Installation of NumPy

In [2]:
```
pip install jupyterlab
```

```
Requirement already satisfied: jupyterlab in /opt/anaconda3/lib/python3.1
2/site-packages (4.2.5)
Requirement already satisfied: async-lru>=1.0.0 in /opt/anaconda3/lib/pyth
on3.12/site-packages (from jupyterlab) (2.0.4)
Requirement already satisfied: httpx>=0.25.0 in /opt/anaconda3/lib/python
3.12/site-packages (from jupyterlab) (0.27.0)
Requirement already satisfied: ipykernel>=6.5.0 in /opt/anaconda3/lib/pyth
on3.12/site-packages (from jupyterlab) (6.28.0)
Requirement already satisfied: jinja2>=3.0.3 in /opt/anaconda3/lib/python
3.12/site-packages (from jupyterlab) (3.1.4)
Requirement already satisfied: jupyter-core in /opt/anaconda3/lib/python3.
12/site-packages (from jupyterlab) (5.7.2)
Requirement already satisfied: jupyter-lsp>=2.0.0 in /opt/anaconda3/lib/py
thon3.12/site-packages (from jupyterlab) (2.2.0)
Requirement already satisfied: jupyter-server<3,>=2.4.0 in /opt/anaconda3/
lib/python3.12/site-packages (from jupyterlab) (2.14.1)
Requirement already satisfied: jupyterlab-server<3,>=2.27.1 in /opt/anacon
da3/lib/python3.12/site-packages (from jupyterlab) (2.27.3)
Requirement already satisfied: notebook-shim>=0.2 in /opt/anaconda3/lib/py
thon3.12/site-packages (from jupyterlab) (0.2.3)
Requirement already satisfied: packaging in /opt/anaconda3/lib/python3.12/
site-packages (from jupyterlab) (24.1)
Requirement already satisfied: setuptools>=40.1.0 in /opt/anaconda3/lib/py
thon3.12/site-packages (from jupyterlab) (75.1.0)
Requirement already satisfied: tornado>=6.2.0 in /opt/anaconda3/lib/python
3.12/site-packages (from jupyterlab) (6.4.1)
Requirement already satisfied: traitlets in /opt/anaconda3/lib/python3.12/
site-packages (from jupyterlab) (5.14.3)
Requirement already satisfied: anyio in /opt/anaconda3/lib/python3.12/site
-packages (from httpx>=0.25.0->jupyterlab) (4.2.0)
Requirement already satisfied: certifi in /opt/anaconda3/lib/python3.12/si
te-packages (from httpx>=0.25.0->jupyterlab) (2024.8.30)
Requirement already satisfied: httpcore==1.* in /opt/anaconda3/lib/python
3.12/site-packages (from httpx>=0.25.0->jupyterlab) (1.0.2)
Requirement already satisfied: idna in /opt/anaconda3/lib/python3.12/site-
packages (from httpx>=0.25.0->jupyterlab) (3.7)
Requirement already satisfied: sniffio in /opt/anaconda3/lib/python3.12/si
te-packages (from httpx>=0.25.0->jupyterlab) (1.3.0)
Requirement already satisfied: h11<0.15,>=0.13 in /opt/anaconda3/lib/pytho
n3.12/site-packages (from httpcore==1.*->httpx>=0.25.0->jupyterlab) (0.14.
0)
Requirement already satisfied: appnope in /opt/anaconda3/lib/python3.12/si
te-packages (from ipykernel>=6.5.0->jupyterlab) (0.1.3)
Requirement already satisfied: comm>=0.1.1 in /opt/anaconda3/lib/python3.1
2/site-packages (from ipykernel>=6.5.0->jupyterlab) (0.2.1)
Requirement already satisfied: debugpy>=1.6.5 in /opt/anaconda3/lib/python
```

```
3.12/site-packages (from ipykernel>=6.5.0->jupyterlab) (1.6.7)
Requirement already satisfied: ipython>=7.23.1 in /opt/anaconda3/lib/pytho
n3.12/site-packages (from ipykernel>=6.5.0->jupyterlab) (8.27.0)
Requirement already satisfied: jupyter-client>=6.1.12 in /opt/anaconda3/li
b/python3.12/site-packages (from ipykernel>=6.5.0->jupyterlab) (8.6.0)
Requirement already satisfied: matplotlib-inline>=0.1 in /opt/anaconda3/li
b/python3.12/site-packages (from ipykernel>=6.5.0->jupyterlab) (0.1.6)
Requirement already satisfied: nest-asyncio in /opt/anaconda3/lib/python3.
12/site-packages (from ipykernel>=6.5.0->jupyterlab) (1.6.0)
Requirement already satisfied: psutil in /opt/anaconda3/lib/python3.12/sit
e-packages (from ipykernel>=6.5.0->jupyterlab) (5.9.0)
Requirement already satisfied: pyzmq>=24 in /opt/anaconda3/lib/python3.12/
site-packages (from ipykernel>=6.5.0->jupyterlab) (25.1.2)
Requirement already satisfied: MarkupSafe>=2.0 in /opt/anaconda3/lib/pytho
n3.12/site-packages (from jinja2>=3.0.3->jupyterlab) (2.1.3)
Requirement already satisfied: platformdirs>=2.5 in /opt/anaconda3/lib/pyt
hon3.12/site-packages (from jupyter-core->jupyterlab) (3.10.0)
Requirement already satisfied: argon2-cffi>=21.1 in /opt/anaconda3/lib/pyt
hon3.12/site-packages (from jupyter-server<3,>=2.4.0->jupyterlab) (21.3.0)
Requirement already satisfied: jupyter-events>=0.9.0 in /opt/anaconda3/li
b/python3.12/site-packages (from jupyter-server<3,>=2.4.0->jupyterlab) (0.
10.0)
Requirement already satisfied: jupyter-server-terminals>=0.4.4 in /opt/ana
conda3/lib/python3.12/site-packages (from jupyter-server<3,>=2.4.0->jupyte
rlab) (0.4.4)
Requirement already satisfied: nbconvert>=6.4.4 in /opt/anaconda3/lib/pyth
on3.12/site-packages (from jupyter-server<3,>=2.4.0->jupyterlab) (7.16.4)
