

Numpy Crash Course

```
In [4]: import numpy as np
```

```
In [5]: np.__version__
```

```
Out[5]: '1.26.4'
```

```
In [6]: import sys  
sys.version
```

```
Out[6]: '3.12.7 | packaged by Anaconda, Inc. | (main, Oct 4 2024, 13:17:27) [MSC v.1929 6  
4 bit (AMD64)]'
```

Creating Arrays

```
In [7]: my_list = [0,1,2,3,4,5]  
my_list
```

```
Out[7]: [0, 1, 2, 3, 4, 5]
```

```
In [8]: type(my_list)
```

```
Out[8]: list
```

```
In [9]: arr = np.array(my_list)
```

```
In [10]: arr
```

```
Out[10]: array([0, 1, 2, 3, 4, 5])
```

```
In [11]: type(arr)
```

```
Out[11]: numpy.ndarray
```

```
In [12]: type(my_list)
```

```
Out[12]: list
```

```
In [13]: np. # we Learn important function
```

```
Cell In[13], line 1  
np. # we learn important function
```

```
^
```

```
SyntaxError: invalid syntax
```

```
In [14]: np.arange(24)
```

```
Out[14]: 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])
```

```
In [15]: np.arange(3.0)
```

```
Out[15]: array([0., 1., 2.])
```

```
In [16]: np.arange(10)
```

```
Out[16]: array([0, 1, 2, 3, 4, 5, 6, 7, 8, 9])
```

```
In [17]: np.arange(10,20)
```

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

```
In [18]: np.arange(20,10)          # 1st arg < 2nd arg
```

```
Out[18]: array([], dtype=int32)
```

```
In [19]: np.arange(-20,10)
```

```
Out[19]: 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 [20]: np.arange(-20,-10)
```

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

```
In [21]: np.arange(20,10)          # 1st arg always be < then 2nd arg
```

```
Out[21]: array([], dtype=int32)
```

```
In [22]: ar = np.arange(-30,20)
ar
```

```
Out[22]: 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 [23]: np.arange(10,10)
```

```
Out[23]: array([], dtype=int32)
```

```
In [24]: np.arange()
```

TypeError

Cell In[24], line 1
----> 1 np.arange()

Traceback (most recent call last)

TypeError: arange() requires stop to be specified.

```
In [25]: np.arange(10,30,5)          # 10- starting from 30- end point 5 - step count
```

```
Out[25]: array([10, 15, 20, 25])
```

```
In [26]: np.arange(10,30,5,6)
```

```
-----  
TypeError                                 Traceback (most recent call last)  
Cell In[26], line 1  
----> 1 np.arange(10,30,5,6)  
  
TypeError: Cannot interpret '6' as a data type
```

```
In [27]: np.zeros(3)                      # parameter tuning
```

```
Out[27]: array([0., 0., 0.])
```

```
In [28]: np.zeros(5, dtype=int)      # hyperparameter tuning
```

```
Out[28]: array([0, 0, 0, 0, 0])
```

```
In [29]: np.zeros((2,2), dtype=int)
```

```
Out[29]: array([[0, 0],  
                 [0, 0]])
```

```
In [30]: zero = np.zeros([2,2])  
print(zero)  
print(type(zero))
```

```
[[0. 0.]  
 [0. 0.]]  
<class 'numpy.ndarray'>
```

```
In [31]: zero = np.zeros([2,2])  
print(zero)  
print ('###')  
print(type(zero))
```

```
[[0. 0.]  
 [0. 0.]]  
###  
<class 'numpy.ndarray'>
```

```
In [32]: np.zeros((2,10))
```

```
Out[32]: array([[0., 0., 0., 0., 0., 0., 0., 0., 0., 0.],  
                 [0., 0., 0., 0., 0., 0., 0., 0., 0., 0.]])
```

```
In [33]: np.zeros((2,2))
```

```
Out[33]: array([[0., 0.],  
                 [0., 0.]])
```

```
In [34]: np.zeros((3,3))
```

```
Out[34]: array([[0., 0., 0.],  
                 [0., 0., 0.],  
                 [0., 0., 0.]])
```

```
In [35]: np.zeros((10,30))
```

```
In [36]: np.zeros((5,10)) # by default large -- will give row & 2nd arg - columns
```

```
Out[36]: 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.]])
```

