In [1]:
```
import numpy as np
```

In [2]:
```
np.__version__
```

Out[2]:
```
'1.24.3'
```

In [3]:
```
import sys
sys.version
```

Out[3]:
```
'3.11.5 | packaged by Anaconda, Inc. | (main, Sep 11 2023, 13:26:23) [MSC v.191
6 64 bit (AMD64)]'
```

Creating Arrays

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

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

In [5]:
```
type(my_list)
```

Out[5]:
```
list
```

In [6]:
```
arr = np.array(my_list)
```

In [7]:
```
arr
```

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

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

Out[8]:
```
numpy.ndarray
```

In [9]:
```
type(my_list)
```

Out[9]:
```
list
```

In [10]:
```
np.arange(15)
```

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

In [11]:
```
np.arange(3.0)
```

Out[11]:
```
array([0., 1., 2.])
```

In [12]:
```
np.arange(10)
```

Out[12]:
```
array([0, 1, 2, 3, 4, 5, 6, 7, 8, 9])
```

In [13]:
```
np.arange(0,5)
```

Out[13]:
```
array([0, 1, 2, 3, 4])
```

In [14]:
```
np.arange(10,20)
```

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

In [15]:
```
np.arange(-20,10)  #1st arguement < 2nd arguement
```

Out[15]:
```
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 [16]:
```
np.arange(-16,10)
```

Out[16]:
```
array([-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 [17]:
```
np.arange(-20,10)
```

Out[17]:
```
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 [18]:
```
np.arange(30,20)      # 1st arguement < 2nd arguement
```

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

In [19]:
```
ar = np.arange(-30,20)
```

In [20]:
```
ar
```

Out[20]:
```
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 [21]:
```
np.arange(10,30,5)   # 10-starting index , 30-end point, 5-step count
```

Out[21]:
```
array([10, 15, 20, 25])
```

In [22]:
```
np.arange(0,10,3)
```

Out[22]:
```
array([0, 3, 6, 9])
```

In [23]:
```
np.arange(10,30,5,8)
```

```
---------------------------------------------------------------------------
TypeError                                 Traceback (most recent call last)
Cell In[23], line 1
----> 1 np.arange(10,30,5,8)

TypeError: Cannot interpret '8' as a data type
```

In [24]:
```
np.zeros(4)   # parameter tunning
```

Out[24]:
```
array([0., 0., 0., 0.])
```

In [25]:
```
np.zeros(5,dtype=int)   #hyperparameter tunning
```

Out[25]:
```
array([0, 0, 0, 0, 0])
```

In [26]:
```
np.zeros((2,2),dtype=int)
```

Out[26]:
```
array([[0, 0],
       [0, 0]])
```

In [27]:
```
zero = np.zeros([2,2])
print(zero)
print(type(zero))
```

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

In [28]:
```
zero = np.zeros([2,2])
print(zero)

print('####')

print(type(zero))
```

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

In [29]:
```
np.zeros((2,8))
```

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

In [30]:
```
np.zeros((5,4))
```

Out[30]:
```
array([[0., 0., 0., 0.],
       [0., 0., 0., 0.],
       [0., 0., 0., 0.],
       [0., 0., 0., 0.],
       [0., 0., 0., 0.]])
```

In [31]:
```
np.zeros((10,20))
```

```
Out[31]: 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.]])
```

```
In [32]: np.zeros((5,10)) # bydefaul 1arge -- will give row & 2nd arg - columns
```

```
Out[32]: 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 [33]: n1 = (5,6)
         n2 = (7,8)
         print(np.zeros(n1))   #parameter tunning
```

```
[[0. 0. 0. 0. 0. 0.]
 [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 [34]: print(np.zeros(n2, dtype=int))   #hyperparameter tunning
```

```
[[0 0 0 0 0 0 0 0]
 [0 0 0 0 0 0 0 0]
 [0 0 0 0 0 0 0 0]
 [0 0 0 0 0 0 0 0]
 [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 [35]: n1
```

```
Out[35]: (5, 6)
```

```
In [36]: n2
```

```
Out[36]: (7, 8)
```

```
In [37]: 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.]]
```