Requirement already satisfied: nbformat>=5.3.0 in /opt/anaconda3/lib/pytho
n3.12/site-packages (from jupyter-server<3,>=2.4.0->jupyterlab) (5.10.4)
Requirement already satisfied: overrides>=5.0 in /opt/anaconda3/lib/python
3.12/site-packages (from jupyter-server<3,>=2.4.0->jupyterlab) (7.4.0)
Requirement already satisfied: prometheus-client>=0.9 in /opt/anaconda3/li
b/python3.12/site-packages (from jupyter-server<3,>=2.4.0->jupyterlab) (0.
14.1)
Requirement already satisfied: send2trash>=1.8.2 in /opt/anaconda3/lib/pyt
hon3.12/site-packages (from jupyter-server<3,>=2.4.0->jupyterlab) (1.8.2)
Requirement already satisfied: terminado>=0.8.3 in /opt/anaconda3/lib/pyth
on3.12/site-packages (from jupyter-server<3,>=2.4.0->jupyterlab) (0.17.1)
Requirement already satisfied: websocket-client>=1.7 in /opt/anaconda3/li
b/python3.12/site-packages (from jupyter-server<3,>=2.4.0->jupyterlab) (1.
8.0)
Requirement already satisfied: babel>=2.10 in /opt/anaconda3/lib/python3.1
2/site-packages (from jupyterlab-server<3,>=2.27.1->jupyterlab) (2.11.0)
Requirement already satisfied: json5>=0.9.0 in /opt/anaconda3/lib/python3.
12/site-packages (from jupyterlab-server<3,>=2.27.1->jupyterlab) (0.9.6)
Requirement already satisfied: jsonschema>=4.18.0 in /opt/anaconda3/lib/py
thon3.12/site-packages (from jupyterlab-server<3,>=2.27.1->jupyterlab) (4.
23.0)
Requirement already satisfied: requests>=2.31 in /opt/anaconda3/lib/python
3.12/site-packages (from jupyterlab-server<3,>=2.27.1->jupyterlab) (2.32.
3)
Requirement already satisfied: argon2-cffi-bindings in /opt/anaconda3/lib/
python3.12/site-packages (from argon2-cffi>=21.1->jupyter-server<3,>=2.4.0
```

```
->jupyterlab) (21.2.0)
Requirement already satisfied: pytz>=2015.7 in /opt/anaconda3/lib/python3.
12/site-packages (from babel>=2.10->jupyterlab-server<3,>=2.27.1->jupyterl
ab) (2024.1)
Requirement already satisfied: decorator in /opt/anaconda3/lib/python3.12/
site-packages (from ipython>=7.23.1->ipykernel>=6.5.0->jupyterlab) (5.1.1)
Requirement already satisfied: jedi>=0.16 in /opt/anaconda3/lib/python3.1
2/site-packages (from ipython>=7.23.1->ipykernel>=6.5.0->jupyterlab) (0.1
9.1)
Requirement already satisfied: prompt-toolkit<3.1.0,>=3.0.41 in /opt/anaco
nda3/lib/python3.12/site-packages (from ipython>=7.23.1->ipykernel>=6.5.0-
>jupyterlab) (3.0.43)
Requirement already satisfied: pygments>=2.4.0 in /opt/anaconda3/lib/pytho
n3.12/site-packages (from ipython>=7.23.1->ipykernel>=6.5.0->jupyterlab) (
2.15.1)
Requirement already satisfied: stack-data in /opt/anaconda3/lib/python3.1
2/site-packages (from ipython>=7.23.1->ipykernel>=6.5.0->jupyterlab) (0.2.
0)
Requirement already satisfied: pexpect>4.3 in /opt/anaconda3/lib/python3.1
2/site-packages (from ipython>=7.23.1->ipykernel>=6.5.0->jupyterlab) (4.8.
0)
Requirement already satisfied: attrs>=22.2.0 in /opt/anaconda3/lib/python
3.12/site-packages (from jsonschema>=4.18.0->jupyterlab-server<3,>=2.27.1-
>jupyterlab) (23.1.0)
Requirement already satisfied: jsonschema-specifications>=2023.03.6 in /op
t/anaconda3/lib/python3.12/site-packages (from jsonschema>=4.18.0->jupyter
lab-server<3,>=2.27.1->jupyterlab) (2023.7.1)
Requirement already satisfied: referencing>=0.28.4 in /opt/anaconda3/lib/p
ython3.12/site-packages (from jsonschema>=4.18.0->jupyterlab-server<3,>=2.
27.1->jupyterlab) (0.30.2)
Requirement already satisfied: rpds-py>=0.7.1 in /opt/anaconda3/lib/python
3.12/site-packages (from jsonschema>=4.18.0->jupyterlab-server<3,>=2.27.1-
>jupyterlab) (0.10.6)
Requirement already satisfied: python-dateutil>=2.8.2 in /opt/anaconda3/li
b/python3.12/site-packages (from jupyter-client>=6.1.12->ipykernel>=6.5.0-
>jupyterlab) (2.9.0.post0)
Requirement already satisfied: python-json-logger>=2.0.4 in /opt/anaconda
3/lib/python3.12/site-packages (from jupyter-events>=0.9.0->jupyter-server
<3,>=2.4.0->jupyterlab) (2.0.7)
Requirement already satisfied: pyyaml>=5.3 in /opt/anaconda3/lib/python3.1
2/site-packages (from jupyter-events>=0.9.0->jupyter-server<3,>=2.4.0->jup
yterlab) (6.0.1)
Requirement already satisfied: rfc3339-validator in /opt/anaconda3/lib/pyt
hon3.12/site-packages (from jupyter-events>=0.9.0->jupyter-server<3,>=2.4.
0->jupyterlab) (0.1.4)
Requirement already satisfied: rfc3986-validator>=0.1.1 in /opt/anaconda3/
lib/python3.12/site-packages (from jupyter-events>=0.9.0->jupyter-server<
3,>=2.4.0->jupyterlab) (0.1.1)
Requirement already satisfied: beautifulsoup4 in /opt/anaconda3/lib/python
3.12/site-packages (from nbconvert>=6.4.4->jupyter-server<3,>=2.4.0->jupyt
erlab) (4.12.3)
Requirement already satisfied: bleach!=5.0.0 in /opt/anaconda3/lib/python
3.12/site-packages (from nbconvert>=6.4.4->jupyter-server<3,>=2.4.0->jupyt
```

```
erlab) (4.1.0)