In []:

```
In [37]: n = (6,7)                      # parameter tuning  
n1 = (6,8)  
print(np.zeros(n1))
```

```
In [38]: print(np.zeros(n,dtype=int))    ## hpyerparameter tunning
```

```
In [39]: n
```

```
Out[39]: (6, 7)
```

```
In [40]: n1
```

```
Out[40]: (6, 8)
```

```
In [41]: 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 [42]: np.ones(3)
```

```
Out[42]: array([1., 1., 1.])
```

```
In [43]: np.ones(4, dtype=int)
```

```
Out[43]: array([1, 1, 1, 1])
```

```
In [44]: np.ones(4)
```

```
Out[44]: array([1., 1., 1., 1.])
```

```
In [45]: n
```

```
Out[45]: (6, 7)
```

```
In [46]: np.ones(n)
```

```
Out[46]: 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.],  
                 [1., 1., 1., 1., 1., 1., 1.]])
```

```
In [47]: np.ones((5,4),dtype=int)      # by default 5- rows & 4 - columns
```

```
Out[47]: array([[1, 1, 1, 1],  
                 [1, 1, 1, 1],  
                 [1, 1, 1, 1],  
                 [1, 1, 1, 1],  
                 [1, 1, 1, 1]])
```

```
In [48]: np.
```

```
Cell In[48], line 1
```

```
    np.
```

```
    ^
```

```
SyntaxError: invalid syntax
```

```
In [49]: np.two(2,3)
```

```
-----  
AttributeError
```

```
Traceback (most recent call last)
```

```
Cell In[49], line 1
```

```
----> 1 np.two(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 'two'
```

```
In [ ]: np.three(2,3)
```

```
In [50]: np.ones(2)
```

```
Out[50]: array([1., 1.])
```

```
In [51]: np.ones((2,4))
```

```
Out[51]: array([[1., 1., 1., 1.],  
                 [1., 1., 1., 1.]])
```

```
In [52]: np.ones((6,10),dtype = int)
```

```
Out[52]: 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, 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 [53]: np.twos((2,4))
```

```
-----  
AttributeError
```

```
Traceback (most recent call last)
```

```
Cell In[53], line 1
```

```
----> 1 np.twos((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 'twos'
```

```
In [54]: np.
```

```
Cell In[54], line 1
  np.
  ^
SyntaxError: invalid syntax
```

```
In [55]: np.three((2,4))
```

```
-----
AttributeError                                     Traceback (most recent call last)
Cell In[55], line 1
----> 1 np.three((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 'three'
```

```
In [56]: range(5)
```

```
Out[56]: range(0, 5)
```

```
In [57]: r= range(5)
r
```

```
Out[57]: range(0, 5)
```

```
In [58]: for i in r:
    print(i)
```

```
0
1
2
3
4
```

```
In [59]: list(range(5))
```

```
Out[59]: [0, 1, 2, 3, 4]
```

```
In [60]: range(1,10)
```

```
Out[60]: range(1, 10)
```

```
In [61]: list(range(1,10,3))
```

```
Out[61]: [1, 4, 7]
```

```
In [62]: y = list(range(12))
y
```

```
Out[62]: [0, 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11]
```

```
In [63]: rand(3,2)
```

```
NameError Traceback (most recent call last)
Cell In[63], line 1
----> 1 rand(3,2)

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

```
In [64]: rand(3,2)
random.rand(3,2)
```

```
NameError Traceback (most recent call last)
Cell In[64], line 1
----> 1 rand(3,2)
      2 random.rand(3,2)

