Numpy

```
In [357... import numpy as np
```

```
In [359... np.__version__
```

```
Out[359... '1.26.4'
```

Creating Arrays

```
In [364... my_list = [0,1,2,3,4,5]
         my_list
```

```
Out[364... [0, 1, 2, 3, 4, 5]
```

```
In [366... type(my_list)
```

```
Out[366...  list
```

```
In [368... arr = np.array(my_list)
```

```
In [370... arr
```

```
Out[370...  array([0, 1, 2, 3, 4, 5])
```

```
In [372... type(arr)
```

```
Out[372...  numpy.ndarray
```

```
In [374... type(my_list)
```

```
Out[374...  list
```

Arange

```
In [378... np.arange(5)
```

```
Out[378...  array([0, 1, 2, 3, 4])
```

```
In [382... np.arange(3.0)
```

```
Out[382...  array([0., 1., 2.])
```

```
In [384... np.arange(10)
```

```
Out[384...  array([0, 1, 2, 3, 4, 5, 6, 7, 8, 9])
```

```
In [388... np.arange(0,5)
```

Out[388…   `array([0, 1, 2, 3, 4])`

In [392…   ```python
np.arange(10,20)
```

Out[392…    `array([10, 11, 12, 13, 14, 15, 16, 17, 18, 19])`

In [398…    ```python
np.arange(20,10)
```

Out[398…   `array([], dtype=int32)`

In [400…   ```python
np.arange(-20,10)
```

Out[400…    ```
array([-20, -19, -18, -17, -16, -15, -14, -13, -12, -11, -10,  -9,  -8,
        -7,  -6,  -5,  -4,  -3,  -2,  -1,   0,   1,   2,   3,   4,   5,
         6,   7,   8,   9])
```

In [404…   ```python
np.arange(-15,10)
```

Out[404…    ```
array([-15, -14, -13, -12, -11, -10,  -9,  -8,  -7,  -6,  -5,  -4,  -3,
        -2,  -1,   0,   1,   2,   3,   4,   5,   6,   7,   8,   9])
```

In [406…   ```python
np.arange(-20,-10)
```

Out[406…    `array([-20, -19, -18, -17, -16, -15, -14, -13, -12, -11])`

In [408…    ```python
np.arange(30,20) # 1st arg should be < than 2nd arg
```

Out[408…   `array([], dtype=int32)`

In [412…   ```python
b = np.arange(-30,20)
b
```

Out[412…    ```
array([-30, -29, -28, -27, -26, -25, -24, -23, -22, -21, -20, -19, -18,
       -17, -16, -15, -14, -13, -12, -11, -10,  -9,  -8,  -7,  -6,  -5,
        -4,  -3,  -2,  -1,   0,   1,   2,   3,   4,   5,   6,   7,   8,
         9,  10,  11,  12,  13,  14,  15,  16,  17,  18,  19])
```

In [414…   ```python
np.arange(10,30,5)
```

Out[414…    `array([10, 15, 20, 25])`

In [416…    ```python
np.arange(0,10,3)
```

Out[416…   `array([0, 3, 6, 9])`

In [418…   ```python
np.arange(10,30,5,1)
```

```
---------------------------------------------------------------------------
TypeError                                 Traceback (most recent call last)
Cell In[418], line 1
----> 1 np.arange(10,30,5,1)

TypeError: Cannot interpret '1' as a data type
```

Zeros

```
In [422…  b1 = np.zeros(2) # paramaeter tunning
          b1
```

```
Out[422…  array([0., 0.])
```

```
In [424…  np.zeros(5,dtype=int)
```

```
Out[424…  array([0, 0, 0, 0, 0])
```

```
In [426…  zero = np.zeros((2,2))
          zero
```

```
Out[426…  array([[0., 0.],
                 [0., 0.]])
```

```
In [428…  np.zeros((10,10))
```

```
Out[428…  array([[0., 0., 0., 0., 0., 0., 0., 0., 0., 0.],
                 [0., 0., 0., 0., 0., 0., 0., 0., 0., 0.],
                 [0., 0., 0., 0., 0., 0., 0., 0., 0., 0.],
                 [0., 0., 0., 0., 0., 0., 0., 0., 0., 0.],
                 [0., 0., 0., 0., 0., 0., 0., 0., 0., 0.],
                 [0., 0., 0., 0., 0., 0., 0., 0., 0., 0.],
                 [0., 0., 0., 0., 0., 0., 0., 0., 0., 0.],
                 [0., 0., 0., 0., 0., 0., 0., 0., 0., 0.],
                 [0., 0., 0., 0., 0., 0., 0., 0., 0., 0.],
                 [0., 0., 0., 0., 0., 0., 0., 0., 0., 0.]])
```

```
In [430…  np.zeros((2,10))
```

```
Out[430…  array([[0., 0., 0., 0., 0., 0., 0., 0., 0., 0.],
                 [0., 0., 0., 0., 0., 0., 0., 0., 0., 0.]])
```

```
In [432…  np.zeros((2,3))
```

```
Out[432…  array([[0., 0., 0.],
                 [0., 0., 0.]])
```

```
In [434…  np.zeros((3,3))
```

```
Out[434…  array([[0., 0., 0.],
                 [0., 0., 0.],
                 [0., 0., 0.]])
```

```
In [436…  np.zeros((10,30))
```

```
Out[436…  array([[0., 0., 0., 0., 0., 0., 0., 0., 0., 0., 0., 0., 0., 0., 0., 0.,
                0., 0., 0., 0., 0., 0., 0., 0., 0., 0., 0., 0., 0., 0.],
               [0., 0., 0., 0., 0., 0., 0., 0., 0., 0., 0., 0., 0., 0., 0., 0.,
                0., 0., 0., 0., 0., 0., 0., 0., 0., 0., 0., 0., 0., 0.],
               [0., 0., 0., 0., 0., 0., 0., 0., 0., 0., 0., 0., 0., 0., 0., 0.,
                0., 0., 0., 0., 0., 0., 0., 0., 0., 0., 0., 0., 0., 0.],
               [0., 0., 0., 0., 0., 0., 0., 0., 0., 0., 0., 0., 0., 0., 0., 0.,
                0., 0., 0., 0., 0., 0., 0., 0., 0., 0., 0., 0., 0., 0.],
               [0., 0., 0., 0., 0., 0., 0., 0., 0., 0., 0., 0., 0., 0., 0., 0.,
                0., 0., 0., 0., 0., 0., 0., 0., 0., 0., 0., 0., 0., 0.],
               [0., 0., 0., 0., 0., 0., 0., 0., 0., 0., 0., 0., 0., 0., 0., 0.,
                0., 0., 0., 0., 0., 0., 0., 0., 0., 0., 0., 0., 0., 0.],
               [0., 0., 0., 0., 0., 0., 0., 0., 0., 0., 0., 0., 0., 0., 0., 0.,
                0., 0., 0., 0., 0., 0., 0., 0., 0., 0., 0., 0., 0., 0.],
               [0., 0., 0., 0., 0., 0., 0., 0., 0., 0., 0., 0., 0., 0., 0., 0.,
                0., 0., 0., 0., 0., 0., 0., 0., 0., 0., 0., 0., 0., 0.],
               [0., 0., 0., 0., 0., 0., 0., 0., 0., 0., 0., 0., 0., 0., 0., 0.,
                0., 0., 0., 0., 0., 0., 0., 0., 0., 0., 0., 0., 0., 0.],
               [0., 0., 0., 0., 0., 0., 0., 0., 0., 0., 0., 0., 0., 0., 0., 0.,
                0., 0., 0., 0., 0., 0., 0., 0., 0., 0., 0., 0., 0., 0.]])
```

In [438…
```python
np.zeros((5,10))
```

Out[438…
```
array([[0., 0., 0., 0., 0., 0., 0., 0., 0., 0.],
       [0., 0., 0., 0., 0., 0., 0., 0., 0., 0.],
       [0., 0., 0., 0., 0., 0., 0., 0., 0., 0.],
       [0., 0., 0., 0., 0., 0., 0., 0., 0., 0.],
       [0., 0., 0., 0., 0., 0., 0., 0., 0., 0.]])
```

In [440…
```python
n = (5,7)
n1 = (6,8)
print(np.zeros(n))
```