Requirement already satisfied: defusedxml in /opt/anaconda3/lib/python3.1
2/site-packages (from nbconvert>=6.4.4->jupyter-server<3,>=2.4.0->jupyterl
ab) (0.7.1)
Requirement already satisfied: jupyterlab-pygments in /opt/anaconda3/lib/p
ython3.12/site-packages (from nbconvert>=6.4.4->jupyter-server<3,>=2.4.0->
jupyterlab) (0.1.2)
Requirement already satisfied: mistune<4,>=2.0.3 in /opt/anaconda3/lib/pyt
hon3.12/site-packages (from nbconvert>=6.4.4->jupyter-server<3,>=2.4.0->ju
pyterlab) (2.0.4)
Requirement already satisfied: nbclient>=0.5.0 in /opt/anaconda3/lib/pytho
n3.12/site-packages (from nbconvert>=6.4.4->jupyter-server<3,>=2.4.0->jupy
terlab) (0.8.0)
Requirement already satisfied: pandocfilters>=1.4.1 in /opt/anaconda3/lib/
python3.12/site-packages (from nbconvert>=6.4.4->jupyter-server<3,>=2.4.0-
>jupyterlab) (1.5.0)
Requirement already satisfied: tinycss2 in /opt/anaconda3/lib/python3.12/s
ite-packages (from nbconvert>=6.4.4->jupyter-server<3,>=2.4.0->jupyterlab)
(1.2.1)
Requirement already satisfied: fastjsonschema>=2.15 in /opt/anaconda3/lib/
python3.12/site-packages (from nbformat>=5.3.0->jupyter-server<3,>=2.4.0->
jupyterlab) (2.16.2)
Requirement already satisfied: charset-normalizer<4,>=2 in /opt/anaconda3/
lib/python3.12/site-packages (from requests>=2.31->jupyterlab-server<3,>=
2.27.1->jupyterlab) (3.3.2)
Requirement already satisfied: urllib3<3,>=1.21.1 in /opt/anaconda3/lib/py
thon3.12/site-packages (from requests>=2.31->jupyterlab-server<3,>=2.27.1-
>jupyterlab) (2.2.3)
Requirement already satisfied: ptyprocess in /opt/anaconda3/lib/python3.1
2/site-packages (from terminado>=0.8.3->jupyter-server<3,>=2.4.0->jupyterl
ab) (0.7.0)
Requirement already satisfied: six>=1.9.0 in /opt/anaconda3/lib/python3.1
2/site-packages (from bleach!=5.0.0->nbconvert>=6.4.4->jupyter-server<3,>=
2.4.0->jupyterlab) (1.16.0)
Requirement already satisfied: webencodings in /opt/anaconda3/lib/python3.
12/site-packages (from bleach!=5.0.0->nbconvert>=6.4.4->jupyter-server<3,>
=2.4.0->jupyterlab) (0.5.1)
Requirement already satisfied: parso<0.9.0,>=0.8.3 in /opt/anaconda3/lib/p
ython3.12/site-packages (from jedi>=0.16->ipython>=7.23.1->ipykernel>=6.5.
0->jupyterlab) (0.8.3)
Requirement already satisfied: fqdn in /opt/anaconda3/lib/python3.12/site-
packages (from jsonschema[format-nongpl]>=4.18.0->jupyter-events>=0.9.0->j
upyter-server<3,>=2.4.0->jupyterlab) (1.5.1)
Requirement already satisfied: isoduration in /opt/anaconda3/lib/python3.1
2/site-packages (from jsonschema[format-nongpl]>=4.18.0->jupyter-events>=
0.9.0->jupyter-server<3,>=2.4.0->jupyterlab) (20.11.0)
Requirement already satisfied: jsonpointer>1.13 in /opt/anaconda3/lib/pyth
on3.12/site-packages (from jsonschema[format-nongpl]>=4.18.0->jupyter-even
ts>=0.9.0->jupyter-server<3,>=2.4.0->jupyterlab) (2.1)
Requirement already satisfied: uri-template in /opt/anaconda3/lib/python3.
12/site-packages (from jsonschema[format-nongpl]>=4.18.0->jupyter-events>=
0.9.0->jupyter-server<3,>=2.4.0->jupyterlab) (1.3.0)
Requirement already satisfied: webcolors>=24.6.0 in /opt/anaconda3/lib/pyt
```

```
hon3.12/site-packages (from jsonschema[format-nongpl]>=4.18.0->jupyter-eve
nts>=0.9.0->jupyter-server<3,>=2.4.0->jupyterlab) (24.11.1)
Requirement already satisfied: wcwidth in /opt/anaconda3/lib/python3.12/si
te-packages (from prompt-toolkit<3.1.0,>=3.0.41->ipython>=7.23.1->ipykerne
l>=6.5.0->jupyterlab) (0.2.5)
Requirement already satisfied: cffi>=1.0.1 in /opt/anaconda3/lib/python3.1
2/site-packages (from argon2-cffi-bindings->argon2-cffi>=21.1->jupyter-ser
ver<3,>=2.4.0->jupyterlab) (1.17.1)
Requirement already satisfied: soupsieve>1.2 in /opt/anaconda3/lib/python
3.12/site-packages (from beautifulsoup4->nbconvert>=6.4.4->jupyter-server<
3,>=2.4.0->jupyterlab) (2.5)
Requirement already satisfied: executing in /opt/anaconda3/lib/python3.12/
site-packages (from stack-data->ipython>=7.23.1->ipykernel>=6.5.0->jupyter
lab) (0.8.3)
Requirement already satisfied: asttokens in /opt/anaconda3/lib/python3.12/
site-packages (from stack-data->ipython>=7.23.1->ipykernel>=6.5.0->jupyter
lab) (2.0.5)
Requirement already satisfied: pure-eval in /opt/anaconda3/lib/python3.12/
site-packages (from stack-data->ipython>=7.23.1->ipykernel>=6.5.0->jupyter
lab) (0.2.2)
Requirement already satisfied: pycparser in /opt/anaconda3/lib/python3.12/
site-packages (from cffi>=1.0.1->argon2-cffi-bindings->argon2-cffi>=21.1->
jupyter-server<3,>=2.4.0->jupyterlab) (2.21)
Requirement already satisfied: arrow>=0.15.0 in /opt/anaconda3/lib/python
3.12/site-packages (from isoduration->jsonschema[format-nongpl]>=4.18.0->j
upyter-events>=0.9.0->jupyter-server<3,>=2.4.0->jupyterlab) (1.2.3)
Note: you may need to restart the kernel to use updated packages.
```