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

```
In [65]: np.random.rand(5)
```

```
Out[65]: array([0.29638605, 0.88066094, 0.38289687, 0.62988233, 0.96178878])
```

```
In [66]: np.rand(4)
```

```
AttributeError Traceback (most recent call last)
Cell In[66], line 1
----> 1 np.rand(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 'rand'
```

```
In [67]: np.random.rand(2,4)
```

```
Out[67]: array([[0.26633356, 0.05999007, 0.25944211, 0.15257742],
               [0.7661239 , 0.9027184 , 0.31573894, 0.46130374]])
```

```
In [68]: np.random.randint(2,4)
```

```
Out[68]: 3
```

```
In [69]: np.random.randint(2,20)      # 2nd argument is exclusive
```

```
Out[69]: 14
```

```
In [70]: np.random.randint(0,1)
```

```
Out[70]: 0

In [71]: np.random.randint(10,20,5)

Out[71]: array([16, 10, 16, 12, 13])

In [72]: np.random.randint(1,6,4)

Out[72]: array([4, 2, 3, 1])

In [73]: np.random.rand(3)

Out[73]: array([0.14613772, 0.66048635, 0.76983764])

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

Out[74]: 0

In [75]: np.random.randint(30,20,10)

-----
ValueError                                     Traceback (most recent call last)
Cell In[75], 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 [76]: np.random.randint(-30,20,10)

Out[76]: array([-2,  0, -28,  16, -20,  17,  13, -27,  12,  17])

In [77]: np.random.randint(20,30,10)

Out[77]: array([20, 24, 28, 21, 25, 22, 27, 28, 21, 25])

In [78]: np.random.randint(5,9)          # GET THE VALUE <=1 & >=5

Out[78]: 5

In [81]: np.random.randint(10,21,3)

Out[81]: array([10, 15, 13])

In [82]: np.random.randint(10,40,(10,10)) # generate the element 10 -30 with 4*4 matrix
```

```
Out[82]: array([[22, 19, 36, 22, 13, 39, 27, 21, 33, 16],  
   [17, 21, 24, 25, 35, 12, 15, 11, 32, 28],  
   [33, 27, 39, 20, 23, 39, 15, 32, 23, 14],  
   [17, 37, 31, 30, 37, 23, 30, 12, 16, 18],  
   [19, 10, 26, 35, 34, 16, 14, 22, 18, 16],  
   [34, 24, 25, 31, 17, 37, 23, 38, 28, 26],  
   [16, 34, 22, 22, 17, 11, 19, 18, 31, 21],  
   [34, 32, 35, 36, 20, 34, 38, 36, 17, 13],  
   [19, 30, 18, 38, 21, 21, 25, 16, 32, 39],  
   [32, 27, 31, 23, 12, 20, 14, 21, 10, 31]])
```

```
In [83]: np.random.randint(1,100,(12,12)) # generate the element 10 -30 with 4*4 matrix
```

```
Out[83]: array([[93, 14, 65, 90, 45, 82, 92, 75, 19, 98, 66, 83],  
   [60, 53, 86, 10, 75, 45, 95, 82, 87, 57, 52, 59],  
   [50, 78, 65, 41, 8, 15, 49, 25, 74, 11, 30, 90],  
   [61, 50, 72, 43, 33, 39, 50, 1, 62, 80, 68, 66],  
   [4, 6, 70, 78, 99, 22, 52, 14, 21, 73, 46, 94],  
   [82, 42, 11, 9, 86, 24, 73, 56, 64, 98, 94, 66],  
   [14, 10, 18, 11, 10, 55, 91, 32, 85, 83, 22, 31],  
   [58, 60, 92, 37, 67, 79, 81, 26, 31, 30, 25, 91],  
   [8, 57, 25, 89, 73, 33, 8, 83, 7, 59, 35, 60],  
   [71, 10, 30, 29, 72, 19, 30, 83, 95, 85, 25, 87],  
   [71, 60, 45, 37, 85, 38, 77, 43, 80, 58, 59, 31],  
   [81, 19, 72, 4, 76, 61, 22, 84, 91, 57, 44, 89]])
```

```
In [84]: np.arange(1,13).reshape(3,4)
```

```
Out[84]: array([[ 1,  2,  3,  4],  
   [ 5,  6,  7,  8],  
   [ 9, 10, 11, 12]])
```

```
In [85]: np.arange(1,13).reshape(12,1)
```

```
Out[85]: array([[ 1],  
   [ 2],  
   [ 3],  
   [ 4],  
   [ 5],  
   [ 6],  
   [ 7],  
   [ 8],  
   [ 9],  
   [10],  
   [11],  
   [12]])
```

```
In [86]: b=np.random.randint(10,20,(5,4))  
b
```

```
Out[86]: array([[19, 10, 11, 15],  
   [15, 15, 12, 17],  
   [15, 16, 10, 11],  
   [16, 12, 16, 12],  
   [17, 17, 15, 15]])
```

```
In [87]: type(b)
```

```
Out[87]: numpy.ndarray
```