```
[[0. 0. 0. 0. 0. 0. 0.]
 [0. 0. 0. 0. 0. 0. 0.]
 [0. 0. 0. 0. 0. 0. 0.]
 [0. 0. 0. 0. 0. 0. 0.]
 [0. 0. 0. 0. 0. 0. 0.]]
```

In [442…
```python
print(np.zeros(n1))
```

```
[[0. 0. 0. 0. 0. 0. 0. 0.]
 [0. 0. 0. 0. 0. 0. 0. 0.]
 [0. 0. 0. 0. 0. 0. 0. 0.]
 [0. 0. 0. 0. 0. 0. 0. 0.]
 [0. 0. 0. 0. 0. 0. 0. 0.]
 [0. 0. 0. 0. 0. 0. 0. 0.]]
```

In [445…
```python
np.ones(4,dtype=int)
```

Out[445…
```
array([1, 1, 1, 1])
```

In [447…
```python
np.ones(4)
```

Out[447…
```
array([1., 1., 1., 1.])
```

In [449…
```python
n
```

Out[449…
```
(5, 7)
```

In [451…
```python
np.ones(n)
```

Out[451…
```
array([[1., 1., 1., 1., 1., 1., 1.],
       [1., 1., 1., 1., 1., 1., 1.],
       [1., 1., 1., 1., 1., 1., 1.],
       [1., 1., 1., 1., 1., 1., 1.],
       [1., 1., 1., 1., 1., 1., 1.]])
```

In [455…
```python
np.ones((5,4),dtype=int)
```

Out[455…
```
array([[1, 1, 1, 1],
       [1, 1, 1, 1],
       [1, 1, 1, 1],
       [1, 1, 1, 1],
       [1, 1, 1, 1]])
```

In [457…
```python
np.twos((2,3))
```

```
---------------------------------------------------------------------------
AttributeError                            Traceback (most recent call last)
Cell In[457], line 1
----> 1 np.twos((2,3))

File ~\anaconda3\Lib\site-packages\numpy\__init__.py:333, in __getattr__(attr)
    330     "Removed in NumPy 1.25.0"
    331     raise RuntimeError("Tester was removed in NumPy 1.25.")
--> 333 raise AttributeError("module {!r} has no attribute "
    334                      "{!r}".format(__name__, attr))

AttributeError: module 'numpy' has no attribute 'twos'
```

In [459…
```python
np.ones((2,4))
```

Out[459…
```
array([[1., 1., 1., 1.],
       [1., 1., 1., 1.]])
```

In [461…
```python
np.ones((6,4),dtype=int)
```

Out[461…
```
array([[1, 1, 1, 1],
       [1, 1, 1, 1],
       [1, 1, 1, 1],
       [1, 1, 1, 1],
       [1, 1, 1, 1],
       [1, 1, 1, 1]])
```

In [463…
```python
np.threes((2,4))
```

```
---------------------------------------------------------------------------
AttributeError                            Traceback (most recent call last)
Cell In[463], line 1
----> 1 np.threes((2,4))

File ~\anaconda3\Lib\site-packages\numpy\__init__.py:333, in __getattr__(attr)
    330     "Removed in NumPy 1.25.0"
    331     raise RuntimeError("Tester was removed in NumPy 1.25.")
--> 333 raise AttributeError("module {!r} has no attribute "
    334                      "{!r}".format(__name__, attr))

AttributeError: module 'numpy' has no attribute 'threes'
```

In [465…
```python
from numpy import *
arange(3)
```

Out[465…
```
array([0, 1, 2])
```

In [467…
```python
range(12)
list(range(12))
```

Out[467…
```
[0, 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11]
```

In [469…
```python
y = list(range(12))
y
```

Out[469…
```
[0, 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11]
```

In [471…
```python
from numpy import *
zeros(5)
```

Out[471…
```
array([0., 0., 0., 0., 0.])
```

In [473…
```python
np.threes((3,2))
```

```
---------------------------------------------------------------------------
AttributeError                            Traceback (most recent call last)
Cell In[473], line 1
----> 1 np.threes((3,2))

File ~\anaconda3\Lib\site-packages\numpy\__init__.py:333, in __getattr__(attr)
    330     "Removed in NumPy 1.25.0"
    331     raise RuntimeError("Tester was removed in NumPy 1.25.")
--> 333 raise AttributeError("module {!r} has no attribute "
    334                      "{!r}".format(__name__, attr))

AttributeError: module 'numpy' has no attribute 'threes'
```

In [3]:
```python
import numpy as np
```

In [3]:
```python
rand(3,2)
```

```
---------------------------------------------------------------------------
NameError                                 Traceback (most recent call last)
Cell In[3], line 1
----> 1 rand(3,2)

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

In [5]:
```python
import random as rand
```

In [9]:
```python
np.random.rand(3,2)
```

Out[9]:
```
array([[0.47806486, 0.13921279],
       [0.92755239, 0.69328269],
       [0.04738789, 0.45440195]])
```

In [17]:
```python
np.random.rand(4,5)
```

```
Out[17]: array([[0.37003704, 0.91003753, 0.91971085, 0.39779105, 0.30386726],
                [0.35659315, 0.87730385, 0.30381141, 0.46263715, 0.42087968],
                [0.19449755, 0.40471517, 0.12878682, 0.36977117, 0.21096677],
                [0.96056802, 0.34381198, 0.97623617, 0.68608704, 0.16242407]])
```

In [19]:
```
np.random.rand(2,3)
```

Out[19]:
```
array([[0.44481872, 0.51273128, 0.34004851],
       [0.06767673, 0.83087368, 0.9010923 ]])
```

In [25]:
```
np.random.randint(2,3)
```

Out[25]: 2

In [33]:
```
np.random.randint(2,4)
```

Out[33]: 2

In [51]:
```
np.random.randint(2,20)
```

Out[51]: 19

In [53]:
```
np.random.randint(0,1)
```

Out[53]: 0

In [60]:
```
np.random.randint(10,20,3)
```

Out[60]: array([13, 14, 13])

In [62]:
```
np.random.randint(10,20,5)
```

Out[62]: array([10, 18, 19, 18, 10])

In [66]:
```
np.random.rand(3)
```

Out[66]: array([0.65920254, 0.01052901, 0.98580052])

In [68]:
```
np.random.randint(30,20,10)
```

```
---------------------------------------------------------------------------
ValueError                                Traceback (most recent call last)
Cell In[68], line 1
----> 1 np.random.randint(30,20,10)

File numpy\\random\\mtrand.pyx:780, in numpy.random.mtrand.RandomState.randint()

File numpy\\random\\_bounded_integers.pyx:1425, in numpy.random._bounded_integers._rand_int32()

ValueError: low >= high
```

In [70]:
```
np.random.randint(-30,20,10)
```

Out[70]: array([16, 19, 14, -20, -14, -30, 15, -16, -14, -30])

In [72]:
```
np.random.randint(10,40,(10,10)) #generate he element 10-30 with 4*4 matrix
```

Out[72]:   array([[29, 21, 18, 10, 11, 16, 22, 19, 37, 24],
                   [19, 15, 37, 18, 26, 34, 22, 33, 33, 13],
                   [31, 25, 20, 12, 38, 31, 13, 29, 35, 33],
                   [32, 29, 21, 32, 16, 39, 17, 10, 10, 30],
                   [10, 16, 39, 13, 35, 21, 37, 28, 12, 33],
                   [30, 23, 17, 12, 13, 15, 17, 27, 23, 38],
                   [10, 14, 21, 24, 12, 32, 14, 36, 38, 18],
                   [28, 31, 18, 31, 30, 33, 20, 32, 10, 14],
                   [28, 39, 31, 31, 15, 28, 32, 24, 21, 22],
                   [36, 38, 32, 15, 37, 39, 33, 28, 20, 29]])

In [78]:   np.random.randint(1,100,(12,12))