In [3]:
```
pip -V
```

```
pip 24.2 from /opt/anaconda3/lib/python3.12/site-packages/pip (python 3.1
2)
Note: you may need to restart the kernel to use updated packages.
```

In [4]:
```
!pip install numpy
```

```
Requirement already satisfied: numpy in /opt/anaconda3/lib/python3.12/site
-packages (1.26.4)
```

In [5]:
```
numpy -V
```

```
---------------------------------------------------------------------------
-
NameError                                 Traceback (most recent call las
t)
Cell In[5], line 1
----> 1 numpy -V

NameError: name 'numpy' is not defined
```

In [ ]:
```
!pip freeze
```

In [ ]:
```
import numpy
```

In [ ]:
```
arr = numpy.array([1,2,3,4,5])
print(arr)
```

NumPy as np

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

In [ ]:
```
arr = np.array([1,2,3,4,5])
print(arr)
```

In [ ]:
```
np.__version__
```

Create a NumPy ndarray Object

In [ ]:
```
arr = np.array([1,2,3,4,5])
print(arr)
print(type(arr))
```

we can pass a list, tuple or any array-like object into the array()

In [ ]:
```
arr = np.array((1,2,3,4))
print(arr)
```

In [ ]:
```
print(type(arr))
```

0-D Arrays

In [ ]:
```
arr = np.array(42)
print(arr)
```

1-D Arrays

In [ ]:
```
arr = np.array([1,2,3,4,5])
print(arr)
```

2-D Arrays

In [ ]:
```
arr = np.array([[1,2,3],[4,5,6]])
print(arr)
```

3-D arrays

In [ ]:
```
arr = np.array([[[1,2,3],[4,5,6]],[[7,8,9],[11,12,13]]])
print(arr)
```

Check Number of Dimensions?