In [38]:
```
np.ones(4)
```

Out[38]:
```
array([1., 1., 1., 1.])
```

In [39]:
```
np.ones(4,dtype=int)
```

Out[39]:
```
array([1, 1, 1, 1])
```

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

Out[40]:
```
(5, 6)
```

In [41]:
```
np.ones(n1)
```

Out[41]:
```
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.]])
```

In [42]:
```
np.ones(n1,dtype=int)
```

Out[42]:
```
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]])
```

In [43]:
```
n2
```

Out[43]:
```
(7, 8)
```

In [44]:
```
np.ones(n2,dtype=int)
```

Out[44]:
```
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]])
```

In [45]:
```
rand(3,2)
```

```
---------------------------------------------------------------------------
NameError                                 Traceback (most recent call last)
Cell In[45], line 1
----> 1 rand(3,2)

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

In [46]:
```
random.rand(3,2)
```

```
---------------------------------------------------------------------------
NameError                                 Traceback (most recent call last)
Cell In[46], line 1
----> 1 random.rand(3,2)

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

In [47]:
```
np.random.rand(5)     # np = package , random = module , rand = function
```

Out[47]:
```
array([0.98030129, 0.58476144, 0.25250443, 0.90865578, 0.54791402])
```

In [48]:
```
np.ran(4)
```

```
---------------------------------------------------------------------------
AttributeError                            Traceback (most recent call last)
Cell In[48], line 1
----> 1 np.ran(4)

File ~\anaconda3\Lib\site-packages\numpy\__init__.py:320, in __getattr__(attr)
    317     from .testing import Tester
    318     return Tester
--> 320 raise AttributeError("module {!r} has no attribute "
    321                      "{!r}".format(__name__, attr))

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

In [49]:
```
np.random.rand(2,5)
```

Out[49]:
```
array([[0.8709715 , 0.49606337, 0.25651302, 0.07327027, 0.65384974],
       [0.20122174, 0.92911522, 0.05493837, 0.50938824, 0.03537343]])
```

In [50]:
```
np.random.randint(2,6)
```

Out[50]:
```
5
```

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

Out[51]:
```
19
```

In [52]:
```
np.random.randint(0,1)
```

Out[52]:
```
0
```

In [53]:
```
np.random.randint(10,20,5)
```

Out[53]:
```
array([19, 18, 15, 15, 17])
```

In [54]:
```
np.random.randint(1,6,4)
```

Out[54]:
```
array([2, 3, 5, 5])
```

In [55]:
```
np.random.rand(3)
```

Out[55]:
```
array([0.89860712, 0.75398763, 0.62692375])
```

In [56]:
```
np.random.randint(1)
```

Out[56]: 0

In [57]:
```
np.random.randint(30,20,10)
```

```
---------------------------------------------------------------------------
ValueError                                Traceback (most recent call last)
Cell In[57], line 1
----> 1 np.random.randint(30,20,10)

File mtrand.pyx:763, in numpy.random.mtrand.RandomState.randint()

File _bounded_integers.pyx:1338, in numpy.random._bounded_integers._rand_int32()