Out[78]:   array([[49, 3, 59, 8, 54, 92, 62, 47, 39, 17, 24, 30],
                   [92, 75, 12, 51, 10, 72, 11, 97, 54, 83, 1, 67],
                   [50, 39, 42, 28, 79, 17, 28, 21, 97, 96, 5, 20],
                   [60, 21, 10, 97, 49, 63, 99, 26, 28, 70, 76, 33],
                   [52, 6, 52, 73, 84, 27, 86, 51, 25, 96, 33, 3],
                   [35, 55, 98, 5, 10, 39, 54, 29, 52, 31, 51, 57],
                   [68, 74, 95, 66, 67, 69, 78, 62, 13, 40, 26, 82],
                   [75, 90, 8, 19, 93, 17, 66, 37, 93, 68, 20, 37],
                   [37, 35, 80, 50, 88, 77, 16, 1, 62, 26, 49, 12],
                   [73, 99, 32, 42, 35, 69, 43, 29, 41, 69, 24, 22],
                   [4, 26, 18, 74, 24, 39, 87, 26, 93, 31, 8, 42],
                   [59, 31, 31, 64, 29, 51, 41, 84, 50, 61, 69, 84]])

In [74]:   np.random.randint(1,12,10)

Out[74]:   array([11, 2, 3, 11, 11, 1, 11, 4, 2, 9])

In [76]:   np.arange(1,16).reshape(3,5)

Out[76]:   array([[1, 2, 3, 4, 5],
                   [6, 7, 8, 9, 10],
                   [11, 12, 13, 14, 15]])

In [80]:   np.arange(1,10).reshape(3,3)

Out[80]:   array([[1, 2, 3],
                   [4, 5, 6],
                   [7, 8, 9]])

In [82]:   np.arange(1,10).reshape(3,4)

```
---------------------------------------------------------------------------
ValueError                                Traceback (most recent call last)
Cell In[82], line 1
----> 1 np.arange(1,10).reshape(3,4)

ValueError: cannot reshape array of size 9 into shape (3,4)
```

In [86]:   np.arange(1,16).reshape(3,5)

Out[86]:   array([[1, 2, 3, 4, 5],
                   [6, 7, 8, 9, 10],
                   [11, 12, 13, 14, 15]])

In [88]:   np.arange(1,13).reshape(12,1)

```
Out[88]:  array([[ 1],
                 [ 2],
                 [ 3],
                 [ 4],
                 [ 5],
                 [ 6],
                 [ 7],
                 [ 8],
                 [ 9],
                 [10],
                 [11],
                 [12]])
```

```
In [90]:  b = np.random.randint(10,20,(5,4))
```

```
In [92]:  b
```

```
Out[92]:  array([[11, 13, 19, 13],
                 [11, 17, 18, 18],
                 [17, 19, 18, 16],
                 [16, 14, 19, 19],
                 [16, 10, 14, 10]])
```

```
In [94]:  type(b)
```

```
Out[94]:  numpy.ndarray
```

```
In [96]:  b
```

```
Out[96]:  array([[11, 13, 19, 13],
                 [11, 17, 18, 18],
                 [17, 19, 18, 16],
                 [16, 14, 19, 19],
                 [16, 10, 14, 10]])
```

```
In [98]:  b[:]
```

```
Out[98]:  array([[11, 13, 19, 13],
                 [11, 17, 18, 18],
                 [17, 19, 18, 16],
                 [16, 14, 19, 19],
                 [16, 10, 14, 10]])
```

```
In [100…  b[1:3]
```

```
Out[100…  array([[11, 17, 18, 18],
                 [17, 19, 18, 16]])
```

```
In [102…  b[1,2]
```

```
Out[102…  18
```

```
In [104…  b
```

```
Out[104…  array([[11, 13, 19, 13],
                 [11, 17, 18, 18],
                 [17, 19, 18, 16],
                 [16, 14, 19, 19],
                 [16, 10, 14, 10]])
```

In [106… `b[1,3]`

Out[106… 18

In [108… `b[0:5]`

Out[108…
```
array([[11, 13, 19, 13],
       [11, 17, 18, 18],
       [17, 19, 18, 16],
       [16, 14, 19, 19],
       [16, 10, 14, 10]])
```

In [110… `b[2,3]`

Out[110… 16

In [112… `b[1,-1]`

Out[112… 18

In [114… `b`

Out[114…
```
array([[11, 13, 19, 13],
       [11, 17, 18, 18],
       [17, 19, 18, 16],
       [16, 14, 19, 19],
       [16, 10, 14, 10]])
```

In [116… `b[2:3]`

Out[116… `array([[17, 19, 18, 16]])`

In [118… `b`

Out[118…
```
array([[11, 13, 19, 13],
       [11, 17, 18, 18],
       [17, 19, 18, 16],
       [16, 14, 19, 19],
       [16, 10, 14, 10]])
```

In [120… `b[0:-2]`

Out[120…
```
array([[11, 13, 19, 13],
       [11, 17, 18, 18],
       [17, 19, 18, 16]])
```

In [122… `b[0,2]`

Out[122… 19

In [124… `b`

Out[124…
```
array([[11, 13, 19, 13],
       [11, 17, 18, 18],
       [17, 19, 18, 16],
       [16, 14, 19, 19],
       [16, 10, 14, 10]])
```

```
In [126... b[-5,-3]
```

```
Out[126...   13
```

```
In [128... b[-4,2]
```

```
Out[128...   18
```

```
In [134... np.random.randint(10,20,(4,4))
```

```
Out[134...   array([[13, 13, 15, 12],
                  [13, 10, 17, 11],
                  [17, 11, 16, 14],
                  [18, 17, 15, 17]])
```

```
In [136... b
```

```
Out[136...   array([[11, 13, 19, 13],
                  [11, 17, 18, 18],
                  [17, 19, 18, 16],
                  [16, 14, 19, 19],
                  [16, 10, 14, 10]])
```

```
In [138... b[-4:2]
```

```
Out[138...   array([[11, 17, 18, 18]])
```

```
In [140... b[:]
```

```
Out[140...   array([[11, 13, 19, 13],
                  [11, 17, 18, 18],
                  [17, 19, 18, 16],
                  [16, 14, 19, 19],
                  [16, 10, 14, 10]])
```