Numpy Slicing

```
In [88]: b
```

```
Out[88]: array([[19, 10, 11, 15],  
                 [15, 15, 12, 17],  
                 [15, 16, 10, 11],  
                 [16, 12, 16, 12],  
                 [17, 17, 15, 15]])
```

```
In [89]: b[:]
```

```
Out[89]: array([[19, 10, 11, 15],  
                 [15, 15, 12, 17],  
                 [15, 16, 10, 11],  
                 [16, 12, 16, 12],  
                 [17, 17, 15, 15]])
```

```
In [90]: b[1:3]
```

```
Out[90]: array([[15, 15, 12, 17],  
                 [15, 16, 10, 11]])
```

```
In [91]: b
```

```
Out[91]: array([[19, 10, 11, 15],  
                 [15, 15, 12, 17],  
                 [15, 16, 10, 11],  
                 [16, 12, 16, 12],  
                 [17, 17, 15, 15]])
```

```
In [92]: b[1,3]
```

```
Out[92]: 17
```

```
In [93]: b[1,-1]
```

```
Out[93]: 17
```

```
In [94]: b
```

```
Out[94]: array([[19, 10, 11, 15],  
                 [15, 15, 12, 17],  
                 [15, 16, 10, 11],  
                 [16, 12, 16, 12],  
                 [17, 17, 15, 15]])
```

```
In [95]: b[2:3]
```

```
Out[95]: array([[15, 16, 10, 11]])
```

```
In [96]: b[0:-2]
```

```
Out[96]: array([[19, 10, 11, 15],  
                 [15, 15, 12, 17],  
                 [15, 16, 10, 11]])
```

```
In [97]: b
```

```
Out[97]: array([[19, 10, 11, 15],  
                 [15, 15, 12, 17],  
                 [15, 16, 10, 11],  
                 [16, 12, 16, 12],  
                 [17, 17, 15, 15]])
```

```
In [98]: b[0,2]
```

```
Out[98]: 11
```

```
In [99]: b
```

```
Out[99]: array([[19, 10, 11, 15],  
                 [15, 15, 12, 17],  
                 [15, 16, 10, 11],  
                 [16, 12, 16, 12],  
                 [17, 17, 15, 15]])
```

```
In [100...]: b[-5,-3]
```

```
Out[100...]: 10
```

```
In [101...]: b
```

```
Out[101...]: array([[19, 10, 11, 15],  
                 [15, 15, 12, 17],  
                 [15, 16, 10, 11],  
                 [16, 12, 16, 12],  
                 [17, 17, 15, 15]])
```

```
In [102...]: b [-4,2]
```

```
Out[102...]: 12
```

```
In [103...]: np.random.randint(10,20,(4,4))
```

```
Out[103...]: array([[10, 15, 14, 13],  
                     [11, 12, 17, 17],  
                     [11, 14, 12, 19],  
                     [16, 15, 15, 14]])
```

```
In [104...]: b
```

```
Out[104... array([[19, 10, 11, 15],  
                  [15, 15, 12, 17],  
                  [15, 16, 10, 11],  
                  [16, 12, 16, 12],  
                  [17, 17, 15, 15]])
```

```
In [105... b[-4,-2]
```

```
Out[105... 12
```

```
In [106... b
```

```
Out[106... array([[19, 10, 11, 15],  
                  [15, 15, 12, 17],  
                  [15, 16, 10, 11],  
                  [16, 12, 16, 12],  
                  [17, 17, 15, 15]])
```

```
In [107... b[-4,:2]
```

```
Out[107... array([15, 15])
```

```
In [108... b[:]
```

```
Out[108... array([[19, 10, 11, 15],  
                  [15, 15, 12, 17],  
                  [15, 16, 10, 11],  
                  [16, 12, 16, 12],  
                  [17, 17, 15, 15]])
```