ValueError: low >= high
```

In [58]:
```
np.random.randint(-30,20,10)
```

Out[58]:
```
array([ 14, -22, -24,  15, -21, -28,  10,  -1, -12, -13])
```

In [59]:
```
np.random.randint(20,30,10)
```

Out[59]:
```
array([21, 20, 25, 28, 28, 28, 21, 21, 26, 26])
```

In [60]:
```
np.random.randint(5,9,4)
```

Out[60]:
```
array([5, 6, 5, 7])
```

In [61]:
```
np.random.randint(10,25,5)
```

Out[61]:
```
array([21, 13, 15, 12, 12])
```

In [62]:
```
np.random.randint(1,12,10)
```

Out[62]:
```
array([ 6, 10,  1,  1,  1, 10,  7,  5,  3,  9])
```

In [63]:
```
np.random.randint(10,40,(10,10))
```

Out[63]:
```
array([[25, 32, 17, 21, 18, 30, 38, 12, 27, 17],
       [23, 15, 22, 31, 24, 39, 38, 31, 39, 13],
       [38, 17, 21, 22, 37, 21, 20, 15, 15, 10],
       [18, 27, 14, 19, 11, 28, 34, 26, 30, 16],
       [25, 15, 34, 17, 22, 18, 39, 37, 33, 19],
       [18, 14, 23, 37, 20, 17, 34, 38, 13, 33],
       [14, 12, 30, 31, 23, 19, 21, 13, 10, 27],
       [16, 33, 22, 11, 16, 38, 34, 17, 35, 31],
       [10, 32, 15, 33, 23, 21, 23, 35, 22, 24],
       [38, 17, 37, 30, 21, 22, 26, 11, 36, 31]])
```

In [64]:
```
np.random.randint(1,100,(12,12))
```

Out[64]:
```
array([[90, 51, 84, 48, 53, 21, 21,  6, 42, 32, 61, 39],
       [52, 17, 79, 72, 25, 78, 26, 17, 98, 69, 79, 73],
       [84, 84, 50, 45, 27, 18, 33, 22,  9, 53,  5, 58],
       [26, 77, 92, 12, 41, 69, 46, 10, 85, 53, 48, 24],
       [26,  5, 43, 77, 32, 21, 28, 32, 62, 79, 44, 46],
       [17, 42, 46, 56, 20, 23, 99, 65,  6, 45, 97, 79],
       [83, 67, 57, 46, 37, 93, 84,  5, 59, 76, 42, 30],
       [28, 64, 87,  5, 42, 40, 11, 38, 30, 50, 81, 68],
       [ 4, 99, 87, 30, 49, 48, 75, 78,  9, 58,  7, 50],
       [62, 93, 91, 81, 10, 59, 51, 50,  3, 58,  4, 32],
       [84, 24, 98, 51, 20, 65, 43, 68, 66, 77, 78, 76],
       [81, 38, 97,  9, 62,  3, 74, 22, 80, 68, 17, 49]])
```

In [65]:
```
np.arange(1,13).reshape(3,4)
```

Out[65]:
```
array([[ 1,  2,  3,  4],
       [ 5,  6,  7,  8],
       [ 9, 10, 11, 12]])
```

In [66]:
```
np.arange(1,13).reshape(12, 1)
```

Out[66]:
```
array([[ 1],
       [ 2],
       [ 3],
       [ 4],
       [ 5],
       [ 6],
       [ 7],
       [ 8],
       [ 9],
       [10],
       [11],
       [12]])
```

In [67]:
```
b = np.random.randint(10,20,(5,4))
b
```

Out[67]:
```
array([[15, 15, 12, 15],
       [18, 10, 15, 14],
       [16, 17, 14, 10],
       [13, 10, 13, 13],
       [16, 18, 10, 16]])
```

In [68]:
```
type(b)
```

Out[68]:
```
numpy.ndarray
```

Indexing

In [69]:
```
b
```

Out[69]:
```
array([[15, 15, 12, 15],
       [18, 10, 15, 14],
       [16, 17, 14, 10],
       [13, 10, 13, 13],
       [16, 18, 10, 16]])
```

In [70]:
```
b[:]
```

Out[70]:
```
array([[15, 15, 12, 15],
       [18, 10, 15, 14],
       [16, 17, 14, 10],
       [13, 10, 13, 13],
       [16, 18, 10, 16]])
```

In [71]:
```
b[1:3]
```

Out[71]:
```
array([[18, 10, 15, 14],
       [16, 17, 14, 10]])
```

In [72]:
```
b
```

Out[72]:
```
array([[15, 15, 12, 15],
       [18, 10, 15, 14],
       [16, 17, 14, 10],
       [13, 10, 13, 13],
       [16, 18, 10, 16]])
```

In [73]:
```
b[1,2]
```

Out[73]:
```
15
```

In [74]:
```
b[4,2]
```

Out[74]:
```
10
```

In [75]:
```
b[1,-1]
```

Out[75]:
```
14
```

In [76]:
```
b
```