Operations

```
In [23]: a = np.random.randint(10,20,5)
         a
```

```
Out[23]:  array([10, 16, 10, 14, 14])
```

```
In [7]:  id(a)
```

```
Out[7]:  1399358406352
```

```
In [17]: import array as arr
```

```
In [25]: arr
```

```
Out[25]:  <module 'array' (built-in)>
```

```
In [27]: arr
```

```
Out[27]:  <module 'array' (built-in)>
```

```
In [29]:  arr1 = np.random.randint(0,100,(10,10))
```

```
In [31]:  arr1
```

```
Out[31]:  array([[ 5, 76, 34, 97, 58, 31, 91, 21, 72, 42],
                 [ 9, 79, 35, 53, 12, 22, 81,  2,  7, 11],
                 [40, 25, 20, 94, 72, 32, 22, 77, 18, 96],
                 [60, 84,  9, 64, 17, 52, 45, 61, 93, 48],
                 [74, 85, 62, 58, 89, 32, 86, 75, 96, 10],
                 [75, 22, 71, 55, 91,  0, 83, 45, 40, 60],
                 [46, 41, 38, 42, 71, 14, 70, 86, 53,  0],
                 [38, 89, 63,  7, 85, 68, 80, 60, 86, 74],
                 [ 2, 83, 44, 50, 66, 49, 74, 74, 73, 72],
                 [ 2, 85, 92, 30, 37, 33, 85, 78, 58, 55]])
```

```
In [33]:  arr
```

```
Out[33]:  <module 'array' (built-in)>
```

```
In [35]:  arr1[:]
```

```
Out[35]:  array([[ 5, 76, 34, 97, 58, 31, 91, 21, 72, 42],
                 [ 9, 79, 35, 53, 12, 22, 81,  2,  7, 11],
                 [40, 25, 20, 94, 72, 32, 22, 77, 18, 96],
                 [60, 84,  9, 64, 17, 52, 45, 61, 93, 48],
                 [74, 85, 62, 58, 89, 32, 86, 75, 96, 10],
                 [75, 22, 71, 55, 91,  0, 83, 45, 40, 60],
                 [46, 41, 38, 42, 71, 14, 70, 86, 53,  0],
                 [38, 89, 63,  7, 85, 68, 80, 60, 86, 74],
                 [ 2, 83, 44, 50, 66, 49, 74, 74, 73, 72],
                 [ 2, 85, 92, 30, 37, 33, 85, 78, 58, 55]])
```

```
In [37]:  arr1[:4]
```

```
Out[37]:  array([[ 5, 76, 34, 97, 58, 31, 91, 21, 72, 42],
                 [ 9, 79, 35, 53, 12, 22, 81,  2,  7, 11],
                 [40, 25, 20, 94, 72, 32, 22, 77, 18, 96],
                 [60, 84,  9, 64, 17, 52, 45, 61, 93, 48]])
```

```
In [39]:  arr1[0:5]
```

```
Out[39]:  array([[ 5, 76, 34, 97, 58, 31, 91, 21, 72, 42],
                 [ 9, 79, 35, 53, 12, 22, 81,  2,  7, 11],
                 [40, 25, 20, 94, 72, 32, 22, 77, 18, 96],
                 [60, 84,  9, 64, 17, 52, 45, 61, 93, 48],
                 [74, 85, 62, 58, 89, 32, 86, 75, 96, 10]])
```

```
In [41]:  arr1[1,5]
```

```
Out[41]:  22
```

```
In [43]:  arr1
```

```
Out[43]: array([[ 5, 76, 34, 97, 58, 31, 91, 21, 72, 42],
                [ 9, 79, 35, 53, 12, 22, 81,  2,  7, 11],
                [40, 25, 20, 94, 72, 32, 22, 77, 18, 96],
                [60, 84,  9, 64, 17, 52, 45, 61, 93, 48],
                [74, 85, 62, 58, 89, 32, 86, 75, 96, 10],
                [75, 22, 71, 55, 91,  0, 83, 45, 40, 60],
                [46, 41, 38, 42, 71, 14, 70, 86, 53,  0],
                [38, 89, 63,  7, 85, 68, 80, 60, 86, 74],
                [ 2, 83, 44, 50, 66, 49, 74, 74, 73, 72],
                [ 2, 85, 92, 30, 37, 33, 85, 78, 58, 55]])
```

In [45]: `arr1[-1,5]`

Out[45]: 33

In [47]: `arr1[-5,5]`

Out[47]: 0

In [49]: `arr1[-5,-5]`

Out[49]: 0

In [51]: `arr1`

```
Out[51]: array([[ 5, 76, 34, 97, 58, 31, 91, 21, 72, 42],
                [ 9, 79, 35, 53, 12, 22, 81,  2,  7, 11],
                [40, 25, 20, 94, 72, 32, 22, 77, 18, 96],
                [60, 84,  9, 64, 17, 52, 45, 61, 93, 48],
                [74, 85, 62, 58, 89, 32, 86, 75, 96, 10],
                [75, 22, 71, 55, 91,  0, 83, 45, 40, 60],
                [46, 41, 38, 42, 71, 14, 70, 86, 53,  0],
                [38, 89, 63,  7, 85, 68, 80, 60, 86, 74],
                [ 2, 83, 44, 50, 66, 49, 74, 74, 73, 72],
                [ 2, 85, 92, 30, 37, 33, 85, 78, 58, 55]])
```

In [53]: `arr1[-1,-2]`

Out[53]: 58

In [57]: `arr1[::-1]`

```
Out[57]: array([[ 2, 85, 92, 30, 37, 33, 85, 78, 58, 55],
                [ 2, 83, 44, 50, 66, 49, 74, 74, 73, 72],
                [38, 89, 63,  7, 85, 68, 80, 60, 86, 74],
                [46, 41, 38, 42, 71, 14, 70, 86, 53,  0],
                [75, 22, 71, 55, 91,  0, 83, 45, 40, 60],
                [74, 85, 62, 58, 89, 32, 86, 75, 96, 10],
                [60, 84,  9, 64, 17, 52, 45, 61, 93, 48],
                [40, 25, 20, 94, 72, 32, 22, 77, 18, 96],
                [ 9, 79, 35, 53, 12, 22, 81,  2,  7, 11],
                [ 5, 76, 34, 97, 58, 31, 91, 21, 72, 42]])
```

In [60]: `arr1[::-2]`

Out[60]: array([[2, 85, 92, 30, 37, 33, 85, 78, 58, 55],
                 [38, 89, 63, 7, 85, 68, 80, 60, 86, 74],
                 [75, 22, 71, 55, 91, 0, 83, 45, 40, 60],
                 [60, 84, 9, 64, 17, 52, 45, 61, 93, 48],
                 [9, 79, 35, 53, 12, 22, 81, 2, 7, 11]])

In [62]: `arr1`

Out[62]: array([[5, 76, 34, 97, 58, 31, 91, 21, 72, 42],
                 [9, 79, 35, 53, 12, 22, 81, 2, 7, 11],
                 [40, 25, 20, 94, 72, 32, 22, 77, 18, 96],
                 [60, 84, 9, 64, 17, 52, 45, 61, 93, 48],
                 [74, 85, 62, 58, 89, 32, 86, 75, 96, 10],
                 [75, 22, 71, 55, 91, 0, 83, 45, 40, 60],
                 [46, 41, 38, 42, 71, 14, 70, 86, 53, 0],
                 [38, 89, 63, 7, 85, 68, 80, 60, 86, 74],
                 [2, 83, 44, 50, 66, 49, 74, 74, 73, 72],
                 [2, 85, 92, 30, 37, 33, 85, 78, 58, 55]])

In [64]: `arr1[::-2]`

Out[64]: array([[2, 85, 92, 30, 37, 33, 85, 78, 58, 55],
                 [38, 89, 63, 7, 85, 68, 80, 60, 86, 74],
                 [75, 22, 71, 55, 91, 0, 83, 45, 40, 60],
                 [60, 84, 9, 64, 17, 52, 45, 61, 93, 48],
                 [9, 79, 35, 53, 12, 22, 81, 2, 7, 11]])

In [66]: `arr1`

Out[66]: array([[5, 76, 34, 97, 58, 31, 91, 21, 72, 42],
                 [9, 79, 35, 53, 12, 22, 81, 2, 7, 11],
                 [40, 25, 20, 94, 72, 32, 22, 77, 18, 96],
                 [60, 84, 9, 64, 17, 52, 45, 61, 93, 48],
                 [74, 85, 62, 58, 89, 32, 86, 75, 96, 10],
                 [75, 22, 71, 55, 91, 0, 83, 45, 40, 60],
                 [46, 41, 38, 42, 71, 14, 70, 86, 53, 0],
                 [38, 89, 63, 7, 85, 68, 80, 60, 86, 74],
                 [2, 83, 44, 50, 66, 49, 74, 74, 73, 72],
                 [2, 85, 92, 30, 37, 33, 85, 78, 58, 55]])

In [110…
```python
arr = np.array([0,1, 2, 3, 4, 5])
print(arr)
```

          [0 1 2 3 4 5]

In [112…
```python
arr.max()
```

Out[112… 5

In [114…
```python
arr.min()
```

Out[114… 0

In [116…
```python
arr.mean()
```

Out[116… 2.5

In [118…
```python
arr.median()
```

```
---------------------------------------------------------------------------
AttributeError                            Traceback (most recent call last)
Cell In[118], line 1
----> 1 arr.median()

AttributeError: 'numpy.ndarray' object has no attribute 'median'
```

In [120…
```python
from numpy import *
a = array([1,2,3,4,9])
median(a)
```

Out[120…   3.0

In [122…
```python
from numpy import *
a = array([1,2,3,4,8])
median(a)
```

Out[122…   3.0

In [124…
```python
arr
```

Out[124…   array([0, 1, 2, 3, 4, 5])