In [ ]:
```
arr0 = np.array(42)
arr1 = np.array([1,2,3])
arr2 = np.array([[1,2,3],[4,5,6]])
arr3 = np.array([[[1,2,3],[4,5,6]],[[7,8,9],[10,11,12]]])
arr4 = np.array([[[[1,2][3,4]],[[5,6],[7,8]]],[[[1,2][3,4]],[[5,6],[7,8]]
print(arr0.ndim)
print(arr1.ndim)
print(arr2.ndim)
print(arr3.ndim)
print(arr4.ndim)
```

In [ ]:
```

```

In [ ]:
```
 arr4d = np.zeros((2,3,4,5))
print(arr4d)
```

In [ ]:
```

```

In [ ]:
```
 arr4d = np.ones((2,3,4,5))
print(arr4d)
```

In [ ]:
```
 arr4d = np.twos((2,3,4,5))
print(arr4d)
```

data-type for the array

In [ ]:
```
arr = np.array([1,2,3,4], dtype=float)
print(arr)
```

In [ ]:
```

```

In [ ]:
```
arr = np.array([1,2,3,4], dtype=complex)
print(arr)
```

In [ ]:
```
arr = np.array([1,2,3,4], dtype=bool)
print(arr)
```

arange

In [ ]:
```

```

In [ ]:
```
arr = np.arange(1,25)
print(arr)
```

In [ ]:
```
arr = np.arange(1,25,2)
print(arr)
```

In [ ]:
```
import numpy as np
arr = np.arange(1,25,3)
print(arr)
```

In [ ]:
```
 np.arange(1,25,3).reshape(2,4)
```

In [ ]:
```
 arr = np.arange(1,2).reshape(1,1)
print(arr)
```

In [ ]:
```

```

Rand function

In [ ]:
```

```

In [ ]:
```

```

In [ ]:
```
# Syntax random.rand(rows,columns) by default the outout in float values

rand(3,2)
```

In [ ]:
```

```

In [ ]:
```

```

In [ ]:
```
random.rand(3)
```

In [ ]:
```
np.random.rand(3)
```

In [ ]:
```
np.random.rand(3,3)
```

In [ ]:
```
np.random.randint(3,100)
```

In [ ]:
```
np.random.rand(3,100)
```

In [ ]:
```
np.random.randint(0,1)
```

In [ ]:
```
b = np.random.rand(2,2)
type(b)
```

In [ ]:
```
np.random.rand(2,1)
```

In [ ]:
```
np.random.rand(1,1)
```

In [ ]:
```
np.random.randint(2,1)
```

In [ ]:
```
np.random.randint(2,2)
```

In [ ]:
```

```

In [ ]:
```
np.random.randint(10,20,3)
```

In [ ]:
```
np.random.randint(1,11,11)
```

In [ ]:
```
np.random.randint(0)
```

In [ ]:
```
np.random.randint(30,20,10)
```

In [ ]:
```
np.random.rand(30,20,10)
```

In [ ]:
```
np.random.randint(-30,20,10)
```

In [ ]:
```
np.random.randint(1,50,(10,10))  # np.random.randint(start value, end val
```

In [ ]:
```
np.random.randint(1,100,(12,12))
```

In [ ]:
```
np.random.rand(1,100,5)
```

Reshape function

In [ ]:
```
np.arange(1,10)
```

In [ ]:
```
np.arange(1,10).reshape(3,3)
```

In [ ]:
```
np.arange(1,11).reshape(2,5)
```

In [ ]:
```
np.arange(1,12).reshape(1,11)
```

In [ ]:
```
np.arange(1,25).reshape(6,4)
```

In [ ]:
```
np.arange(2,2).reshape(1,1)
```

In [ ]:
```
np.arange(10,20).reshape(5,2)
```

In [ ]:
```
b1 = np.random.randint(10,20,(5,4))
print(b1)
type(b1)
```

Slicing & Indexing in Numpy

In [ ]:

In [ ]:

In [ ]:
```
print(b1)
```

In [ ]:

In [ ]:
```
b1[:]
```

In [ ]:
```
b1[::]
```

In [ ]:
```
b1[::3]
```

In [ ]:
```
b1[1:3]
```

In [ ]:
```
b1[1,2]
```

In [ ]:
```
b1[1,3]
```

In [ ]:
```
b1[0:1]
```

In [ ]:
```
b1[0:-2]
```

In [ ]:
```
b1[0,-2]
```

In [ ]:
```
b1[::]
```

In [ ]:
```
b1[-4:2]
```

In [ ]:
```
b2 = np.arange(1,100).reshape(11,9)
```

```
print(b2)
```

In [ ]:
```
b2[0:5 ]
```

In [ ]:
```
arr = np.random.randint(1,100,(10,10))
print(arr)
```

In [ ]:
```
arr[1,4]
```

In [ ]:
```
b2[1,4]
b2[1:4]
```

In [ ]:
```
arr.max()
```

In [ ]:
```
arr.min()
```

In [ ]:
```
arr1 = np.array([1,2,3,3,4])
print(arr1)
print(type(arr1))
```

In [ ]:
```
arr1.mean()
```

In [ ]:
```
np.median(arr1)
```

In [ ]:
```
mat = np.arange(0,100).reshape(10,10)
print(mat)
```

In [ ]:
```

```

In [ ]:
```
mat[4,5]
```

In [ ]:
```
mat[4]
```

In [ ]:
```
mat[:,5]
```

In [ ]:
```

```

In [ ]:
```
mat[6,:]
```

In [ ]:
```
mat[6]
```

In [ ]:
```
mat[2:6,2:4]
```

In [ ]:
```
print(mat)
```

In [ ]:
```

```

In [ ]:
```
mat[2:3, 2:3]
```

In [ ]:
```

```

In [ ]:
```
mat[3:5,2:4]
```

In [ ]:
```

```

In [ ]:
```
mat[4:7,4:6]
```

In [ ]:
```
mat [2:5, 4:5]
```

Linearly space

In [ ]:
```

```

In [ ]:
```
import numpy as np
arr = np.arange(1,11).reshape(5,2)
print(arr)
```

In [ ]:
```
arr[0]
```

In [ ]:
```

```

In [ ]:
```
arr[0] = [11,12]
```

In [ ]:
```
print(arr)
```

In [ ]:
```
arr[1,1]
```

Array attributes

linspace()

In [ ]:
```
arr = np.linspace(0, 10, num= 10)
print(arr)
```

In [ ]:
```
arr = np.linspace(0,10, num=10, endpoint=False)
print(arr)
```

In [ ]:
```
arr = np.linspace(-5,5, num=4, retstep=True)
print(arr)
```

In [ ]:
```
arr = np.linspace([10,20],[15,25], num=3, endpoint = True, axis=1, )
print(arr)
```

identity

In [ ]:
```
arr = np.identity(3)
print(arr)
newmat = arr.astype(int)
print(newmat)
```

numpy.arange() in Python

In [ ]:
```
arr = np.arange(4).reshape(2,2)
print(arr)
```

In [ ]:
```
arr = np.arange(4)
print(arr)
```

In [ ]:
```
arr = np.arange(1, 20, 2)
print(arr)
```

In [ ]:
```
print(np.arange(1, 2, 0.1))
```

Counting Backwards

In [ ]:
```
arr = np.arange(5,1,1)
print(arr)
```

In [ ]:
```

```

In [ ]:
```
arr = np.arange(1,20,2)[::-1]
print(arr)
```

In [ ]:
```
arr = np.arange(8,2,1)
print(arr)
```

In [ ]:
```
arr = np.arange(2,9,2)
print(arr)
```

In [ ]:
```
arr = np.arange(9,9)
print(arr)
```

In [ ]:
```
arr = np.arange(10,9,1)
print(arr)
```

```
arr.ndim
```

In [ ]:
```
arr = np.arange(1,21).reshape(4,5)
print(arr)
```

In [ ]:
```
arr.ndim
```

In [ ]:
```
arr.ndmin
```

In [ ]:
```
arr = np.array([1,2,3,4,5], ndmin=5)
print(arr)
```

In [ ]:
```
print(arr.ndim)
```

In [ ]:
```
arr = np.array([[1,2,3,4],[5,6,7,8]])
print(arr.shape)
print(arr.ndim)
```

item size

In [ ]:
```
import numpy as np
a1 = np.arange(0,10)
print(a1)
```

In [ ]:
```
a1.itemsize
```

In [ ]:
```
a1.dtype
```

Changing Data Type

In [ ]:
```
x = np.array([1,2,3,4.5,6.7])
x
```

In [ ]:
```
x.astype(int)
```

In [ ]:
```
x.astype(float)
```

In [ ]:
```
x.astype(complex)
```

In [ ]:
```
x.astype(bool)
```

In [ ]:
```
x.astype(str)
```

Array operations

In [ ]:
```
z1 = np.arange(12).reshape(3,4)
z2 = np.arange(12,24).reshape(3,4)
print(z1)
print(z2)
```