Out[76]:
```
array([[15, 15, 12, 15],
       [18, 10, 15, 14],
       [16, 17, 14, 10],
       [13, 10, 13, 13],
       [16, 18, 10, 16]])
```

In [77]:
```
b[2:3]
```

Out[77]:
```
array([[16, 17, 14, 10]])
```

In [78]:
```
b[0:-2]
```

Out[78]:
```
array([[15, 15, 12, 15],
       [18, 10, 15, 14],
       [16, 17, 14, 10]])
```

In [79]:
```
b
```

Out[79]:
```
array([[15, 15, 12, 15],
       [18, 10, 15, 14],
       [16, 17, 14, 10],
       [13, 10, 13, 13],
       [16, 18, 10, 16]])
```

In [80]:
```
b[0,2]
```

Out[80]:
```
12
```

In [81]:
```
b[-5,-3]
```

Out[81]:
```
15
```

In [82]:
```
b[-4,2]
```

Out[82]:
```
15
```

In [83]:
```
c = np.random.randint(10,20,(4,4))
c
```

Out[83]:
```
array([[16, 19, 17, 14],
       [15, 12, 12, 19],
       [14, 18, 12, 16],
       [14, 14, 13, 12]])
```

In [84]:
```
c[-4,-2]
```

Out[84]:
```
17
```

In [85]:
```
c[-4:2]
```

Out[85]:
```
array([[16, 19, 17, 14],
       [15, 12, 12, 19]])
```

In [86]:
```
c[:]
```

Out[86]:
```
array([[16, 19, 17, 14],
       [15, 12, 12, 19],
       [14, 18, 12, 16],
       [14, 14, 13, 12]])
```

Operations

In [87]:
```
a = np.random.randint(10,30,10)
a
```

Out[87]:
```
array([23, 16, 27, 20, 17, 15, 13, 19, 24, 23])
```

In [88]:
```
id(a)
```

Out[88]:
```
2030669896400
```

In [89]:
```
arr
```

Out[89]:
```
array([0, 1, 2, 3, 4, 5])
```

In [90]:
```
arr1 = np.random.randint(0,100,(10,10))
arr1
```

Out[90]:
```
array([[66, 60, 96, 49, 66, 95, 50, 43, 31, 29],
       [87, 76, 56, 87, 73,  6, 57, 47, 48, 42],
       [ 1, 30, 50, 48, 29, 51, 43, 20, 78, 25],
       [93, 64, 91, 81,  1, 46, 96, 65, 72, 51],
       [41, 35, 37, 54, 86, 87, 54, 94, 95, 37],
       [91, 54, 78, 47,  0, 63, 63, 37, 39, 28],
       [28, 49, 96, 97, 67, 58, 46, 40, 13, 39],
       [95, 55, 50, 72, 26, 15, 33, 14, 71, 37],
       [24, 69,  8,  4, 47,  5, 46, 82, 73, 35],
       [64, 89, 80, 20,  1, 45, 48, 41, 47, 65]])
```

In [91]:
```
arr
```

Out[91]:
```
array([0, 1, 2, 3, 4, 5])
```

In [92]:
```
arr[:]
```

Out[92]:
```
array([0, 1, 2, 3, 4, 5])
```

In [93]:
```
arr[:4]
```

Out[93]:
```
array([0, 1, 2, 3])
```

In [94]:
```
arr1[:]
```

Out[94]:
```
array([[66, 60, 96, 49, 66, 95, 50, 43, 31, 29],
       [87, 76, 56, 87, 73,  6, 57, 47, 48, 42],
       [ 1, 30, 50, 48, 29, 51, 43, 20, 78, 25],
       [93, 64, 91, 81,  1, 46, 96, 65, 72, 51],
       [41, 35, 37, 54, 86, 87, 54, 94, 95, 37],
       [91, 54, 78, 47,  0, 63, 63, 37, 39, 28],
       [28, 49, 96, 97, 67, 58, 46, 40, 13, 39],
       [95, 55, 50, 72, 26, 15, 33, 14, 71, 37],
       [24, 69,  8,  4, 47,  5, 46, 82, 73, 35],
       [64, 89, 80, 20,  1, 45, 48, 41, 47, 65]])
```

In [95]:
```
arr1[0:5]
```

Out[95]:
```
array([[66, 60, 96, 49, 66, 95, 50, 43, 31, 29],
       [87, 76, 56, 87, 73,  6, 57, 47, 48, 42],
       [ 1, 30, 50, 48, 29, 51, 43, 20, 78, 25],
       [93, 64, 91, 81,  1, 46, 96, 65, 72, 51],
       [41, 35, 37, 54, 86, 87, 54, 94, 95, 37]])
```

In [96]:
```
arr1
```

Out[96]:
```
array([[66, 60, 96, 49, 66, 95, 50, 43, 31, 29],
       [87, 76, 56, 87, 73,  6, 57, 47, 48, 42],
       [ 1, 30, 50, 48, 29, 51, 43, 20, 78, 25],
       [93, 64, 91, 81,  1, 46, 96, 65, 72, 51],
       [41, 35, 37, 54, 86, 87, 54, 94, 95, 37],