In [126…
```python
arr.reshape(2,3)
```

Out[126…   array([[0, 1, 2],
               [3, 4, 5]])

In [128…
```python
arr.reshape(6,1)
```

Out[128…   array([[0],
               [1],
               [2],
               [3],
               [4],
               [5]])

In [130…
```python
arr.reshape(1,6)
```

Out[130…   array([[0, 1, 2, 3, 4, 5]])

In [132…
```python
arr.reshape(1,5)
```

```
---------------------------------------------------------------------------
ValueError                                Traceback (most recent call last)
Cell In[132], line 1
----> 1 arr.reshape(1,5)

ValueError: cannot reshape array of size 6 into shape (1,5)
```

In [134…
```python
arr.reshape(3,2,order='C')
```

Out[134…   array([[0, 1],
               [2, 3],
               [4, 5]])

In [136…
```python
arr.reshape(3,2,order='F')
```

Out[136... `array([[0, 3],`
`[1, 4],`
`[2, 5]])`

In [142... `arr.reshape(3,2,order='A')`

Out[142... `array([[0, 1],`
`[2, 3],`
`[4, 5]])`

In [154... `arr.reshape(3,2,order='K')`

```
---------------------------------------------------------------------------
ValueError                                Traceback (most recent call last)
Cell In[154], line 1
----> 1 arr.reshape(3,2,order='K')

ValueError: order 'K' is not permitted for reshaping
```

In [156... `arr`

Out[156... `array([0, 1, 2, 3, 4, 5])`

In [158... `arr.reshape(2,3)`

Out[158... `array([[0, 1, 2],`
`[3, 4, 5]])`

In [162... `arr.reshape(1,4)`

```
---------------------------------------------------------------------------
ValueError                                Traceback (most recent call last)
Cell In[162], line 1
----> 1 arr.reshape(1,4)

ValueError: cannot reshape array of size 6 into shape (1,4)
```

In [164... `arr.reshape(1,6)`

Out[164... `array([[0, 1, 2, 3, 4, 5]])`

In [166... `arr.reshape(1,5)`

```
---------------------------------------------------------------------------
ValueError                                Traceback (most recent call last)
Cell In[166], line 1
----> 1 arr.reshape(1,5)

ValueError: cannot reshape array of size 6 into shape (1,5)
```

In [168... `arr.reshape(6,1)`

Out[168... `array([[0],`
`[1],`
`[2],`
`[3],`
`[4],`
`[5]])`

In [170…   ```
           arr.reshape(2,6)
           ```

```
---------------------------------------------------------------------------
ValueError                                Traceback (most recent call last)
Cell In[170], line 1
----> 1 arr.reshape(2,6)

ValueError: cannot reshape array of size 6 into shape (2,6)
```

In [172…   ```
           arr.reshape(3,3)
           ```

```
---------------------------------------------------------------------------
ValueError                                Traceback (most recent call last)
Cell In[172], line 1
----> 1 arr.reshape(3,3)

ValueError: cannot reshape array of size 6 into shape (3,3)
```

In [174…   ```
           arr
           ```

Out[174…   ```
           array([0, 1, 2, 3, 4, 5])
           ```

In [176…   ```
           arr.reshape(3,2)
           ```

Out[176…   ```
           array([[0, 1],
                  [2, 3],
                  [4, 5]])
           ```

# Indexing

In [179…   ```
           mat = np.arange(0,100).reshape(10,10)
           ```

In [181…   ```
           mat
           ```

Out[181…   ```
           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, 27, 28, 29],
                  [30, 31, 32, 33, 34, 35, 36, 37, 38, 39],
                  [40, 41, 42, 43, 44, 45, 46, 47, 48, 49],
                  [50, 51, 52, 53, 54, 55, 56, 57, 58, 59],
                  [60, 61, 62, 63, 64, 65, 66, 67, 68, 69],
                  [70, 71, 72, 73, 74, 75, 76, 77, 78, 79],
                  [80, 81, 82, 83, 84, 85, 86, 87, 88, 89],
                  [90, 91, 92, 93, 94, 95, 96, 97, 98, 99]])
           ```

In [183…   ```
           row = 4
           col = 5
           ```

In [185…   ```
           col
           ```

Out[185…   ```
           5
           ```

In [187…   ```
           row
           ```

Out[187…   ```
           4
           ```

In [189…    `mat`

Out[189…   ```
           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, 27, 28, 29],
                  [30, 31, 32, 33, 34, 35, 36, 37, 38, 39],
                  [40, 41, 42, 43, 44, 45, 46, 47, 48, 49],
                  [50, 51, 52, 53, 54, 55, 56, 57, 58, 59],
                  [60, 61, 62, 63, 64, 65, 66, 67, 68, 69],
                  [70, 71, 72, 73, 74, 75, 76, 77, 78, 79],
                  [80, 81, 82, 83, 84, 85, 86, 87, 88, 89],
                  [90, 91, 92, 93, 94, 95, 96, 97, 98, 99]])
           ```

In [191…   `mat[row,col]`

Out[191…   45

In [193…   `mat[4,5]`

Out[193…   45

In [195…   `mat`

Out[195…   ```
           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, 27, 28, 29],
                  [30, 31, 32, 33, 34, 35, 36, 37, 38, 39],
                  [40, 41, 42, 43, 44, 45, 46, 47, 48, 49],
                  [50, 51, 52, 53, 54, 55, 56, 57, 58, 59],
                  [60, 61, 62, 63, 64, 65, 66, 67, 68, 69],
                  [70, 71, 72, 73, 74, 75, 76, 77, 78, 79],
                  [80, 81, 82, 83, 84, 85, 86, 87, 88, 89],
                  [90, 91, 92, 93, 94, 95, 96, 97, 98, 99]])
           ```

In [197…    `mat[:]`

Out[197…   ```
           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, 27, 28, 29],
                  [30, 31, 32, 33, 34, 35, 36, 37, 38, 39],
                  [40, 41, 42, 43, 44, 45, 46, 47, 48, 49],
                  [50, 51, 52, 53, 54, 55, 56, 57, 58, 59],
                  [60, 61, 62, 63, 64, 65, 66, 67, 68, 69],
                  [70, 71, 72, 73, 74, 75, 76, 77, 78, 79],
                  [80, 81, 82, 83, 84, 85, 86, 87, 88, 89],
                  [90, 91, 92, 93, 94, 95, 96, 97, 98, 99]])
           ```