scalar operations

In [ ]:
```
z1
```

In [ ]:
```
z1+2
```

In [ ]:
```
z2+1
```

In [ ]:
```
# Subtraction

z1-1
```

In [ ]:
```
z2-1
```

In [ ]:
```
# Multiplication
z1*2
```

In [ ]:
```
z2*3
```

In [ ]:
```
# power

z1**2
```

In [ ]:
```
z2**2
```

In [ ]:
```
## Modulo

z1%1
```

In [ ]:
```
z2%1
```

In [ ]:
```
z2%0
```

relational Operators

In [ ]:
```
z1
```

In [ ]:
```
z2
```

In [ ]:
```
z1>1
```

In [ ]:
```
z1>5
```

In [ ]:
```
z2<3
```

Vector Operation

In [ ]:
```
z1
```

In [ ]:
```
z2
```

In [ ]:
```
z1 + z2
```

In [ ]:
```
z1-z2
```

In [ ]:
```
z1*z2
```

In [ ]:
```
z1/z2
```

Array Functions

In [ ]:
```
k1 = np.random.random((3,3))
k1
```

In [ ]:
```

```

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

In [ ]:
```
k2 = np.random.rand(3,3)
k2
```

In [ ]:
```
k1 = np.round(k1*100)
k1
```

In [ ]:
```
np.max(k1)
```

In [ ]:
```
np.min(k1)
```

In [ ]:
```
np.sum(k1)
```

In [ ]:
```
np.prod(k1)
```

In [ ]:
```
# if we want maximum of every row
np.max(k1, axis=1)  #row =1 , col=0
```

In [ ]:
```
# maximum of every column
np.max(k1, axis=0)
```

In [ ]:
```
arr = np.random.rand(1,12)
arr1 = arr.astype(int)
arr1
```

In [ ]:
```
# product of every column
np.prod(k1, axis=0)
```

Statistics related fuctions

In [ ]:
```
# round / floor /ceil
```

In [ ]:
```
arr = np.array([1.6,3.2,4.6,3.7])
np.round(arr)
```

In [ ]:
```
# Round to two decimals
arr = np.array([1.234, 2.567, 3.891])
np.round(arr, decimals=2)
```

In [ ]:
```
arr = np.array([[[0, 1],
                 [2, 3]],

                [[4, 5],
                 [6, 7]]])
arr
```

In [ ]:
```
arr[1,1,1]
```

arr[0,1,0]

In [ ]:
```
arr[1,0,1]
```

In [ ]:
```
p2 = np.array([[ 0, 1, 2, 3],
[ 4, 5, 6, 7],
[ 8, 9, 10, 11]])
p2
```

In [ ]:
```
p2[1:2]
```

In [ ]:
```
p2[:]
```

In [ ]:
```

```

In [ ]:
```
p2[0,:]
```

In [ ]:
```
p2[1,]
```

In [ ]:
```
p2[2,]
```

In [ ]:
```
p2[:,2]
```

In [ ]:
```
p2[:,0]
```

In [ ]:
```
p2[1:2:1]
```

In [ ]:
```
p2[1:3, 1:3]
```

In [ ]:
```
p2[-2:1, -2:1]
```

In [ ]:
```
# Slicing
```

In [ ]:
```
import numpy as np
p1 = np.array([0, 1, 2, 3, 4, 5, 6, 7, 8, 9])
p1
```

In [ ]:
```
p1[2:5]
```

In [ ]:
```
p2 = np.array([[ 0, 1, 2, 3],
[ 4, 5, 6, 7],
[ 8, 9, 10, 11]])
p2
```

In [ ]:
```

```

In [ ]:
```
p2[0,:]
```

In [ ]:
```
p2[:,3]
```

In [ ]:
```
p2[::2,::3]
```

p2[row_start,row_stop,row_stpe:col_start,cc

In [ ]:
```
arr = np.array([[1, 3, 5, 7],
                [9, 11, 13, 15]])
arr
```

In [ ]:
```
arr[:]
```

In [ ]:
```
arr[:2,:2]
```

In [ ]:
```
arr[0:3,1:3]
```

In [ ]:
```
arr[:3,0:2]
```

In [ ]:
```
arr[]
```

In [ ]:
```
arr[-1,-3]
```

In [ ]:
```
arr
```

In [ ]:
```
arr[-1,2:4]
```

In [ ]:
```
arr[0,2:]
```

In [ ]:
```
    arr[0,1:3]
```

In [ ]:
```
arr[1,0:2]
```

In [ ]:
```
arr
```

In [ ]:
```
arr[1,2:4]
```

In [ ]:
```

```

In [ ]:
```
p2 = np.array([[ 0, 1, 2, 3],[ 4, 5, 6, 7],[ 8, 9, 10, 11]])
p2
```

In [ ]:
```
p2[0:2, 1:]
```

In [ ]:
```
p2[1:2,2:3]
```

In [100…
```
import numpy as np

p2 = np.array([[ 0, 1, 2, 3],
[ 4, 5, 6, 7],
[ 8, 9, 10, 11]])
```

In [102…
```
p2
```

Out[102…
```
array([[ 0,  1,  2,  3],
       [ 4,  5,  6,  7],
       [ 8,  9, 10, 11]])
```

In [104…
```
p2 [2:]
```

Out[104…
```
array([[ 8,  9, 10, 11]])
```

In [106…
```
p2[:2]
```

Out[106…
```
array([[0, 1, 2, 3],
       [4, 5, 6, 7]])
```

In [ ]:

In [110…
```
p2[0,:]
```

Out[110…
```
array([0, 1, 2, 3])
```

In [112…
```
p2[1:3]
```

Out[112…
```
array([[ 4,  5,  6,  7],
       [ 8,  9, 10, 11]])
```

In [116…
```
p2[1:3,1:3]
```

Out[116…
```
array([[ 5,  6],
       [ 9, 10]])
```

In [118…
```
p2
```

Out[118…
```
array([[ 0,  1,  2,  3],
       [ 4,  5,  6,  7],
       [ 8,  9, 10, 11]])
```

In [120…
```
p2[0:2]
```

Out[120…
```
array([[0, 1, 2, 3],
       [4, 5, 6, 7]])
```

In [126…
```
p2[2,]
```

Out[126…
```
array([ 8,  9, 10, 11])
```

In [140…
```
p2[0:2,2:]
```

Out[140…
```
array([[2, 3],
       [6, 7]])
```

In [142…
```
p2
```

Out[142…
```
array([[ 0,  1,  2,  3],
       [ 4,  5,  6,  7],
       [ 8,  9, 10, 11]])
```

In [144…
```
p2[0:2]
```

Out[144…
```
array([[0, 1, 2, 3],
       [4, 5, 6, 7]])
```

In [146…
```
p2[0:2,1:3]
```

Out[146…
```
array([[1, 2],
       [5, 6]])
```

In [164…
```
p2[0:2,1::2]
```

Out[164…
```
array([[1, 3],
       [5, 7]])
```

In [168…
```
p2[1:2]
```

Out[168…
```
array([[4, 5, 6, 7]])
```

In [172…
```
p2
```

Out[172…
```
array([[ 0,  1,  2,  3],
       [ 4,  5,  6,  7],
       [ 8,  9, 10, 11]])
```

In [178…
```
p2[0:2, 0:2]
```

Out[178…
```
array([[0, 1],
       [4, 5]])
```

In [184…
```
p2[1:3,2:]
```

Out[184…
```
array([[ 6,  7],
       [10, 11]])
```

In [190…
```
p2[1:3,0::2]
```

Out[190…
```
array([[ 4,  6],
       [ 8, 10]])
```

In [194…
```
p2[1,1]
```

Out[194…
```
5
```

In [196…
```
# Slicing in 3D
```

In [200…
```
p3 = np.arange(27).reshape(3,3,3)
p3
```

Out[200…
```
array([[[ 0,  1,  2],
        [ 3,  4,  5],
        [ 6,  7,  8]],

       [[ 9, 10, 11],
        [12, 13, 14],
        [15, 16, 17]],

       [[18, 19, 20],
        [21, 22, 23],
        [24, 25, 26]]])
```

In [204…
```
p3[0]
```

Out[204…
```
array([[0, 1, 2],
       [3, 4, 5],
       [6, 7, 8]])
```

In [208…
```
p3[1]
```

Out[208…
```
array([[ 9, 10, 11],
       [12, 13, 14],
       [15, 16, 17]])
```

In [224…
```
p3[0]
```

Out[224…
```
array([[0, 1, 2],
       [3, 4, 5],
       [6, 7, 8]])
```

In [232…
```
p3[0,1]
```

Out[232…
```
array([3, 4, 5])
```

In [238…
```
p3[0,:,1]
```

Out[238…
```
array([1, 4, 7])
```

In [241…
```
p3[2]
```

Out[241…
```
array([[18, 19, 20],
       [21, 22, 23],
       [24, 25, 26]])
```

In [247…
```
p3[2,1:]
```

Out[247…
```
array([[21, 22, 23],
       [24, 25, 26]])
```

In [253…
```
p3[2, 1:,1:]
```

Out[253…
```
array([[22, 23],
       [25, 26]])
```

In [257…
```
p3[1]
```

Out[257…
```
array([[ 9, 10, 11],
       [12, 13, 14],
       [15, 16, 17]])
```

In [261…
```
p3[1,0:2]
```

Out[261…
```
array([[ 9, 10, 11],
       [12, 13, 14]])
```

In [289…
```
p3[1, 0:2,:2]
```

Out[289…
```
array([[ 9, 10],
       [12, 13]])
```

In [291…
```
p3[0]
```

Out[291…
```
array([[0, 1, 2],
       [3, 4, 5],
       [6, 7, 8]])
```

In [299…
```
p3[0,]
```

Out[299…
```
array([[0, 1, 2],
       [3, 4, 5],
       [6, 7, 8]])
```

In [305…
```
p3[0]
```

Out[305…
```
array([[0, 1, 2],
       [3, 4, 5],
       [6, 7, 8]])
```

In [311…
```
p3[0, 1:3,1:]
```

Out[311…
```
array([[4, 5],
       [7, 8]])
```

In [329…
```
p3[0,0:1,1:]
```

Out[329…
```
array([[1, 2]])
```

Examples from WEC

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

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

Out[2]:
```
array([[[ 1,  2,  3],
        [ 4,  5,  6]],

       [[ 7,  8,  9],
        [10, 11, 12]]])
```

In [4]:
```
arr[1,1,1]
```

Out[4]:
```
11
```

In [6]:
```
arr[0,0,0]
```

Out[6]:
```
1
```

In [12]:
```
arr[0,1:]
```

Out[12]:
```
array([[4, 5, 6]])
```

NumPy Array Copy vs View

In [15]:
```
import numpy as np

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

newarr = arr.copy()
arr[0] = 21
print(newarr)
print(arr)
```

```
[1 2 3 4 5]
[21  2  3  4  5]
```

In [ ]:
```

```