       [91, 54, 78, 47,  0, 63, 63, 37, 39, 28],
       [28, 49, 96, 97, 67, 58, 46, 40, 13, 39],
       [95, 55, 50, 72, 26, 15, 33, 14, 71, 37],
       [24, 69,  8,  4, 47,  5, 46, 82, 73, 35],
       [64, 89, 80, 20,  1, 45, 48, 41, 47, 65]])
```

In [97]:
```
arr1[1,4]
```

Out[97]: 73

In [98]:
```
arr1[-5,5]
```

Out[98]: 63

In [99]:
```
arr1[-5,-5]
```

Out[99]: 63

In [100…
```
arr1[-1,-2]
```

Out[100… 47

In [101…
```
arr1
```

Out[101…
```
array([[66, 60, 96, 49, 66, 95, 50, 43, 31, 29],
       [87, 76, 56, 87, 73,  6, 57, 47, 48, 42],
       [ 1, 30, 50, 48, 29, 51, 43, 20, 78, 25],
       [93, 64, 91, 81,  1, 46, 96, 65, 72, 51],
       [41, 35, 37, 54, 86, 87, 54, 94, 95, 37],
       [91, 54, 78, 47,  0, 63, 63, 37, 39, 28],
       [28, 49, 96, 97, 67, 58, 46, 40, 13, 39],
       [95, 55, 50, 72, 26, 15, 33, 14, 71, 37],
       [24, 69,  8,  4, 47,  5, 46, 82, 73, 35],
       [64, 89, 80, 20,  1, 45, 48, 41, 47, 65]])
```

In [102…
```
arr1[::-1]
```

Out[102…
```
array([[64, 89, 80, 20,  1, 45, 48, 41, 47, 65],
       [24, 69,  8,  4, 47,  5, 46, 82, 73, 35],
       [95, 55, 50, 72, 26, 15, 33, 14, 71, 37],
       [28, 49, 96, 97, 67, 58, 46, 40, 13, 39],
       [91, 54, 78, 47,  0, 63, 63, 37, 39, 28],
       [41, 35, 37, 54, 86, 87, 54, 94, 95, 37],
       [93, 64, 91, 81,  1, 46, 96, 65, 72, 51],
       [ 1, 30, 50, 48, 29, 51, 43, 20, 78, 25],
       [87, 76, 56, 87, 73,  6, 57, 47, 48, 42],
       [66, 60, 96, 49, 66, 95, 50, 43, 31, 29]])
```

In [103…
```
arr1[::-2]
```

Out[103…
```
array([[64, 89, 80, 20,  1, 45, 48, 41, 47, 65],
       [95, 55, 50, 72, 26, 15, 33, 14, 71, 37],
       [91, 54, 78, 47,  0, 63, 63, 37, 39, 28],
       [93, 64, 91, 81,  1, 46, 96, 65, 72, 51],
       [87, 76, 56, 87, 73,  6, 57, 47, 48, 42]])
```

In [104…
```
arr1[::-3]
```

Out[104…
```
array([[64, 89, 80, 20,  1, 45, 48, 41, 47, 65],
       [28, 49, 96, 97, 67, 58, 46, 40, 13, 39],
       [93, 64, 91, 81,  1, 46, 96, 65, 72, 51],
       [66, 60, 96, 49, 66, 95, 50, 43, 31, 29]])
```

In [105…
```
arr1
```

Out[105…
```
array([[66, 60, 96, 49, 66, 95, 50, 43, 31, 29],
       [87, 76, 56, 87, 73,  6, 57, 47, 48, 42],
       [ 1, 30, 50, 48, 29, 51, 43, 20, 78, 25],
       [93, 64, 91, 81,  1, 46, 96, 65, 72, 51],
       [41, 35, 37, 54, 86, 87, 54, 94, 95, 37],
       [91, 54, 78, 47,  0, 63, 63, 37, 39, 28],
       [28, 49, 96, 97, 67, 58, 46, 40, 13, 39],
       [95, 55, 50, 72, 26, 15, 33, 14, 71, 37],
       [24, 69,  8,  4, 47,  5, 46, 82, 73, 35],
       [64, 89, 80, 20,  1, 45, 48, 41, 47, 65]])
```

In [106…
```
arr1[:-3]
```

Out[106…
```
array([[66, 60, 96, 49, 66, 95, 50, 43, 31, 29],
       [87, 76, 56, 87, 73,  6, 57, 47, 48, 42],
       [ 1, 30, 50, 48, 29, 51, 43, 20, 78, 25],
       [93, 64, 91, 81,  1, 46, 96, 65, 72, 51],
       [41, 35, 37, 54, 86, 87, 54, 94, 95, 37],
       [91, 54, 78, 47,  0, 63, 63, 37, 39, 28],
       [28, 49, 96, 97, 67, 58, 46, 40, 13, 39]])
```

In [107…
```
arr
```

Out[107…
```
array([0, 1, 2, 3, 4, 5])
```

In [108…
```
arr.max()
```

Out[108…
```
5
```

In [109…
```
arr.min()
```

Out[109…
```
0
```

In [110…
```
arr.mean()
```

Out[110…
```
2.5
```

In [111…
```
arr
```

Out[111…
```
array([0, 1, 2, 3, 4, 5])
```

In [112…
```
arr.median()
```