In [199…   `col = 6`

In [201…   `mat`

```
Out[201…   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, 27, 28, 29],
                  [30, 31, 32, 33, 34, 35, 36, 37, 38, 39],
                  [40, 41, 42, 43, 44, 45, 46, 47, 48, 49],
                  [50, 51, 52, 53, 54, 55, 56, 57, 58, 59],
                  [60, 61, 62, 63, 64, 65, 66, 67, 68, 69],
                  [70, 71, 72, 73, 74, 75, 76, 77, 78, 79],
                  [80, 81, 82, 83, 84, 85, 86, 87, 88, 89],
                  [90, 91, 92, 93, 94, 95, 96, 97, 98, 99]])
```

```
In [203…   mat[:,col]
```

```
Out[203…   array([ 6, 16, 26, 36, 46, 56, 66, 76, 86, 96])
```

```
In [207…   mat[row,:]
```

```
Out[207…   array([40, 41, 42, 43, 44, 45, 46, 47, 48, 49])
```

```
In [209…   mat
```

```
Out[209…   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, 27, 28, 29],
                  [30, 31, 32, 33, 34, 35, 36, 37, 38, 39],
                  [40, 41, 42, 43, 44, 45, 46, 47, 48, 49],
                  [50, 51, 52, 53, 54, 55, 56, 57, 58, 59],
                  [60, 61, 62, 63, 64, 65, 66, 67, 68, 69],
                  [70, 71, 72, 73, 74, 75, 76, 77, 78, 79],
                  [80, 81, 82, 83, 84, 85, 86, 87, 88, 89],
                  [90, 91, 92, 93, 94, 95, 96, 97, 98, 99]])
```

```
In [211…   mat[:col]
```

```
Out[211…   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, 27, 28, 29],
                  [30, 31, 32, 33, 34, 35, 36, 37, 38, 39],
                  [40, 41, 42, 43, 44, 45, 46, 47, 48, 49],
                  [50, 51, 52, 53, 54, 55, 56, 57, 58, 59]])
```

```
In [213…   mat[:row]
```

```
Out[213…   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, 27, 28, 29],
                  [30, 31, 32, 33, 34, 35, 36, 37, 38, 39]])
```

```
In [215…   mat[row:]
```

```
Out[215…   array([[40, 41, 42, 43, 44, 45, 46, 47, 48, 49],
                  [50, 51, 52, 53, 54, 55, 56, 57, 58, 59],
                  [60, 61, 62, 63, 64, 65, 66, 67, 68, 69],
                  [70, 71, 72, 73, 74, 75, 76, 77, 78, 79],
                  [80, 81, 82, 83, 84, 85, 86, 87, 88, 89],
                  [90, 91, 92, 93, 94, 95, 96, 97, 98, 99]])
```

```
In [217…   mat[:,7]
```

```
Out[217…  array([ 7, 17, 27, 37, 47, 57, 67, 77, 87, 97])
```

```
In [221…  mat
```

```
Out[221…  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, 27, 28, 29],
                 [30, 31, 32, 33, 34, 35, 36, 37, 38, 39],
                 [40, 41, 42, 43, 44, 45, 46, 47, 48, 49],
                 [50, 51, 52, 53, 54, 55, 56, 57, 58, 59],
                 [60, 61, 62, 63, 64, 65, 66, 67, 68, 69],
                 [70, 71, 72, 73, 74, 75, 76, 77, 78, 79],
                 [80, 81, 82, 83, 84, 85, 86, 87, 88, 89],
                 [90, 91, 92, 93, 94, 95, 96, 97, 98, 99]])
```

```
In [223…  mat[:,-9]
```

```
Out[223…  array([ 1, 11, 21, 31, 41, 51, 61, 71, 81, 91])
```

```
In [225…  mat[:,-1]
```

```
Out[225…  array([ 9, 19, 29, 39, 49, 59, 69, 79, 89, 99])
```

```
In [227…  mat
```

```
Out[227…  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, 27, 28, 29],
                 [30, 31, 32, 33, 34, 35, 36, 37, 38, 39],
                 [40, 41, 42, 43, 44, 45, 46, 47, 48, 49],
                 [50, 51, 52, 53, 54, 55, 56, 57, 58, 59],
                 [60, 61, 62, 63, 64, 65, 66, 67, 68, 69],
                 [70, 71, 72, 73, 74, 75, 76, 77, 78, 79],
                 [80, 81, 82, 83, 84, 85, 86, 87, 88, 89],
                 [90, 91, 92, 93, 94, 95, 96, 97, 98, 99]])
```

```
In [229…  mat[:,2]
```

```
Out[229…  array([ 2, 12, 22, 32, 42, 52, 62, 72, 82, 92])
```

```
In [233…  mat[2,:]
```

```
Out[233…  array([20, 21, 22, 23, 24, 25, 26, 27, 28, 29])
```

```
In [235…  mat
```

```
Out[235…  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, 27, 28, 29],
                 [30, 31, 32, 33, 34, 35, 36, 37, 38, 39],
                 [40, 41, 42, 43, 44, 45, 46, 47, 48, 49],
                 [50, 51, 52, 53, 54, 55, 56, 57, 58, 59],
                 [60, 61, 62, 63, 64, 65, 66, 67, 68, 69],
                 [70, 71, 72, 73, 74, 75, 76, 77, 78, 79],
                 [80, 81, 82, 83, 84, 85, 86, 87, 88, 89],
                 [90, 91, 92, 93, 94, 95, 96, 97, 98, 99]])
```

```
In [237…  row
```

Out[237…   4

In [239…   `col`

Out[239…   6

In [241…   `mat[:,col]`

Out[241…   array([6, 16, 26, 36, 46, 56, 66, 76, 86, 96])

In [243…   `mat[1,4]`

Out[243…   14

In [245…   `mat[1:4]`

Out[245…   array([[10, 11, 12, 13, 14, 15, 16, 17, 18, 19],
                   [20, 21, 22, 23, 24, 25, 26, 27, 28, 29],
                   [30, 31, 32, 33, 34, 35, 36, 37, 38, 39]])

In [247…   `mat`

Out[247…   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, 27, 28, 29],
                   [30, 31, 32, 33, 34, 35, 36, 37, 38, 39],
                   [40, 41, 42, 43, 44, 45, 46, 47, 48, 49],
                   [50, 51, 52, 53, 54, 55, 56, 57, 58, 59],
                   [60, 61, 62, 63, 64, 65, 66, 67, 68, 69],
                   [70, 71, 72, 73, 74, 75, 76, 77, 78, 79],
                   [80, 81, 82, 83, 84, 85, 86, 87, 88, 89],
                   [90, 91, 92, 93, 94, 95, 96, 97, 98, 99]])

In [249…   `mat[3:-3]`

Out[249…   array([[30, 31, 32, 33, 34, 35, 36, 37, 38, 39],
                   [40, 41, 42, 43, 44, 45, 46, 47, 48, 49],
                   [50, 51, 52, 53, 54, 55, 56, 57, 58, 59],
                   [60, 61, 62, 63, 64, 65, 66, 67, 68, 69]])

In [251…   `mat[0]`

Out[251…   array([0, 1, 2, 3, 4, 5, 6, 7, 8, 9])

In [253…   `mat[4]`

Out[253…   array([40, 41, 42, 43, 44, 45, 46, 47, 48, 49])

In [255…   `mat`

Out[255… 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, 27, 28, 29],
                 [30, 31, 32, 33, 34, 35, 36, 37, 38, 39],
                 [40, 41, 42, 43, 44, 45, 46, 47, 48, 49],
                 [50, 51, 52, 53, 54, 55, 56, 57, 58, 59],
                 [60, 61, 62, 63, 64, 65, 66, 67, 68, 69],
                 [70, 71, 72, 73, 74, 75, 76, 77, 78, 79],
                 [80, 81, 82, 83, 84, 85, 86, 87, 88, 89],
                 [90, 91, 92, 93, 94, 95, 96, 97, 98, 99]])

In [257… `mat[6:]`

Out[257… array([[60, 61, 62, 63, 64, 65, 66, 67, 68, 69],
                 [70, 71, 72, 73, 74, 75, 76, 77, 78, 79],
                 [80, 81, 82, 83, 84, 85, 86, 87, 88, 89],
                 [90, 91, 92, 93, 94, 95, 96, 97, 98, 99]])

In [259… `mat[:6]`

Out[259… 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, 27, 28, 29],
                 [30, 31, 32, 33, 34, 35, 36, 37, 38, 39],
                 [40, 41, 42, 43, 44, 45, 46, 47, 48, 49],
                 [50, 51, 52, 53, 54, 55, 56, 57, 58, 59]])

In [261… `mat`

Out[261… 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, 27, 28, 29],
                 [30, 31, 32, 33, 34, 35, 36, 37, 38, 39],
                 [40, 41, 42, 43, 44, 45, 46, 47, 48, 49],
                 [50, 51, 52, 53, 54, 55, 56, 57, 58, 59],
                 [60, 61, 62, 63, 64, 65, 66, 67, 68, 69],
                 [70, 71, 72, 73, 74, 75, 76, 77, 78, 79],
                 [80, 81, 82, 83, 84, 85, 86, 87, 88, 89],
                 [90, 91, 92, 93, 94, 95, 96, 97, 98, 99]])

In [263… `mat[5:7]`

Out[263… array([[50, 51, 52, 53, 54, 55, 56, 57, 58, 59],
                 [60, 61, 62, 63, 64, 65, 66, 67, 68, 69]])

