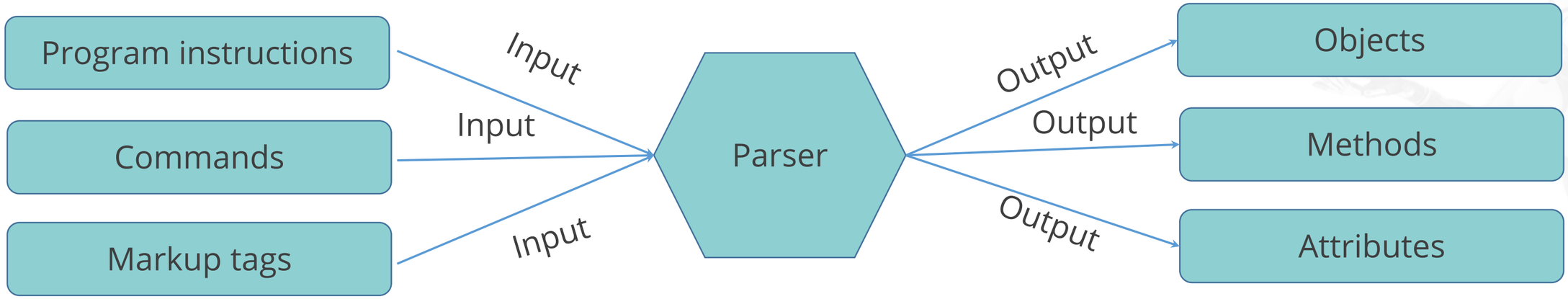
Common Data or Page Formats on the Web

Data is stored in many file formats on the web and can be processed using web scraping.

Parser

A parser is a basic tool to interpret or render information from a web document.

It is also used to validate the input information before processing it.

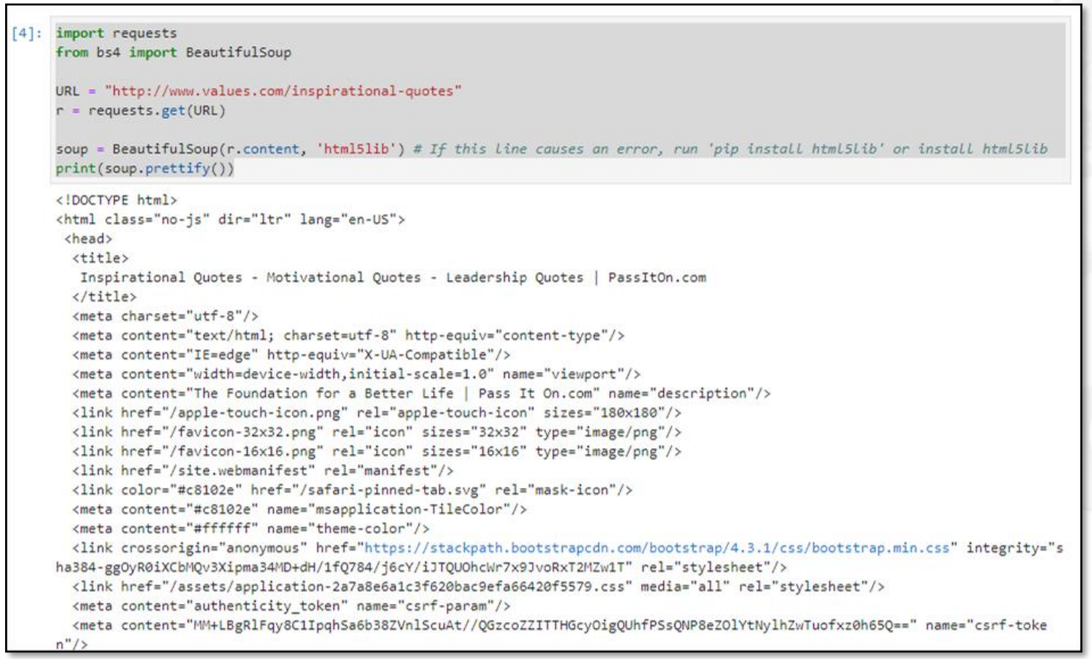


BeautifulSoup: Demo

Example:

```
import requests

from bs4 import BeautifulSoup

URL =
"http://www.values.com/inspirational-
quotes"

r = requests.get(URL)

soup = BeautifulSoup(r.content, 'html5lib')
# If this line causes an error, run 'pip install
html5lib' or install html5lib

print(soup.prettify())
```

Output:



```
[4]: import requests
     from bs4 import BeautifulSoup

     URL = "http://www.values.com/inspirational-quotes"
     r = requests.get(URL)

     soup = BeautifulSoup(r.content, 'html5lib') # If this line causes an error, run 'pip install html5lib' or install html5lib
     print(soup.prettify())

<!DOCTYPE html>
<html class="no-js" dir="ltr" lang="en-US">
 <head>
  <title>
   Inspirational Quotes - Motivational Quotes - Leadership Quotes | PassItOn.com
  </title>
  <meta charset="utf-8"/>
  <meta content="text/html; charset=utf-8" http-equiv="content-type"/>
  <meta content="IE=edge" http-equiv="X-UA-Compatible"/>
  <meta content="width=device-width,initial-scale=1.0" name="viewport"/>
  <meta content="The Foundation for a Better Life | Pass It On.com" name="description"/>
  <link href="/apple-touch-icon.png" rel="apple-touch-icon" sizes="180x180"/>
  <link href="/favicon-32x32.png" rel="icon" sizes="32x32" type="image/png"/>
  <link href="/favicon-16x16.png" rel="icon" sizes="16x16" type="image/png"/>
  <link href="/site.webmanifest" rel="manifest"/>
  <link color="#c8102e" href="/safari-pinned-tab.svg" rel="mask-icon"/>
  <meta content="#c8102e" name="msapplication-TileColor"/>
  <meta content="#ffffff" name="theme-color"/>
  <link crossorigin="anonymous" href="https://stackpath.bootstrapcdn.com/bootstrap/4.3.1/css/bootstrap.min.css" integrity="s
ha384-ggOyR0iXCbMQv3Xipma34MD+dH/1fQ784/j6cY/iJTQUOhcWr7x9JvoRxT2MZw1T" rel="stylesheet"/>
  <link href="/assets/application-2a7a8e6a1c3f620bac9efa66420f5579.css" media="all" rel="stylesheet"/>
  <meta content="authenticity_token" name="csrf-param"/>
  <meta content="MM+LBgRlFqy8C1IpqhSa6b38ZVnlScuAt//QGzcoZZITTHGcyOigQUhfPSsQNP8eZOlYtNylhZwTuofxz0h65Q==" name="csrf-toke
n"/>
```

Key Takeaways

- SciPy is a free and open-source Python library used for scientific and technical computing.
- NumPy (Numerical Python) is a library that consists of multidimensional array objects and a collection of functions for manipulating them.
- Matplotlib is a visualization tool that uses a low-level graph plotting library written in Python.
- Scikit is a powerful and modern machine learning Python library. It is used for fully- and semi-automated data analysis and information extraction.

Knowledge Check

Knowledge Check

Knowledge Check

1

Which of the following SciPy sub-packages is incorrect?

A. scipy.cluster

B. scipy.source

C. scipy.interpolate

D. scipy.signal

Knowledge Check

1

Which of the following SciPy sub-packages is incorrect?

A. scipy.cluster

B. scipy.source

C. scipy.interpolate

D. scipy.signal

The correct answer is **B**

scipy.source is not a sub-package of SciPy.

Knowledge Check

2

_____ is an important library used for analyzing data.

A. Math

B. Random

C. Pandas

D. None of the above

Knowledge Check

2

_____ is an important library used for analyzing data.

A. Math

B. Random

C. Pandas

D. None of the above

The correct answer is **C**

Pandas is an important library used for analyzing data.

Knowledge Check

3

Matplotlib is a _____plotting library.

A. 1D

B. 2D

C. 3D

D. All of the above

Knowledge Check

3

Matplotlib is a _____plotting library.

A. 1D

B. 2D

C. 3D

D. All of the above

The correct answer is **B**

Matplotlib is a 2D plotting library.