```
---------------------------------------------------------------------------
AttributeError                            Traceback (most recent call last)
Cell In[112], line 1
----> 1 arr.median()

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

In [113…
```
from numpy import *
a = array([1,2,3,4,9])
median(a)
```

Out[113…
```
3.0
```

In [114…
```
arr
```

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

In [115…
```
arr.reshape(3,2)
```

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

In [116…
```
arr.reshape(6,1)
```

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

In [117…
```
arr.reshape(1,6)
```

Out[117…
```
array([[0, 1, 2, 3, 4, 5]])
```

In [118…
```
arr.reshape(2,3)
```

Out[118…
```
array([[0, 1, 2],
       [3, 4, 5]])
```

In [119…
```
arr.reshape(3,2)
```

Out[119…
```
array([[0, 1],
       [2, 3],
       [4, 5]])
```

In [132…
```
arr
```

Out[132…
```
array([0, 1, 2, 3, 4, 5])
```

In [120…
```
arr.reshape(2,3,order='C')
```

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

In [123…
```
arr.reshape(2,3,order='F') # print element with fortran
```

Out[123…
```
array([[0, 2, 4],
       [1, 3, 5]])
```

In [124…
```
arr.reshape(2,3,order='A') # A almost give you c type output
```

Out[124…
```
array([[0, 1, 2],
       [3, 4, 5]])
```

In [134…
```
a = np.array([4,5,6,1,2,3])
a.reshape(2,3,order='F')   # Column wise
```

Out[134…
```
array([[4, 6, 2],
       [5, 1, 3]])
```

In [136…
```
a.reshape(2,3,order='C')   # It row wise
```

Out[136…
```
array([[4, 5, 6],
       [1, 2, 3]])
```

In [137…
```
a.reshape(2,3,order='A')   # It is taking automatically by compiler
```

Out[137…
```
array([[4, 5, 6],
       [1, 2, 3]])
```

In [138…
```
arr
```

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

In [139…
```
arr.reshape(2,3)
```

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

Indexing

In [141…
```
mat = np.arange(0,100).reshape(10,10)
```

In [142…
```
mat
```

Out[142…
```
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 [144…
```
row = 4
col = 5
```

In [145…
```
col
```

Out[145…
```
5
```

In [146…
```
row
```

Out[146…
```
4
```

In [149…
```
mat[row,col]
```

Out[149…
```
45
```

In [150…
```
mat[:]
```

Out[150…
```
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 [151…
```
col = 6
```

In [154…
```
mat[6]          # default it represent to rows
```

Out[154…
```
array([60, 61, 62, 63, 64, 65, 66, 67, 68, 69])
```

In [155…
```
mat[:,7]
```

Out[155…
```
array([ 7, 17, 27, 37, 47, 57, 67, 77, 87, 97])
```

In [156…
```
mat[::1]
```

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…
```
mat[1:2,2:4]
```

Out[157…
```
array([[12, 13]])
```

In [158…
```
mat
```

Out[158…
```
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 [159…
```
# with slices
mat[:,col]
```

Out[159…
```
array([ 6, 16, 26, 36, 46, 56, 66, 76, 86, 96])
```

In [160…
```
mat[row,:]
```

Out[160… array([40, 41, 42, 43, 44, 45, 46, 47, 48, 49])

In [161…
```
mat
```

Out[161…
```
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 [162…
```
mat[:,8]
```

Out[162… array([8, 18, 28, 38, 48, 58, 68, 78, 88, 98])

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[:col]
```

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]])
```

In [165…
```
mat[:6]
```

Out[165…
```
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 [166…
```
row
```

Out[166… 4

In [167…
```
col
```

Out[167… 6

In [170…
```
mat[:row]
```

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]])
```

In [172…
```
mat[row:]
```

Out[172…
```
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 [173…
```
mat[:]
```

Out[173…
```
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 [174…
```
mat[:,8]
```

Out[174…
```
array([ 8, 18, 28, 38, 48, 58, 68, 78, 88, 98])
```

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[:,-1]
```

Out[176…
```
array([ 9, 19, 29, 39, 49, 59, 69, 79, 89, 99])
```

In [178…
```
mat
```

Out[178…
```
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 [179…
```
row
```

Out[179…
```
4
```

In [180…
```
col
```

Out[180…
```
6
```

In [181…
```
mat[:,col]
```

Out[181…
```
array([ 6, 16, 26, 36, 46, 56, 66, 76, 86, 96])
```

In [182…
```
mat[1:4]
```

Out[182…
```
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 [183…
```
mat[1,4]
```

Out[183…
```
14
```

In [184…
```
mat[3:-3]
```

Out[184…
```
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 [185…
```
mat
```

Out[185…
```
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 [186…
```
mat[0]
```

Out[186…
```
array([0, 1, 2, 3, 4, 5, 6, 7, 8, 9])
```

In [187…
```
mat[6]
```

Out[187…
```
array([60, 61, 62, 63, 64, 65, 66, 67, 68, 69])
```

In [188…
```
mat
```

Out[188…
```
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 [189…
```
mat[6:]
```

Out[189…
```
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 [190…
```
mat[:6]
```

Out[190…
```
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 [191…
```
mat
```