In [265… `mat[0:10]`

Out[265… 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, 27, 28, 29],
                 [30, 31, 32, 33, 34, 35, 36, 37, 38, 39],
                 [40, 41, 42, 43, 44, 45, 46, 47, 48, 49],
                 [50, 51, 52, 53, 54, 55, 56, 57, 58, 59],
                 [60, 61, 62, 63, 64, 65, 66, 67, 68, 69],
                 [70, 71, 72, 73, 74, 75, 76, 77, 78, 79],
                 [80, 81, 82, 83, 84, 85, 86, 87, 88, 89],
                 [90, 91, 92, 93, 94, 95, 96, 97, 98, 99]])

In [267… `mat[0:10:3]`

Out[267…   array([[0, 1, 2, 3, 4, 5, 6, 7, 8, 9],
                   [30, 31, 32, 33, 34, 35, 36, 37, 38, 39],
                   [60, 61, 62, 63, 64, 65, 66, 67, 68, 69],
                   [90, 91, 92, 93, 94, 95, 96, 97, 98, 99]])

In [269…   mat[0:10:4]

Out[269…   array([[0, 1, 2, 3, 4, 5, 6, 7, 8, 9],
                   [40, 41, 42, 43, 44, 45, 46, 47, 48, 49],
                   [80, 81, 82, 83, 84, 85, 86, 87, 88, 89]])

In [271…   mat

Out[271…   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, 27, 28, 29],
                   [30, 31, 32, 33, 34, 35, 36, 37, 38, 39],
                   [40, 41, 42, 43, 44, 45, 46, 47, 48, 49],
                   [50, 51, 52, 53, 54, 55, 56, 57, 58, 59],
                   [60, 61, 62, 63, 64, 65, 66, 67, 68, 69],
                   [70, 71, 72, 73, 74, 75, 76, 77, 78, 79],
                   [80, 81, 82, 83, 84, 85, 86, 87, 88, 89],
                   [90, 91, 92, 93, 94, 95, 96, 97, 98, 99]])

In [273…   mat[4:]

Out[273…   array([[40, 41, 42, 43, 44, 45, 46, 47, 48, 49],
                   [50, 51, 52, 53, 54, 55, 56, 57, 58, 59],
                   [60, 61, 62, 63, 64, 65, 66, 67, 68, 69],
                   [70, 71, 72, 73, 74, 75, 76, 77, 78, 79],
                   [80, 81, 82, 83, 84, 85, 86, 87, 88, 89],
                   [90, 91, 92, 93, 94, 95, 96, 97, 98, 99]])

In [277…   mat

Out[277…   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, 27, 28, 29],
                   [30, 31, 32, 33, 34, 35, 36, 37, 38, 39],
                   [40, 41, 42, 43, 44, 45, 46, 47, 48, 49],
                   [50, 51, 52, 53, 54, 55, 56, 57, 58, 59],
                   [60, 61, 62, 63, 64, 65, 66, 67, 68, 69],
                   [70, 71, 72, 73, 74, 75, 76, 77, 78, 79],
                   [80, 81, 82, 83, 84, 85, 86, 87, 88, 89],
                   [90, 91, 92, 93, 94, 95, 96, 97, 98, 99]])

In [279…   mat[::-3]

Out[279…   array([[90, 91, 92, 93, 94, 95, 96, 97, 98, 99],
                   [60, 61, 62, 63, 64, 65, 66, 67, 68, 69],
                   [30, 31, 32, 33, 34, 35, 36, 37, 38, 39],
                   [0, 1, 2, 3, 4, 5, 6, 7, 8, 9]])

In [281…   mat

```
Out[281…   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, 27, 28, 29],
                  [30, 31, 32, 33, 34, 35, 36, 37, 38, 39],
                  [40, 41, 42, 43, 44, 45, 46, 47, 48, 49],
                  [50, 51, 52, 53, 54, 55, 56, 57, 58, 59],
                  [60, 61, 62, 63, 64, 65, 66, 67, 68, 69],
                  [70, 71, 72, 73, 74, 75, 76, 77, 78, 79],
                  [80, 81, 82, 83, 84, 85, 86, 87, 88, 89],
                  [90, 91, 92, 93, 94, 95, 96, 97, 98, 99]])
```

```
In [283…   mat[::-5]
```

```
Out[283…   array([[90, 91, 92, 93, 94, 95, 96, 97, 98, 99],
                  [40, 41, 42, 43, 44, 45, 46, 47, 48, 49]])
```

```
In [285…   mat
```

```
Out[285…   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, 27, 28, 29],
                  [30, 31, 32, 33, 34, 35, 36, 37, 38, 39],
                  [40, 41, 42, 43, 44, 45, 46, 47, 48, 49],
                  [50, 51, 52, 53, 54, 55, 56, 57, 58, 59],
                  [60, 61, 62, 63, 64, 65, 66, 67, 68, 69],
                  [70, 71, 72, 73, 74, 75, 76, 77, 78, 79],
                  [80, 81, 82, 83, 84, 85, 86, 87, 88, 89],
                  [90, 91, 92, 93, 94, 95, 96, 97, 98, 99]])
```

```
In [287…   mat[2:6]
```

```
Out[287…   array([[20, 21, 22, 23, 24, 25, 26, 27, 28, 29],
                  [30, 31, 32, 33, 34, 35, 36, 37, 38, 39],
                  [40, 41, 42, 43, 44, 45, 46, 47, 48, 49],
                  [50, 51, 52, 53, 54, 55, 56, 57, 58, 59]])
```

```
In [289…   mat
```

```
Out[289…   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, 27, 28, 29],
                  [30, 31, 32, 33, 34, 35, 36, 37, 38, 39],
                  [40, 41, 42, 43, 44, 45, 46, 47, 48, 49],
                  [50, 51, 52, 53, 54, 55, 56, 57, 58, 59],
                  [60, 61, 62, 63, 64, 65, 66, 67, 68, 69],
                  [70, 71, 72, 73, 74, 75, 76, 77, 78, 79],
                  [80, 81, 82, 83, 84, 85, 86, 87, 88, 89],
                  [90, 91, 92, 93, 94, 95, 96, 97, 98, 99]])
```

```
In [291…   mat[2:6,2:4]
```

```
Out[291…   array([[22, 23],
                  [32, 33],
                  [42, 43],
                  [52, 53]])
```

```
In [293…   mat
```

Out[293…   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, 27, 28, 29],
                   [30, 31, 32, 33, 34, 35, 36, 37, 38, 39],
                   [40, 41, 42, 43, 44, 45, 46, 47, 48, 49],
                   [50, 51, 52, 53, 54, 55, 56, 57, 58, 59],
                   [60, 61, 62, 63, 64, 65, 66, 67, 68, 69],
                   [70, 71, 72, 73, 74, 75, 76, 77, 78, 79],
                   [80, 81, 82, 83, 84, 85, 86, 87, 88, 89],
                   [90, 91, 92, 93, 94, 95, 96, 97, 98, 99]])

In [295…   ```python
            mat[0,1]
            ```

Out[295…    1

In [297…    ```python
            mat[1,6]
            ```

Out[297…   16

In [299…   ```python
            mat
            ```

Out[299…    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, 27, 28, 29],
                   [30, 31, 32, 33, 34, 35, 36, 37, 38, 39],
                   [40, 41, 42, 43, 44, 45, 46, 47, 48, 49],
                   [50, 51, 52, 53, 54, 55, 56, 57, 58, 59],
                   [60, 61, 62, 63, 64, 65, 66, 67, 68, 69],
                   [70, 71, 72, 73, 74, 75, 76, 77, 78, 79],
                   [80, 81, 82, 83, 84, 85, 86, 87, 88, 89],
                   [90, 91, 92, 93, 94, 95, 96, 97, 98, 99]])

In [301…    ```python
            mat[1:6]
            ```

Out[301…   array([[10, 11, 12, 13, 14, 15, 16, 17, 18, 19],
                   [20, 21, 22, 23, 24, 25, 26, 27, 28, 29],
                   [30, 31, 32, 33, 34, 35, 36, 37, 38, 39],
                   [40, 41, 42, 43, 44, 45, 46, 47, 48, 49],
                   [50, 51, 52, 53, 54, 55, 56, 57, 58, 59]])