Numpy Operations

```
In [110... a = np.random.randint(10,20,10)  
a
```

```
Out[110... array([11, 17, 19, 16, 17, 18, 11, 17, 13, 13])
```

```
In [111... id(a)
```

```
Out[111... 2865267591088
```

```
In [112... arr
```

```
Out[112... array([0, 1, 2, 3, 4, 5])
```

```
In [113... arr2 = np.random.randint(0,100,(10,10))  
arr2
```

```
Out[113... array([[84, 27, 15, 8, 99, 20, 48, 86, 52, 43],  
                  [45, 94, 54, 21, 92, 97, 64, 55, 5, 32],  
                  [47, 15, 58, 75, 39, 36, 28, 69, 77, 70],  
                  [95, 78, 23, 92, 38, 45, 49, 0, 92, 28],  
                  [65, 26, 77, 21, 72, 35, 1, 77, 13, 16],  
                  [87, 82, 8, 20, 65, 75, 21, 12, 22, 90],  
                  [11, 41, 27, 75, 17, 52, 34, 21, 17, 30],  
                  [21, 66, 98, 96, 65, 55, 40, 86, 74, 71],  
                  [37, 19, 69, 5, 55, 73, 35, 3, 85, 74],  
                  [ 4, 53, 41, 11, 27, 7, 44, 69, 96, 23]])
```

```
In [114... arr
```

```
Out[114... array([0, 1, 2, 3, 4, 5])
```

```
In [115... arr[:]
```

```
Out[115... array([0, 1, 2, 3, 4, 5])
```

```
In [116... arr
```

```
Out[116... array([0, 1, 2, 3, 4, 5])
```

```
In [117... arr[:4]
```

```
Out[117... array([0, 1, 2, 3])
```

```
In [118... arr2[:]
```

```
Out[118... array([[84, 27, 15, 8, 99, 20, 48, 86, 52, 43],  
                  [45, 94, 54, 21, 92, 97, 64, 55, 5, 32],  
                  [47, 15, 58, 75, 39, 36, 28, 69, 77, 70],  
                  [95, 78, 23, 92, 38, 45, 49, 0, 92, 28],  
                  [65, 26, 77, 21, 72, 35, 1, 77, 13, 16],  
                  [87, 82, 8, 20, 65, 75, 21, 12, 22, 90],  
                  [11, 41, 27, 75, 17, 52, 34, 21, 17, 30],  
                  [21, 66, 98, 96, 65, 55, 40, 86, 74, 71],  
                  [37, 19, 69, 5, 55, 73, 35, 3, 85, 74],  
                  [ 4, 53, 41, 11, 27, 7, 44, 69, 96, 23]])
```

```
In [119... arr2[0:5]
```

```
Out[119... array([[84, 27, 15, 8, 99, 20, 48, 86, 52, 43],  
                  [45, 94, 54, 21, 92, 97, 64, 55, 5, 32],  
                  [47, 15, 58, 75, 39, 36, 28, 69, 77, 70],  
                  [95, 78, 23, 92, 38, 45, 49, 0, 92, 28],  
                  [65, 26, 77, 21, 72, 35, 1, 77, 13, 16]])
```

```
In [120... arr2[1,4]
```

```
Out[120... 92
```

```
In [121... arr2
```

```
Out[121... array([[84, 27, 15, 8, 99, 20, 48, 86, 52, 43],  
   [45, 94, 54, 21, 92, 97, 64, 55, 5, 32],  
   [47, 15, 58, 75, 39, 36, 28, 69, 77, 70],  
   [95, 78, 23, 92, 38, 45, 49, 0, 92, 28],  
   [65, 26, 77, 21, 72, 35, 1, 77, 13, 16],  
   [87, 82, 8, 20, 65, 75, 21, 12, 22, 90],  
   [11, 41, 27, 75, 17, 52, 34, 21, 17, 30],  
   [21, 66, 98, 96, 65, 55, 40, 86, 74, 71],  
   [37, 19, 69, 5, 55, 73, 35, 3, 85, 74],  
   [4, 53, 41, 11, 27, 7, 44, 69, 96, 23]])
```

```
In [122... arr2[-5,5]
```

```
Out[122... 75
```

```
In [123... arr2
```

```
Out[123... array([[84, 27, 15, 8, 99, 20, 48, 86, 52, 43],  
   [45, 94, 54, 21, 92, 97, 64, 55, 5, 32],  
   [47, 15, 58, 75, 39, 36, 28, 69, 77, 70],  
   [95, 78, 23, 92, 38, 45, 49, 0, 92, 28],  
   [65, 26, 77, 21, 72, 35, 1, 77, 13, 16],  
   [87, 82, 8, 20, 65, 75, 21, 12, 22, 90],  
   [11, 41, 27, 75, 17, 52, 34, 21, 17, 30],  
   [21, 66, 98, 96, 65, 55, 40, 86, 74, 71],  
   [37, 19, 69, 5, 55, 73, 35, 3, 85, 74],  
   [4, 53, 41, 11, 27, 7, 44, 69, 96, 23]])
```

```
In [124... arr2[::-1]
```

```
Out[124... array([[ 4, 53, 41, 11, 27, 7, 44, 69, 96, 23],  
   [37, 19, 69, 5, 55, 73, 35, 3, 85, 74],  
   [21, 66, 98, 96, 65, 55, 40, 86, 74, 71],  
   [11, 41, 27, 75, 17, 52, 34, 21, 17, 30],  
   [87, 82, 8, 20, 65, 75, 21, 12, 22, 90],  
   [65, 26, 77, 21, 72, 35, 1, 77, 13, 16],  
   [95, 78, 23, 92, 38, 45, 49, 0, 92, 28],  
   [47, 15, 58, 75, 39, 36, 28, 69, 77, 70],  
   [45, 94, 54, 21, 92, 97, 64, 55, 5, 32],  
   [84, 27, 15, 8, 99, 20, 48, 86, 52, 43]])
```

```
In [125... arr2
```

```
Out[125... array([[84, 27, 15, 8, 99, 20, 48, 86, 52, 43],  
   [45, 94, 54, 21, 92, 97, 64, 55, 5, 32],  
   [47, 15, 58, 75, 39, 36, 28, 69, 77, 70],  
   [95, 78, 23, 92, 38, 45, 49, 0, 92, 28],  
   [65, 26, 77, 21, 72, 35, 1, 77, 13, 16],  
   [87, 82, 8, 20, 65, 75, 21, 12, 22, 90],  
   [11, 41, 27, 75, 17, 52, 34, 21, 17, 30],  
   [21, 66, 98, 96, 65, 55, 40, 86, 74, 71],  
   [37, 19, 69, 5, 55, 73, 35, 3, 85, 74],  
   [4, 53, 41, 11, 27, 7, 44, 69, 96, 23]])
```

```
In [126... arr2[::-2]
```

```
Out[126... array([[ 4, 53, 41, 11, 27, 7, 44, 69, 96, 23],  
   [21, 66, 98, 96, 65, 55, 40, 86, 74, 71],  
   [87, 82, 8, 20, 65, 75, 21, 12, 22, 90],  
   [95, 78, 23, 92, 38, 45, 49, 0, 92, 28],  
   [45, 94, 54, 21, 92, 97, 64, 55, 5, 32]])
```

```
In [127... arr2
```

```
Out[127... array([[84, 27, 15, 8, 99, 20, 48, 86, 52, 43],  
   [45, 94, 54, 21, 92, 97, 64, 55, 5, 32],  
   [47, 15, 58, 75, 39, 36, 28, 69, 77, 70],  
   [95, 78, 23, 92, 38, 45, 49, 0, 92, 28],  
   [65, 26, 77, 21, 72, 35, 1, 77, 13, 16],  
   [87, 82, 8, 20, 65, 75, 21, 12, 22, 90],  
   [11, 41, 27, 75, 17, 52, 34, 21, 17, 30],  
   [21, 66, 98, 96, 65, 55, 40, 86, 74, 71],  
   [37, 19, 69, 5, 55, 73, 35, 3, 85, 74],  
   [4, 53, 41, 11, 27, 7, 44, 69, 96, 23]])
```

```
In [128... arr2[::-3]
```

```
Out[128... array([[ 4, 53, 41, 11, 27, 7, 44, 69, 96, 23],  
   [11, 41, 27, 75, 17, 52, 34, 21, 17, 30],  
   [95, 78, 23, 92, 38, 45, 49, 0, 92, 28],  
   [84, 27, 15, 8, 99, 20, 48, 86, 52, 43]])
```

```
In [129... arr2
```

```
Out[129... array([[84, 27, 15, 8, 99, 20, 48, 86, 52, 43],  
   [45, 94, 54, 21, 92, 97, 64, 55, 5, 32],  
   [47, 15, 58, 75, 39, 36, 28, 69, 77, 70],  
   [95, 78, 23, 92, 38, 45, 49, 0, 92, 28],  
   [65, 26, 77, 21, 72, 35, 1, 77, 13, 16],  
   [87, 82, 8, 20, 65, 75, 21, 12, 22, 90],  
   [11, 41, 27, 75, 17, 52, 34, 21, 17, 30],  
   [21, 66, 98, 96, 65, 55, 40, 86, 74, 71],  
   [37, 19, 69, 5, 55, 73, 35, 3, 85, 74],  
   [4, 53, 41, 11, 27, 7, 44, 69, 96, 23]])
```

```
In [130... arr2[:-4]
```

```
Out[130... array([[84, 27, 15, 8, 99, 20, 48, 86, 52, 43],  
   [45, 94, 54, 21, 92, 97, 64, 55, 5, 32],  
   [47, 15, 58, 75, 39, 36, 28, 69, 77, 70],  
   [95, 78, 23, 92, 38, 45, 49, 0, 92, 28],  
   [65, 26, 77, 21, 72, 35, 1, 77, 13, 16],  
   [87, 82, 8, 20, 65, 75, 21, 12, 22, 90]])
```

```
In [131... arr
```

```
Out[131... array([0, 1, 2, 3, 4, 5])
```

```
In [132... arr.max()
```

```
Out[132... 5
```

```
In [133... arr.min()
```

```
Out[133... 0
```

```
In [134... arr.mean()
```

```
Out[134... 2.5
```

```
In [135... arr
```

```
Out[135... array([0, 1, 2, 3, 4, 5])
```

```
In [136... arr.median()
```

```
-----  
AttributeError  
Cell In[136], line 1  
----> 1 arr.median()
```

Traceback (most recent call last)

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

```
In [137... from numpy import *  
a = array([1,2,3,4,9])  
median(a)
```

```
Out[137... 3.0
```

Without Work on import* can you please find the median,mode.

```
In [138... arr
```

```
Out[138... array([0, 1, 2, 3, 4, 5])
```

```
In [139... arr.reshape(3,2)
```

```
Out[139... array([[0, 1],  
[2, 3],  
[4, 5]])
```

```
In [140... arr.reshape(6,1)
```

```
Out[140... array([[0],  
[1],  
[2],  
[3],  
[4],  
[5]])
```

```
In [141... arr
```

```
Out[141... array([0, 1, 2, 3, 4, 5])
```

```
In [142... arr
```

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

```
In [143... arr.reshape(1,6)
```

```
Out[143... array([[0, 1, 2, 3, 4, 5]])
```

```
In [144... arr.reshape(2,4)
```

```
-----  
ValueError  
Cell In[144], line 1  
----> 1 arr.reshape(2,4)
```

```
Traceback (most recent call last)
```

```
ValueError: cannot reshape array of size 6 into shape (2,4)
```

```
In [145... arr
```

```
Out[145... array([0, 1, 2, 3, 4, 5])
```

```
In [146... arr.reshape(2,3,order='c')
```

```
Out[146... array([[0, 1, 2],  
[3, 4, 5]])
```

```
In [147... arr.reshape(2,3,order='F') # print element with fortran
```

```
Out[147... array([[0, 2, 4],  
[1, 3, 5]])
```

```
In [148... arr.reshape(2,3,order='A') # A almost give you c type output
```

```
Out[148... array([[0, 1, 2],  
[3, 4, 5]])
```

```
In [149... arr
```

```
Out[149... array([0, 1, 2, 3, 4, 5])
```

```
In [150... arr.reshape(2,3)
```

```
Out[150... array([[0, 1, 2],  
[3, 4, 5]])
```

```
In [151... arr.reshape(1,6)
```

```
Out[151... array([[0, 1, 2, 3, 4, 5]])
```

```
In [152... arr.reshape(6,1)
```

```
Out[152... array([[0],  
[1],  
[2],  
[3],  
[4],  
[5]])
```

```
In [153... arr.reshape(2,6)
```

```
-----  
ValueError Traceback (most recent call last)  
Cell In[153], line 1  
----> 1 arr.reshape(2,6)  
  
ValueError: cannot reshape array of size 6 into shape (2,6)
```

```
In [154... arr.reshape(3,3)
```

```
-----  
ValueError Traceback (most recent call last)  
Cell In[154], line 1  
----> 1 arr.reshape(3,3)  
  
ValueError: cannot reshape array of size 6 into shape (3,3)
```

Indexing

```
In [155... mat = np.arange(0,100).reshape(10,10)
```

```
In [156... mat
```

```
Out[156... 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 [157... row=4  
col=5
```

```
In [158... col
```

```
Out[158... 5
```

```
In [159... row
```

```
Out[159... 4
```

```
In [160... mat
```

```
Out[160... 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 [161... mat[row,col]
```

```
Out[161... 45
```

```
In [162... mat[4,5]
```

```
Out[162... 45
```

```
In [163... mat
```

```
Out[163... 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 [164... mat[:]
```

```
Out[164... 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 [166... col=6
```

```
In [167... mat
```

```
Out[167... 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 [168... mat[6]
```

```
Out[168... array([60, 61, 62, 63, 64, 65, 66, 67, 68, 69])
```

```
In [169... mat[6] # befault it represent to rows
```

```
Out[169... array([60, 61, 62, 63, 64, 65, 66, 67, 68, 69])
```

```
In [170... mat
```

```
Out[170... 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 [171... mat[:,col]      # With Slices
```

```
Out[171... array([ 6, 16, 26, 36, 46, 56, 66, 76, 86, 96])
```

```
In [172... mat
```

```
Out[172... 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 [173... mat[row,:]
```

```
Out[173... array([40, 41, 42, 43, 44, 45, 46, 47, 48, 49])
```

```
In [174... mat[:,row]
```

```
Out[174... array([ 4, 14, 24, 34, 44, 54, 64, 74, 84, 94])
```

```
In [175... mat
```

```
Out[175... 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 [176... mat[:8]
```

```
Out[176... 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]])
```

```
In [177... mat
```

```
Out[177... 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 [178... row
```

```
Out[178... 4
```

```
In [179... col
```

```
Out[179... 6
```

```
In [180... mat[1,4]
```

```
Out[180... 14
```

```
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 [182... mat[3,:-3]
```

```
Out[182... array([30, 31, 32, 33, 34, 35, 36])
```

```
In [183... mat
```

```
Out[183... 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 [185... mat[0]
```

```
Out[185... array([0, 1, 2, 3, 4, 5, 6, 7, 8, 9])
```

```
In [187... mat
```

```
Out[187... 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 [188... mat[6]
```

```
Out[188... array([60, 61, 62, 63, 64, 65, 66, 67, 68, 69])
```

```
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 [190... mat[6:]
```

```
Out[190... 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 [192... mat[:6]
```

```
Out[192... 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 [193... mat
```

```
Out[193... 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 [194... mat[5:7]
```

```
Out[194... array([[50, 51, 52, 53, 54, 55, 56, 57, 58, 59],
   [60, 61, 62, 63, 64, 65, 66, 67, 68, 69]])
```

```
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[0:10]
```

```
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 [198... mat
```

```
Out[198... 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... mat[0:10:3]
```

```
Out[199... 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 [200... mat
```

```
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, 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 [201... mat[4:]
```

```
Out[201... 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 [202... mat[:4]
```

```
Out[202... 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 [203... mat
```

```
Out[203... 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 [204... mat[::-1]
```

```
Out[204... array([[90, 91, 92, 93, 94, 95, 96, 97, 98, 99],  
[80, 81, 82, 83, 84, 85, 86, 87, 88, 89],  
[70, 71, 72, 73, 74, 75, 76, 77, 78, 79],  
[60, 61, 62, 63, 64, 65, 66, 67, 68, 69],  
[50, 51, 52, 53, 54, 55, 56, 57, 58, 59],  
[40, 41, 42, 43, 44, 45, 46, 47, 48, 49],  
[30, 31, 32, 33, 34, 35, 36, 37, 38, 39],  
[20, 21, 22, 23, 24, 25, 26, 27, 28, 29],  
[10, 11, 12, 13, 14, 15, 16, 17, 18, 19],  
[ 0,  1,  2,  3,  4,  5,  6,  7,  8,  9]])
```

```
In [205... mat
```

```
Out[205... 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 [206... mat[:::-3]
```

```
Out[206... 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 [208... mat[:::-5]
```

```
Out[208... array([[90, 91, 92, 93, 94, 95, 96, 97, 98, 99],  
                  [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 [210... mat[2:6]
```

```
Out[210... 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 [211... mat
```

```
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],  
                  [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 [212... mat[2:6,2:4]      # 1:5 --> only row part /// 1:3 -- it indicates only column parts
```

```
Out[212... array([[22, 23],  
                  [32, 33],  
                  [42, 43],  
                  [52, 53]]))
```

```
In [213... mat
```

```
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],
   [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 [216... mat[1,2]
```

```
Out[216... 12
```

```
In [217... mat[1,6]
```

```
Out[217... 16
```

```
In [218... mat
```

```
Out[218... 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 [219... mat[1:6]
```

```
Out[219... 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 [220... mat[1:]
```

```
Out[220... 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],
   [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 [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 [222... mat[:6]
```

```
Out[222... 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 [223... mat[0:1]
```

```
Out[223... array([[0, 1, 2, 3, 4, 5, 6, 7, 8, 9]])
```

```
In [224... mat
```

```
Out[224... 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 [225... mat[3,5]
```

```
Out[225... 35
```

```
In [226... mat
```

```
Out[226... 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 [227... mat[1:2,2:4]
```

```
Out[227... array([[12, 13]])
```

```
In [228... mat
```

```
Out[228... 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 [230... mat[2:3,2:3]
```

```
Out[230... array([[22]])
```

```
In [231... mat
```

```
Out[231... 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]])
```

Masking

```
In [233... mat      # we also called as filter
```

```
Out[233... 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 [234... id(mat)
```

```
Out[234... 2865267605200
```

```
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... mat<50]
```

```
Out[237... [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],
   [ 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 [238... mat[mat<50]
```

```
Out[238... 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 [239... mat[mat<=50]
```

```
Out[239... 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 [240... mat>50
```

```
Out[240... 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, 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,
        True]]))
```

```
In [241... mat[mat==50]
```

```
Out[241... array([50])
```

```
In [242... mat
```

```
Out[242... 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 [244... a1 = mat[mat<50]
```

```
a1
```

```
Out[244... 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 [246... a2 = mat[mat>50]
```

```
a2
```

```
Out[246... 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 [248... a3 = mat[mat<=50]
```

```
a3
```

```
Out[248... 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 [250... a4 = mat[mat==50]
a4
```

```
Out[250... array([50])
```