Out[191…
```
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 [192…
```
mat[5:7]
```

Out[192…
```
array([[50, 51, 52, 53, 54, 55, 56, 57, 58, 59],
       [60, 61, 62, 63, 64, 65, 66, 67, 68, 69]])
```

In [193…
```
mat[0:10]
```

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[0:10:3]
```

Out[194…
```
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 [195…
```
mat[4:]
```

Out[195…
```
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 [196…
```
mat[:4]
```

Out[196…
```
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 [197…
```
mat[::-1]
```

Out[197…
```
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 [198…
```
mat[::-3]
```

Out[198…
```
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 [199…
```
mat[::-5]
```

Out[199…
```
array([[90, 91, 92, 93, 94, 95, 96, 97, 98, 99],
       [40, 41, 42, 43, 44, 45, 46, 47, 48, 49]])
```

In [200…
```
mat[2:6]
```

Out[200…
```
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 [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[2:6,2:4]    # 2:6 -only row part // 1:3 -- it indicates only coulmn parts
```

Out[203…
```
array([[22, 23],
       [32, 33],
       [42, 43],
       [52, 53]])
```

In [204…
```
mat
```

Out[204…
```
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 [205…
```
mat[0,1]
```

Out[205…
```
1
```

In [206…
```
mat[1,6]
```

Out[206…
```
16
```

In [207…
```
mat[1:6]
```

Out[207…
```
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 [208…
```
mat[1:]
```

Out[208…
```
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 [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[:6]
```

Out[210…
```
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 [211…
```
mat[0:1]
```

Out[211…
```
array([[0, 1, 2, 3, 4, 5, 6, 7, 8, 9]])
```

In [212…
```
mat[3:5]
```

Out[212…
```
array([[30, 31, 32, 33, 34, 35, 36, 37, 38, 39],
       [40, 41, 42, 43, 44, 45, 46, 47, 48, 49]])
```

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 [214…
```
mat[1:2,2:4]
```

Out[214…
```
array([[12, 13]])
```

In [215…
```
mat
```

Out[215…
```
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 [217…
```
mat[2:3,2:3]
```

Out[217…
```
array([[22]])
```

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

Out[219…
```
array([[23, 24],
       [33, 34]])
```

In [220…
```
mat[3:5,2:4]
```

Out[220…
```
array([[32, 33],
       [42, 43]])
```

In [221…
```
mat[2:3,4:5]
```

Out[221…
```
array([[24]])
```

Masking

In [222…
```
mat
```

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],
       [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…
```
id(mat)
```

Out[223…
```
2030670940464
```

In [224…
```
mat[mat<50]
```

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])
```

In [225…
```
mat > 50
```

Out[225…
```
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 [226…
```
mat[mat==50]
```

Out[226…
```
array([50])
```

In [227…
```
a1 = mat[mat<50]
a1
```

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])
```

In [229…
```
a2 = mat[mat>50]
a2
```

Out[229…
```
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 [230…
```
a3 = mat[mat<=50]
a3
```

Out[230…
```
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 [231…
```
a4 = mat[mat==50]
a4
```

Out[231…
```
array([50])
```

Python Program to generate OTP

In [241…
```
import random

def generate_otp(length=4):
    """Generate a numeric OTP of a specified length."""
    digits = '012345'
    otp = ''.join(random.choice(digits) for _ in range(length))
    return otp

# Example usage
otp_length = 4  # You can change this to any length you prefer
otp = generate_otp(otp_length)
print(f"Your OTP is: {otp}")
```

```
Your OTP is: 5321
```

In [237…
```
def wish():
    print('good even')
wish()

def wish():
    print('good even')
wish()

def wish():
    print('good even')
wish()
```

```
good even
good even
good even
```

In [242…
```
def wish():
    print('good even')

wish()
wish()
wish()
```

```
good even
good even
good even
```

In [239…
```
list1=['a','b','g',1,5]
print(list1.pop())
```

```
5
```

In [243…
```
x = [1,2,3]
y = x.copy()
x.append(4)
print(x)
```

```
[1, 2, 3, 4]
```