In [303…   ```python
            mat
            ```

Out[303…    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, 27, 28, 29],
                   [30, 31, 32, 33, 34, 35, 36, 37, 38, 39],
                   [40, 41, 42, 43, 44, 45, 46, 47, 48, 49],
                   [50, 51, 52, 53, 54, 55, 56, 57, 58, 59],
                   [60, 61, 62, 63, 64, 65, 66, 67, 68, 69],
                   [70, 71, 72, 73, 74, 75, 76, 77, 78, 79],
                   [80, 81, 82, 83, 84, 85, 86, 87, 88, 89],
                   [90, 91, 92, 93, 94, 95, 96, 97, 98, 99]])

In [305…    ```python
            mat[3:5]
            ```

Out[305…   array([[30, 31, 32, 33, 34, 35, 36, 37, 38, 39],
                   [40, 41, 42, 43, 44, 45, 46, 47, 48, 49]])

In [307…   ```python
            mat
            ```

Out[307…    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, 27, 28, 29],
                   [30, 31, 32, 33, 34, 35, 36, 37, 38, 39],
                   [40, 41, 42, 43, 44, 45, 46, 47, 48, 49],
                   [50, 51, 52, 53, 54, 55, 56, 57, 58, 59],
                   [60, 61, 62, 63, 64, 65, 66, 67, 68, 69],
                   [70, 71, 72, 73, 74, 75, 76, 77, 78, 79],
                   [80, 81, 82, 83, 84, 85, 86, 87, 88, 89],
                   [90, 91, 92, 93, 94, 95, 96, 97, 98, 99]])

In [311…    ```python
            mat[1:2,2:4]
            ```

Out[311…   array([[12, 13]])

In [315…   ```python
            mat[1:4,2:6]
            ```

Out[315…    array([[12, 13, 14, 15],
                   [22, 23, 24, 25],
                   [32, 33, 34, 35]])

# Masking

In [320…    ```python
            mat # we also callled as filter
            ```

Out[320…   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, 27, 28, 29],
                   [30, 31, 32, 33, 34, 35, 36, 37, 38, 39],
                   [40, 41, 42, 43, 44, 45, 46, 47, 48, 49],
                   [50, 51, 52, 53, 54, 55, 56, 57, 58, 59],
                   [60, 61, 62, 63, 64, 65, 66, 67, 68, 69],
                   [70, 71, 72, 73, 74, 75, 76, 77, 78, 79],
                   [80, 81, 82, 83, 84, 85, 86, 87, 88, 89],
                   [90, 91, 92, 93, 94, 95, 96, 97, 98, 99]])

In [322…   ```python
            id(mat)
            ```

Out[322…    1399371173968

In [324…    ```python
            mat
            ```

Out[324…   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, 27, 28, 29],
                   [30, 31, 32, 33, 34, 35, 36, 37, 38, 39],
                   [40, 41, 42, 43, 44, 45, 46, 47, 48, 49],
                   [50, 51, 52, 53, 54, 55, 56, 57, 58, 59],
                   [60, 61, 62, 63, 64, 65, 66, 67, 68, 69],
                   [70, 71, 72, 73, 74, 75, 76, 77, 78, 79],
                   [80, 81, 82, 83, 84, 85, 86, 87, 88, 89],
                   [90, 91, 92, 93, 94, 95, 96, 97, 98, 99]])

In [326…   ```python
            mat < 50
            ```

```
Out[326…   array([[ True,  True,  True,  True,  True,  True,  True,  True,  True,
                    True],
                  [ True,  True,  True,  True,  True,  True,  True,  True,  True,
                    True],
                  [ True,  True,  True,  True,  True,  True,  True,  True,  True,
                    True],
                  [ True,  True,  True,  True,  True,  True,  True,  True,  True,
                    True],
                  [ True,  True,  True,  True,  True,  True,  True,  True,  True,
                    True],
                  [False, False, False, False, False, False, False, False, False,
                    False],
                  [False, False, False, False, False, False, False, False, False,
                    False],
                  [False, False, False, False, False, False, False, False, False,
                    False],
                  [False, False, False, False, False, False, False, False, False,
                    False],
                  [False, False, False, False, False, False, False, False, False,
                    False]])
```

```
In [328…   mat > 50
```

```
Out[328…   array([[False, False, False, False, False, False, False, False, False,
                    False],
                  [False, False, False, False, False, False, False, False, False,
                    False],
                  [False, False, False, False, False, False, False, False, False,
                    False],
                  [False, False, False, False, False, False, False, False, False,
                    False],
                  [False, False, False, False, False, False, False, False, False,
                    False],
                  [False,  True,  True,  True,  True,  True,  True,  True,  True,
                    True],
                  [ True,  True,  True,  True,  True,  True,  True,  True,  True,
                    True],
                  [ True,  True,  True,  True,  True,  True,  True,  True,  True,
                    True],
                  [ True,  True,  True,  True,  True,  True,  True,  True,  True,
                    True],
                  [ True,  True,  True,  True,  True,  True,  True,  True,  True,
                    True]])
```

```
In [331…   mat == 50
```

Out[331…   array([[False, False, False, False, False, False, False, False, False,
                    False],
                   [False, False, False, False, False, False, False, False, False,
                    False],
                   [False, False, False, False, False, False, False, False, False,
                    False],
                   [False, False, False, False, False, False, False, False, False,
                    False],
                   [False, False, False, False, False, False, False, False, False,
                    False],
                   [True, False, False, False, False, False, False, False, False,
                    False],
                   [False, False, False, False, False, False, False, False, False,
                    False],
                   [False, False, False, False, False, False, False, False, False,
                    False],
                   [False, False, False, False, False, False, False, False, False,
                    False],
                   [False, False, False, False, False, False, False, False, False,
                    False]])

In [333…   ```python
           mat[mat==50]
           ```

Out[333…   array([50])

In [335…   ```python
           a1 = mat[mat<50]
           ```

In [337…    ```python
           a1
           ```

Out[337…   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, 27, 28, 29, 30, 31, 32, 33,
                   34, 35, 36, 37, 38, 39, 40, 41, 42, 43, 44, 45, 46, 47, 48, 49])

In [339…   ```python
           a2 = mat[mat>50]
           ```

In [341…    ```python
           a2
           ```

Out[341…   array([51, 52, 53, 54, 55, 56, 57, 58, 59, 60, 61, 62, 63, 64, 65, 66, 67,
                   68, 69, 70, 71, 72, 73, 74, 75, 76, 77, 78, 79, 80, 81, 82, 83, 84,
                   85, 86, 87, 88, 89, 90, 91, 92, 93, 94, 95, 96, 97, 98, 99])

In [343…   ```python
           a3 = mat[mat<=50]
           ```

In [345…    ```python
           a3
           ```

Out[345…   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, 27, 28, 29, 30, 31, 32, 33,
                   34, 35, 36, 37, 38, 39, 40, 41, 42, 43, 44, 45, 46, 47, 48, 49, 50])

In [347…   ```python
           a4 = mat[mat>=50]
           ```

In [349…    ```python
           a4
           ```

Out[349…   array([50, 51, 52, 53, 54, 55, 56, 57, 58, 59, 60, 61, 62, 63, 64, 65, 66,
                   67, 68, 69, 70, 71, 72, 73, 74, 75, 76, 77, 78, 79, 80, 81, 82, 83,
                   84, 85, 86, 87, 88, 89, 90, 91, 92, 93, 94, 95, 96, 97, 98, 99])

In [351…   ```python
           mat
           ```

```
Out[351…   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, 27, 28, 29],
                  [30, 31, 32, 33, 34, 35, 36, 37, 38, 39],
                  [40, 41, 42, 43, 44, 45, 46, 47, 48, 49],
                  [50, 51, 52, 53, 54, 55, 56, 57, 58, 59],
                  [60, 61, 62, 63, 64, 65, 66, 67, 68, 69],
                  [70, 71, 72, 73, 74, 75, 76, 77, 78, 79],
                  [80, 81, 82, 83, 84, 85, 86, 87, 88, 89],
                  [90, 91, 92, 93, 94, 95, 96, 97, 98, 99]])
```

In [ ]: