NumPY

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

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

Out[2]:
```
'1.26.4'
```

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

Out[3]:
```
'3.12.7 | packaged by Anaconda, Inc. | (main, Oct  4 2024, 13:17:27) [MSC v.192
9 64 bit (AMD64)]'
```

Creating Arrays

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

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

In [6]:
```
type(my_list)
```

Out[6]:
```
list
```

In [7]:
```
arr = np.array(my_list)
```

In [8]:
```
arr
```

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

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

Out[9]:
```
numpy.ndarray
```

In [10]:
```
type(my_list)
```

Out[10]:
```
list
```

In [11]:
```
np.
```

```
  Cell In[11], line 1
    np.
       ^
SyntaxError: invalid syntax
```

Arange - (Return evenly spaced values within a given interval.)

In [12]:
```
np.arange(15)
```

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

In [13]:
```
np.arange(3.0)
```

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

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

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

In [15]:
```
np.arange(0,5)
```

Out[15]:
```
array([0, 1, 2, 3, 4])
```

In [16]:
```
np.arange(10,20)
```

Out[16]:
```
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(-16,10)
```

Out[20]:
```
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 [21]:
```
np.arange(-20,-10)
```

Out[21]:
```
array([-20, -19, -18, -17, -16, -15, -14, -13, -12, -11])
```

In [23]:
```
np.arange(30,20)  # 1st arg always be < then 2nd arg
```

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

In [24]:
```
ar = np.arange(-30,20)
ar
```

Out[24]:
```
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 [25]:
```
np.arange(10,10)
```

Out[25]:
```
array([], dtype=int32)
```

In [26]:
```
np.arange()
```

```
---------------------------------------------------------------------------
TypeError                                 Traceback (most recent call last)
Cell In[26], line 1
----> 1 np.arange()

TypeError: arange() requires stop to be specified.
```

In [27]:
```
np.arange(10,30,5)
```

Out[27]:
```
array([10, 15, 20, 25])
```

In [28]:
```
np.arange(0,10,3)
```

Out[28]:
```
array([0, 3, 6, 9])
```

In [29]:
```
np.arange(10,30,5,8)
```

```
---------------------------------------------------------------------------
TypeError                                 Traceback (most recent call last)
Cell In[29], line 1
----> 1 np.arange(10,30,5,8)

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

In [30]:
```
np.zeros(3) # parameter tuning
```

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

In [31]:
```
np.zeros(5, dtype=int) # Hyperparameter tuning
```

Out[31]:
```
array([0, 0, 0, 0, 0])
```

In [32]:
```
np.zeros((2,2), dtype=int)
```

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

In [33]:
```
zero = np.zeros([2,2])
print(zero)
print(type(zero))
```

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

In [35]:
```
zero = np.zeros([2,2])
print(zero)

print('####')
print(type(zero))
```

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

In [36]:
```
np.zeros((2,10))
```

Out[36]:
```
array([[0., 0., 0., 0., 0., 0., 0., 0., 0., 0.],
       [0., 0., 0., 0., 0., 0., 0., 0., 0., 0.]])
```

In [37]:
```
np.zeros((2,2))
```

Out[37]:
```
array([[0., 0.],
       [0., 0.]])
```

In [38]:
```
np.zeros((3,3))
```

Out[38]:
```
array([[0., 0., 0.],
       [0., 0., 0.],
       [0., 0., 0.]])
```

In [39]:
```
np.zeros((10,30))
```

Out[39]:
```
array([[0., 0., 0., 0., 0., 0., 0., 0., 0., 0., 0., 0., 0., 0., 0., 0.,
        0., 0., 0., 0., 0., 0., 0., 0., 0., 0., 0., 0., 0., 0.],
       [0., 0., 0., 0., 0., 0., 0., 0., 0., 0., 0., 0., 0., 0., 0., 0.,
        0., 0., 0., 0., 0., 0., 0., 0., 0., 0., 0., 0., 0., 0.],
       [0., 0., 0., 0., 0., 0., 0., 0., 0., 0., 0., 0., 0., 0., 0., 0.,
        0., 0., 0., 0., 0., 0., 0., 0., 0., 0., 0., 0., 0., 0.],
       [0., 0., 0., 0., 0., 0., 0., 0., 0., 0., 0., 0., 0., 0., 0., 0.,
        0., 0., 0., 0., 0., 0., 0., 0., 0., 0., 0., 0., 0., 0.],
       [0., 0., 0., 0., 0., 0., 0., 0., 0., 0., 0., 0., 0., 0., 0., 0.,
        0., 0., 0., 0., 0., 0., 0., 0., 0., 0., 0., 0., 0., 0.],
       [0., 0., 0., 0., 0., 0., 0., 0., 0., 0., 0., 0., 0., 0., 0., 0.,
        0., 0., 0., 0., 0., 0., 0., 0., 0., 0., 0., 0., 0., 0.],
       [0., 0., 0., 0., 0., 0., 0., 0., 0., 0., 0., 0., 0., 0., 0., 0.,
        0., 0., 0., 0., 0., 0., 0., 0., 0., 0., 0., 0., 0., 0.],
       [0., 0., 0., 0., 0., 0., 0., 0., 0., 0., 0., 0., 0., 0., 0., 0.,
        0., 0., 0., 0., 0., 0., 0., 0., 0., 0., 0., 0., 0., 0.],
       [0., 0., 0., 0., 0., 0., 0., 0., 0., 0., 0., 0., 0., 0., 0., 0.,
        0., 0., 0., 0., 0., 0., 0., 0., 0., 0., 0., 0., 0., 0.],
       [0., 0., 0., 0., 0., 0., 0., 0., 0., 0., 0., 0., 0., 0., 0., 0.,
        0., 0., 0., 0., 0., 0., 0., 0., 0., 0., 0., 0., 0., 0.]])
```

In [41]:
```
np.zeros((5,10))
```

Out[41]:
```
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 [43]:
```
n = (6,7)
n1 = (6,8)
print(np.zeros(n1)) # parameter tuning
```

```
[[0. 0. 0. 0. 0. 0. 0. 0.]
 [0. 0. 0. 0. 0. 0. 0. 0.]
 [0. 0. 0. 0. 0. 0. 0. 0.]
 [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 [44]:
```
print(np.zeros(n,dtype=int)) # Hyperparameter tuning
```

```
[[0 0 0 0 0 0 0]
 [0 0 0 0 0 0 0]
 [0 0 0 0 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 [45]:
```
n
```

Out[45]: (6, 7)

In [46]:
```
n1
```

Out[46]: (6, 8)

In [47]:
```
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 [48]:
```
np.ones(3)
```

Out[48]: array([1., 1., 1.])

In [49]:
```
np.ones(4, dtype=int)
```

Out[49]: array([1, 1, 1, 1])

In [50]:
```
np.ones(4)
```

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

In [51]:
```
n
```

Out[51]: (6, 7)

In [52]:
```
np.ones(n)
```

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.]])
```

In [53]:
```
np.ones((5,4),dtype=int)
```

Out[53]:
```
array([[1, 1, 1, 1],
       [1, 1, 1, 1],
       [1, 1, 1, 1],
       [1, 1, 1, 1],
       [1, 1, 1, 1]])
```

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

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

In [55]:
```
np.twos((2,3))
```

```
---------------------------------------------------------------------------
AttributeError                            Traceback (most recent call last)
Cell In[55], line 1
----> 1 np.twos((2,3))

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

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

In [56]:
```
np.three(2,3)
```

```
---------------------------------------------------------------------------
AttributeError                            Traceback (most recent call last)
Cell In[56], line 1
----> 1 np.three(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 'three'
```

In [57]:
```
np.ones(2)
```

Out[57]:
```
array([1., 1.])
```

In [58]:
```
np.ones((2,4))
```

Out[58]:
```
array([[1., 1., 1., 1.],
       [1., 1., 1., 1.]])
```

In [59]:
```
np.ones((6,10),dtype = int)
```

Out[59]:
```
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 [60]:
```
np.twos((2,4))
```

```
---------------------------------------------------------------------------
AttributeError                            Traceback (most recent call last)
Cell In[60], 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'
```

Range

In [61]:
```
range(5)
```

Out[61]: range(0, 5)

In [62]:
```
r = range(5)
r
```

Out[62]: range(0, 5)

In [63]:
```
for i in r:
    print(i)
```

```
0
1
2
3
4
```

In [64]:
```
list(range(5))
```

Out[64]: [0, 1, 2, 3, 4]

In [65]:
```
range(1,10)
```

Out[65]: range(1, 10)

In [68]:
```
list(range(1,10))
```

Out[68]: [1, 2, 3, 4, 5, 6, 7, 8, 9]

In [69]:
```
list(range(1,10,3))
```

Out[69]: [1, 4, 7]

In [70]:
```
y = list(range(12))
y
```

Out[70]: [0, 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11]

Rand

The Rand function in Python is commonly used from the NumPy library to generate random numbers.It creates an array of random numbers uniformely distributedbetween 0 and 1.

In [71]:
```
rand(3,2)
```

```
---------------------------------------------------------------------------
NameError                                 Traceback (most recent call last)
Cell In[71], line 1
----> 1 rand(3,2)

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

In [72]:
```
rand(3,2)
random.rand(3,2)
```

```
---------------------------------------------------------------------------
NameError                                 Traceback (most recent call last)
Cell In[72], line 1
----> 1 rand(3,2)
      2 random.rand(3,2)

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

In [73]:
```
np.random.rand(5)
```

Out[73]:
```
array([0.14081143, 0.56458534, 0.06514382, 0.07970915, 0.92704465])
```

In [74]:
```
np.rand(4)
```

```
---------------------------------------------------------------------------
AttributeError                            Traceback (most recent call last)
Cell In[74], 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 [77]:
```
np.random.rand(2,4)
```

Out[77]:
```
array([[0.97087818, 0.10826458, 0.77207686, 0.76113899],
       [0.21240808, 0.88911028, 0.7211799 , 0.46053589]])
```

In [86]:
```
np.random.randint(2,4)
```

Out[86]:
```
3
```

In [93]:
```
np.random.randint(2,20)
```

Out[93]:
```
12
```

In [95]:
```
np.random.randint(0,1)
```

Out[95]:
```
0
```

In [99]:
```
np.random.randint(10,20,5)
```

Out[99]:
```
array([19, 15, 15, 19, 11])
```

In [100…
```
np.random.randint(1,6,4)
```

Out[100…
```
array([5, 3, 3, 2])
```

In [101…
```
np.random.rand(3)
```

Out[101…
```
array([0.99742931, 0.6075022 , 0.02900662])
```

In [103…
```
np.random.randint(1)
```

Out[103…
```
0
```

In [104…
```
np.random.randint(30,20,10)
```

```
---------------------------------------------------------------------------
ValueError                                Traceback (most recent call last)
Cell In[104], 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 [112…
```
np.random.randint(-30,20,10)
```

Out[112…
```
array([ -1,   5,  12,   1,   6, -11,  -6,  15,  -9,  14])
```

In [113…
```
np.random.randint(20,30,10)
```

Out[113…
```
array([23, 28, 23, 20, 22, 29, 27, 28, 24, 24])
```

In [118…
```
np.random.randint(5,9)
```

Out[118…
```
6
```

In [119…
```
np.random.randint(10,21,3)
```

Out[119…
```
array([11, 16, 18])
```

In [120…
```
np.random.randint(1,12,10)
```

Out[120…
```
array([ 2,  4,  5,  7, 11,  2,  4,  1,  6,  4])
```

In [121…
```
np.random.randint(10,40,(10,10))
```

Out[121…
```
array([[23, 34, 13, 39, 29, 28, 29, 17, 22, 11],
       [31, 34, 30, 32, 31, 29, 15, 23, 18, 38],
       [21, 39, 30, 23, 23, 23, 35, 21, 35, 39],
       [10, 24, 36, 17, 23, 24, 30, 21, 35, 14],
       [11, 38, 24, 35, 18, 34, 27, 33, 14, 29],
       [20, 39, 36, 37, 34, 10, 10, 19, 32, 14],
       [21, 30, 27, 20, 31, 11, 33, 11, 25, 13],
       [12, 36, 19, 26, 20, 16, 16, 14, 23, 37],
       [11, 25, 37, 23, 20, 20, 21, 28, 34, 38],
       [27, 23, 30, 21, 38, 37, 36, 25, 17, 36]])
```

In [122…
```
np.random.randint(1,100,(12,12))
```

Out[122…
```
array([[95, 72, 71, 75, 43, 89, 45, 87, 79, 22, 90, 17],
       [82, 57, 20, 69, 84, 96, 99, 34, 19, 57, 50, 45],
       [16, 47, 88, 13, 68, 64, 89, 44, 24, 41, 61, 15],
       [ 8,  4, 18, 53, 70, 87,  1, 27, 82, 44, 92, 54],
       [45, 43,  1, 52, 61, 84, 23, 12, 71,  1, 24, 99],
       [57,  5, 85, 58, 88, 36,  2, 18, 67, 57, 53, 75],
       [30, 44, 47, 90, 68,  8, 38, 40, 30, 49, 11,  3],
       [82,  1, 36,  6, 52, 78, 90, 74, 59, 87, 69, 80],
       [80,  9, 82, 84, 41, 61,  5, 93, 84, 37, 91, 80],
       [51, 30, 17, 30, 92, 57, 11, 54, 37, 58, 21, 82],
       [96, 58, 80, 57, 75, 75, 59, 51,  9, 57, 69, 32],
       [26, 12, 36, 10, 45, 96, 72, 75, 92, 71, 94,  2]])
```

Reshape - Gives a new shape to an array without changing its data

In [123…
```
np.arange(1,13).reshape(3,4)
```

Out[123…
```
array([[ 1,  2,  3,  4],
       [ 5,  6,  7,  8],
       [ 9, 10, 11, 12]])
```

In [124…
```
np.arange(1,13).reshape(12,1)
```

Out[124…
```
array([[ 1],
       [ 2],
       [ 3],
       [ 4],
       [ 5],
       [ 6],
       [ 7],
       [ 8],
       [ 9],
       [10],
       [11],
       [12]])
```

In [125…
```
b = np.random.randint(10,20,(5,4))
b
```

Out[125…
```
array([[15, 18, 13, 13],
       [16, 12, 12, 10],
       [13, 18, 18, 16],
       [14, 19, 15, 17],
       [15, 11, 12, 17]])
```

In [126…
```
type(b)
```

Out[126…
```
numpy.ndarray
```

In [127…
```
b
```

Out[127…
```
array([[15, 18, 13, 13],
       [16, 12, 12, 10],
       [13, 18, 18, 16],
       [14, 19, 15, 17],
       [15, 11, 12, 17]])
```

In [128…
```
b[:]
```

Out[128…
```
array([[15, 18, 13, 13],
       [16, 12, 12, 10],
       [13, 18, 18, 16],
       [14, 19, 15, 17],
       [15, 11, 12, 17]])
```

In [129…
```
b[1:3]
```

Out[129…
```
array([[16, 12, 12, 10],
       [13, 18, 18, 16]])
```

In [130…
```
b
```

Out[130…
```
array([[15, 18, 13, 13],
       [16, 12, 12, 10],
       [13, 18, 18, 16],
       [14, 19, 15, 17],
       [15, 11, 12, 17]])
```

In [131…
```
b[1,2]
```

Out[131…
```
12
```

In [132…
```
b
```

Out[132…
```
array([[15, 18, 13, 13],
       [16, 12, 12, 10],
       [13, 18, 18, 16],
       [14, 19, 15, 17],
       [15, 11, 12, 17]])
```

In [133…
```
b[1,3]
```

Out[133…
```
10
```

In [134…
```
b[1,-1]
```

Out[134…
```
10
```

In [135…
```
b
```

Out[135…
```
array([[15, 18, 13, 13],
       [16, 12, 12, 10],
       [13, 18, 18, 16],
       [14, 19, 15, 17],
       [15, 11, 12, 17]])
```

In [136…
```
b[2:3]
```

Out[136…
```
array([[13, 18, 18, 16]])
```

In [137…
```
b
```

Out[137…
```
array([[15, 18, 13, 13],
       [16, 12, 12, 10],
       [13, 18, 18, 16],
       [14, 19, 15, 17],
       [15, 11, 12, 17]])
```

In [138…
```
b[0:-2]
```

Out[138…
```
array([[15, 18, 13, 13],
       [16, 12, 12, 10],
       [13, 18, 18, 16]])
```

In [139…
```
b
```

Out[139…
```
array([[15, 18, 13, 13],
       [16, 12, 12, 10],
       [13, 18, 18, 16],
       [14, 19, 15, 17],
       [15, 11, 12, 17]])
```

In [140…
```
b[0,2]
```

Out[140…
```
13
```

In [141…
```
b
```

Out[141…
```
array([[15, 18, 13, 13],
       [16, 12, 12, 10],
       [13, 18, 18, 16],
       [14, 19, 15, 17],
       [15, 11, 12, 17]])
```

In [142…
```
b[-5,-3]
```

Out[142…
```
18
```

In [143…
```
b
```

Out[143…
```
array([[15, 18, 13, 13],
       [16, 12, 12, 10],
       [13, 18, 18, 16],
       [14, 19, 15, 17],
       [15, 11, 12, 17]])
```

In [144…
```
b[-4,2]
```

Out[144… 12

In [145…
```
np.random.randint(10,20,(4,4))
```

Out[145…
```
array([[11, 19, 14, 17],
       [15, 15, 12, 15],
       [11, 14, 17, 16],
       [19, 16, 11, 12]])
```

In [146…
```
b
```

Out[146…
```
array([[15, 18, 13, 13],
       [16, 12, 12, 10],
       [13, 18, 18, 16],
       [14, 19, 15, 17],
       [15, 11, 12, 17]])
```

In [147…
```
b[-4,-2]
```

Out[147… 12

In [148…
```
b
```

Out[148…
```
array([[15, 18, 13, 13],
       [16, 12, 12, 10],
       [13, 18, 18, 16],
       [14, 19, 15, 17],
       [15, 11, 12, 17]])
```

In [149…
```
b[-4:2]
```

Out[149…
```
array([[16, 12, 12, 10]])
```

In [150…
```
b[:]
```

Out[150…
```
array([[15, 18, 13, 13],
       [16, 12, 12, 10],
       [13, 18, 18, 16],
       [14, 19, 15, 17],
       [15, 11, 12, 17]])
```

Operations

In [151…
```
a = np.random.randint(10,20,10)
a
```

Out[151… array([18, 15, 14, 16, 16, 11, 15, 10, 12, 19])

In [152…
```
id(a)
```

Out[152… 2140799623952

In [153…
```
arr
```

Out[153… array([0, 1, 2, 3, 4, 5])

In [154…
```
arr2 = np.random.randint(0,100,(10,10))
```

In [155…
```
arr2
```

Out[155…
```
array([[51, 34, 97, 87, 45, 16, 56, 69, 66, 97],
       [22, 50, 68, 93,  5,  4, 77, 78, 88, 45],
       [81, 75, 10, 65, 76, 35,  4, 33, 23, 33],
       [98, 35, 70, 99, 22, 44, 14, 58, 96, 42],
       [56, 44, 67,  7, 96, 50, 71, 81, 24, 35],
       [94, 58, 39, 44, 69, 13, 67, 38,  6, 37],
       [49, 41, 92, 26,  9, 29, 33,  3, 61, 43],
       [90, 82, 80, 82, 92,  4, 69, 71, 56, 99],
       [58, 59,  6, 71, 60, 14, 38, 11,  4, 75],
       [86, 98, 54, 17, 14, 71,  6, 49, 19, 40]])
```

In [156…
```
arr
```

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

In [157…
```
arr[:]
```

Out[157…
```
array([0, 1, 2, 3, 4, 5])
```

In [158…
```
arr
```

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

In [159…
```
arr[:4]
```

Out[159…
```
array([0, 1, 2, 3])
```

In [160…
```
arr2[:]
```

Out[160…
```
array([[51, 34, 97, 87, 45, 16, 56, 69, 66, 97],
       [22, 50, 68, 93,  5,  4, 77, 78, 88, 45],
       [81, 75, 10, 65, 76, 35,  4, 33, 23, 33],
       [98, 35, 70, 99, 22, 44, 14, 58, 96, 42],
       [56, 44, 67,  7, 96, 50, 71, 81, 24, 35],
       [94, 58, 39, 44, 69, 13, 67, 38,  6, 37],
       [49, 41, 92, 26,  9, 29, 33,  3, 61, 43],
       [90, 82, 80, 82, 92,  4, 69, 71, 56, 99],
       [58, 59,  6, 71, 60, 14, 38, 11,  4, 75],
       [86, 98, 54, 17, 14, 71,  6, 49, 19, 40]])
```

In [161…
```
arr2[0:5]
```

Out[161…
```
array([[51, 34, 97, 87, 45, 16, 56, 69, 66, 97],
       [22, 50, 68, 93,  5,  4, 77, 78, 88, 45],
       [81, 75, 10, 65, 76, 35,  4, 33, 23, 33],
       [98, 35, 70, 99, 22, 44, 14, 58, 96, 42],
       [56, 44, 67,  7, 96, 50, 71, 81, 24, 35]])
```

In [162…
```
arr2
```

Out[162…
```
array([[51, 34, 97, 87, 45, 16, 56, 69, 66, 97],
       [22, 50, 68, 93,  5,  4, 77, 78, 88, 45],
       [81, 75, 10, 65, 76, 35,  4, 33, 23, 33],
       [98, 35, 70, 99, 22, 44, 14, 58, 96, 42],
       [56, 44, 67,  7, 96, 50, 71, 81, 24, 35],
       [94, 58, 39, 44, 69, 13, 67, 38,  6, 37],
       [49, 41, 92, 26,  9, 29, 33,  3, 61, 43],
       [90, 82, 80, 82, 92,  4, 69, 71, 56, 99],
       [58, 59,  6, 71, 60, 14, 38, 11,  4, 75],
       [86, 98, 54, 17, 14, 71,  6, 49, 19, 40]])
```

In [163…
```
arr2[1,4]
```

Out[163…
```
5
```

In [164…
```
arr2
```

Out[164…
```
array([[51, 34, 97, 87, 45, 16, 56, 69, 66, 97],
       [22, 50, 68, 93,  5,  4, 77, 78, 88, 45],
       [81, 75, 10, 65, 76, 35,  4, 33, 23, 33],
       [98, 35, 70, 99, 22, 44, 14, 58, 96, 42],
       [56, 44, 67,  7, 96, 50, 71, 81, 24, 35],
       [94, 58, 39, 44, 69, 13, 67, 38,  6, 37],
       [49, 41, 92, 26,  9, 29, 33,  3, 61, 43],
       [90, 82, 80, 82, 92,  4, 69, 71, 56, 99],
       [58, 59,  6, 71, 60, 14, 38, 11,  4, 75],
       [86, 98, 54, 17, 14, 71,  6, 49, 19, 40]])
```

In [165…
```
arr2[-5,5]
```

Out[165…
```
13
```

In [166…
```
arr2[-5,-5]
```

Out[166…
```
13
```

In [167…
```
arr2
```

Out[167…
```
array([[51, 34, 97, 87, 45, 16, 56, 69, 66, 97],
       [22, 50, 68, 93,  5,  4, 77, 78, 88, 45],
       [81, 75, 10, 65, 76, 35,  4, 33, 23, 33],
       [98, 35, 70, 99, 22, 44, 14, 58, 96, 42],
       [56, 44, 67,  7, 96, 50, 71, 81, 24, 35],
       [94, 58, 39, 44, 69, 13, 67, 38,  6, 37],
       [49, 41, 92, 26,  9, 29, 33,  3, 61, 43],
       [90, 82, 80, 82, 92,  4, 69, 71, 56, 99],
       [58, 59,  6, 71, 60, 14, 38, 11,  4, 75],
       [86, 98, 54, 17, 14, 71,  6, 49, 19, 40]])
```

In [168…
```
arr2[-1,-2]
```

Out[168…
```
19
```

In [169…
```
arr2
```

Out[169…
```
array([[51, 34, 97, 87, 45, 16, 56, 69, 66, 97],
       [22, 50, 68, 93,  5,  4, 77, 78, 88, 45],
       [81, 75, 10, 65, 76, 35,  4, 33, 23, 33],
       [98, 35, 70, 99, 22, 44, 14, 58, 96, 42],
       [56, 44, 67,  7, 96, 50, 71, 81, 24, 35],
       [94, 58, 39, 44, 69, 13, 67, 38,  6, 37],
       [49, 41, 92, 26,  9, 29, 33,  3, 61, 43],
       [90, 82, 80, 82, 92,  4, 69, 71, 56, 99],
       [58, 59,  6, 71, 60, 14, 38, 11,  4, 75],
       [86, 98, 54, 17, 14, 71,  6, 49, 19, 40]])
```

In [170…
```
arr2[::-1]
```

Out[170…
```
array([[86, 98, 54, 17, 14, 71,  6, 49, 19, 40],
       [58, 59,  6, 71, 60, 14, 38, 11,  4, 75],
       [90, 82, 80, 82, 92,  4, 69, 71, 56, 99],
       [49, 41, 92, 26,  9, 29, 33,  3, 61, 43],
       [94, 58, 39, 44, 69, 13, 67, 38,  6, 37],
       [56, 44, 67,  7, 96, 50, 71, 81, 24, 35],
       [98, 35, 70, 99, 22, 44, 14, 58, 96, 42],
       [81, 75, 10, 65, 76, 35,  4, 33, 23, 33],
       [22, 50, 68, 93,  5,  4, 77, 78, 88, 45],
       [51, 34, 97, 87, 45, 16, 56, 69, 66, 97]])
```

In [171…
```
arr2
```

Out[171…
```
array([[51, 34, 97, 87, 45, 16, 56, 69, 66, 97],
       [22, 50, 68, 93,  5,  4, 77, 78, 88, 45],
       [81, 75, 10, 65, 76, 35,  4, 33, 23, 33],
       [98, 35, 70, 99, 22, 44, 14, 58, 96, 42],
       [56, 44, 67,  7, 96, 50, 71, 81, 24, 35],
       [94, 58, 39, 44, 69, 13, 67, 38,  6, 37],
       [49, 41, 92, 26,  9, 29, 33,  3, 61, 43],
       [90, 82, 80, 82, 92,  4, 69, 71, 56, 99],
       [58, 59,  6, 71, 60, 14, 38, 11,  4, 75],
       [86, 98, 54, 17, 14, 71,  6, 49, 19, 40]])
```

In [173…
```
arr2[::-2] # step slicing (-2)
```

Out[173…
```
array([[86, 98, 54, 17, 14, 71,  6, 49, 19, 40],
       [90, 82, 80, 82, 92,  4, 69, 71, 56, 99],
       [94, 58, 39, 44, 69, 13, 67, 38,  6, 37],
       [98, 35, 70, 99, 22, 44, 14, 58, 96, 42],
       [22, 50, 68, 93,  5,  4, 77, 78, 88, 45]])
```

In [174…
```
arr2
```

Out[174…
```
array([[51, 34, 97, 87, 45, 16, 56, 69, 66, 97],
       [22, 50, 68, 93,  5,  4, 77, 78, 88, 45],
       [81, 75, 10, 65, 76, 35,  4, 33, 23, 33],
       [98, 35, 70, 99, 22, 44, 14, 58, 96, 42],
       [56, 44, 67,  7, 96, 50, 71, 81, 24, 35],
       [94, 58, 39, 44, 69, 13, 67, 38,  6, 37],
       [49, 41, 92, 26,  9, 29, 33,  3, 61, 43],
       [90, 82, 80, 82, 92,  4, 69, 71, 56, 99],
       [58, 59,  6, 71, 60, 14, 38, 11,  4, 75],
       [86, 98, 54, 17, 14, 71,  6, 49, 19, 40]])
```

In [175…
```
arr2[::-3]
```

Out[175…
```
array([[86, 98, 54, 17, 14, 71,  6, 49, 19, 40],
       [49, 41, 92, 26,  9, 29, 33,  3, 61, 43],
       [98, 35, 70, 99, 22, 44, 14, 58, 96, 42],
       [51, 34, 97, 87, 45, 16, 56, 69, 66, 97]])
```

In [176…
```
arr2
```

Out[176…
```
array([[51, 34, 97, 87, 45, 16, 56, 69, 66, 97],
       [22, 50, 68, 93,  5,  4, 77, 78, 88, 45],
       [81, 75, 10, 65, 76, 35,  4, 33, 23, 33],
       [98, 35, 70, 99, 22, 44, 14, 58, 96, 42],
       [56, 44, 67,  7, 96, 50, 71, 81, 24, 35],
       [94, 58, 39, 44, 69, 13, 67, 38,  6, 37],
       [49, 41, 92, 26,  9, 29, 33,  3, 61, 43],
       [90, 82, 80, 82, 92,  4, 69, 71, 56, 99],
       [58, 59,  6, 71, 60, 14, 38, 11,  4, 75],
       [86, 98, 54, 17, 14, 71,  6, 49, 19, 40]])
```

In [177…
```
arr2[:-3]
```

Out[177…
```
array([[51, 34, 97, 87, 45, 16, 56, 69, 66, 97],
       [22, 50, 68, 93,  5,  4, 77, 78, 88, 45],
       [81, 75, 10, 65, 76, 35,  4, 33, 23, 33],
       [98, 35, 70, 99, 22, 44, 14, 58, 96, 42],
       [56, 44, 67,  7, 96, 50, 71, 81, 24, 35],
       [94, 58, 39, 44, 69, 13, 67, 38,  6, 37],
       [49, 41, 92, 26,  9, 29, 33,  3, 61, 43]])
```

In [178…
```
arr
```

Out[178…
```
array([0, 1, 2, 3, 4, 5])
```

In [179…
```
arr.max()
```

Out[179…
```
5
```

In [180…
```
arr.min()
```

Out[180…
```
0
```

In [181…
```
arr
```

Out[181…
```
array([0, 1, 2, 3, 4, 5])
```

In [182…
```
arr.mean()
```

Out[182…
```
2.5
```

find the median,mode without work on import*

In [183…
```
arr
```

Out[183…
```
array([0, 1, 2, 3, 4, 5])
```

In [184…
```
arr.median()
```

```
---------------------------------------------------------------------------
AttributeError                            Traceback (most recent call last)
Cell In[184], line 1
----> 1 arr.median()

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

In [185…
```
from numpy import *
a = array([1,2,3,4,9])
median(a)
```

Out[185…
```
3.0
```

In [186…
```
arr
```

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

In [187…
```
arr.reshape(3,2)
```

Out[187…
```
array([[0, 1],
       [2, 3],
       [4, 5]])
```

In [188…
```
arr.reshape(6,1)
```

Out[188…
```
array([[0],
       [1],
       [2],
       [3],
       [4],
       [5]])
```

In [189…
```
arr.reshape(1,6)
```

Out[189…
```
array([[0, 1, 2, 3, 4, 5]])
```

In [190…
```
arr
```

Out[190…
```
array([0, 1, 2, 3, 4, 5])
```

In [191…
```
arr.reshape(2,4)
```

```
---------------------------------------------------------------------------
ValueError                                Traceback (most recent call last)
Cell In[191], line 1
----> 1 arr.reshape(2,4)

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

In [192…
```
arr
```

Out[192…
```
array([0, 1, 2, 3, 4, 5])
```

In [193…
```
arr.reshape(2,3,order='C')
```

Out[193…
```
array([[0, 1, 2],
       [3, 4, 5]])
```

In [194…
```
arr.reshape(2,3,order='F') # print element with fortran
```

Out[194…
```
array([[0, 2, 4],
       [1, 3, 5]])
```

In [195…
```
arr.reshape(2,3,order='A') # almost give you C type output
```

Out[195…
```
array([[0, 1, 2],
       [3, 4, 5]])
```

In [196…
```
arr
```

Out[196…
```
array([0, 1, 2, 3, 4, 5])
```

In [197…
```
arr.reshape(2,3)
```

Out[197…
```
array([[0, 1, 2],
       [3, 4, 5]])
```

In [198…
```
arr.reshape(1,4)
```

```
---------------------------------------------------------------------------
ValueError                                Traceback (most recent call last)
Cell In[198], line 1
----> 1 arr.reshape(1,4)

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

In [199…
```
arr.reshape(1,6)
```

Out[199…
```
array([[0, 1, 2, 3, 4, 5]])
```

In [200…
```
arr.reshape(6,1)
```

Out[200…
```
array([[0],
       [1],
       [2],
       [3],
       [4],
       [5]])
```

In [201…
```
arr.reshape(2,6)
```

```
---------------------------------------------------------------------------
ValueError                                Traceback (most recent call last)
Cell In[201], line 1
----> 1 arr.reshape(2,6)

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

In [202…
```
arr.reshape(3,3)
```

```
---------------------------------------------------------------------------
ValueError                                Traceback (most recent call last)
Cell In[202], line 1
----> 1 arr.reshape(3,3)

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

In [203…
```
arr
```

Out[203…
```
array([0, 1, 2, 3, 4, 5])
```

In [204…
```
arr.reshape(3,2)
```

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

Array Indexing

In [205…
```
mat = np.arange(0,100).reshape(10,10)
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…
```
row = 4
col = 5
```

In [207…
```
col
```

Out[207…
```
5
```

In [208…
```
row
```

Out[208…
```
4
```

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[row,col]
```

Out[210…
```
45
```

In [211…
```
mat[4,5]
```

Out[211… 45

In [212…
```
mat
```

Out[212…
```
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 [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…
```
col = 6
```

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 [216…
```
mat[6]
```

Out[216…
```
array([60, 61, 62, 63, 64, 65, 66, 67, 68, 69])
```

In [217…
```
mat
```

Out[217…
```
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[:,col] # with slices
```

Out[219…
```
array([ 6, 16, 26, 36, 46, 56, 66, 76, 86, 96])
```

In [220…
```
mat
```

Out[220…
```
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 [221…
```
mat[row,:]
```

Out[221…
```
array([40, 41, 42, 43, 44, 45, 46, 47, 48, 49])
```

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…
```
mat[:,8]
```

Out[223…
```
array([ 8, 18, 28, 38, 48, 58, 68, 78, 88, 98])
```

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[:col]
```

Out[225…
```
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 [226…
```
mat[:6]
```

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]])
```

In [227…
```
row
```

Out[227…
```
4
```

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 [229…
```
mat[:row]
```

Out[229…
```
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 [230…
```
mat
```

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, 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 [231…
```
mat[row:]
```

Out[231…
```
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 [232…
```
mat[:]
```

Out[232…
```
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 [233…
```
mat[:,8]
```

Out[233…
```
array([ 8, 18, 28, 38, 48, 58, 68, 78, 88, 98])
```

In [234…
```
mat
```

Out[234…
```
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 [235…
```
mat[:,-1]
```

Out[235…
```
array([ 9, 19, 29, 39, 49, 59, 69, 79, 89, 99])
```

In [236…
```
mat
```

Out[236…
```
array([[ 0,  1,  2,  3,  4,  5,  6,  7,  8,  9],
       [10, 11, 12, 13, 14, 15, 16, 17, 18, 19],
       [20, 21, 22, 23, 24, 25, 26, 27, 28, 29],
       [30, 31, 32, 33, 34, 35, 36, 37, 38, 39],
       [40, 41, 42, 43, 44, 45, 46, 47, 48, 49],
       [50, 51, 52, 53, 54, 55, 56, 57, 58, 59],
       [60, 61, 62, 63, 64, 65, 66, 67, 68, 69],
       [70, 71, 72, 73, 74, 75, 76, 77, 78, 79],
       [80, 81, 82, 83, 84, 85, 86, 87, 88, 89],
       [90, 91, 92, 93, 94, 95, 96, 97, 98, 99]])
```

In [237…
```
row
```

Out[237…
```
4
```

In [238…
```
col
```

Out[238… 6

In [239…
```
mat[:,col]
```

Out[239…
```
array([ 6, 16, 26, 36, 46, 56, 66, 76, 86, 96])
```

In [240…
```
mat
```

Out[240…
```
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 [241…
```
mat[1,4]
```

Out[241… 14

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 [243…
```
mat[1:4]
```

Out[243…
```
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 [244…
```
mat
```

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],
       [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 [245…
```
mat[3:-3]
```

Out[245…
```
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 [246…
```
mat
```

Out[246…
```
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 [247…
```
mat[0]
```

Out[247…
```
array([0, 1, 2, 3, 4, 5, 6, 7, 8, 9])
```

In [248…
```
mat[6]
```

Out[248…
```
array([60, 61, 62, 63, 64, 65, 66, 67, 68, 69])
```

In [249…
```
mat
```

Out[249…
```
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 [250…
```
mat[6:]
```

Out[250…
```
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 [251…
```
mat[:6]
```

Out[251…
```
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 [252…
```
mat
```

Out[252…
```
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 [253…
```
mat[5:7]
```

Out[253…
```
array([[50, 51, 52, 53, 54, 55, 56, 57, 58, 59],
       [60, 61, 62, 63, 64, 65, 66, 67, 68, 69]])
```

In [254…
```
mat
```

Out[254…
```
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 [255…
```
mat[0:10]
```

Out[255…
```
array([[ 0,  1,  2,  3,  4,  5,  6,  7,  8,  9],
       [10, 11, 12, 13, 14, 15, 16, 17, 18, 19],
       [20, 21, 22, 23, 24, 25, 26, 27, 28, 29],
       [30, 31, 32, 33, 34, 35, 36, 37, 38, 39],
       [40, 41, 42, 43, 44, 45, 46, 47, 48, 49],
       [50, 51, 52, 53, 54, 55, 56, 57, 58, 59],
       [60, 61, 62, 63, 64, 65, 66, 67, 68, 69],
       [70, 71, 72, 73, 74, 75, 76, 77, 78, 79],
       [80, 81, 82, 83, 84, 85, 86, 87, 88, 89],
       [90, 91, 92, 93, 94, 95, 96, 97, 98, 99]])
```

In [256…
```
mat
```

Out[256…
```
array([[ 0,  1,  2,  3,  4,  5,  6,  7,  8,  9],
       [10, 11, 12, 13, 14, 15, 16, 17, 18, 19],
       [20, 21, 22, 23, 24, 25, 26, 27, 28, 29],
       [30, 31, 32, 33, 34, 35, 36, 37, 38, 39],
       [40, 41, 42, 43, 44, 45, 46, 47, 48, 49],
       [50, 51, 52, 53, 54, 55, 56, 57, 58, 59],
       [60, 61, 62, 63, 64, 65, 66, 67, 68, 69],
       [70, 71, 72, 73, 74, 75, 76, 77, 78, 79],
       [80, 81, 82, 83, 84, 85, 86, 87, 88, 89],
       [90, 91, 92, 93, 94, 95, 96, 97, 98, 99]])
```

In [257…
```
mat[0:10:3]
```

Out[257…
```
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 [258…
```
mat[0:10]
```

Out[258…
```
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 [259…
```
mat
```

Out[259…
```
array([[ 0,  1,  2,  3,  4,  5,  6,  7,  8,  9],
       [10, 11, 12, 13, 14, 15, 16, 17, 18, 19],
       [20, 21, 22, 23, 24, 25, 26, 27, 28, 29],
       [30, 31, 32, 33, 34, 35, 36, 37, 38, 39],
       [40, 41, 42, 43, 44, 45, 46, 47, 48, 49],
       [50, 51, 52, 53, 54, 55, 56, 57, 58, 59],
       [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 [260…
```
mat[4:]
```

Out[260…
```
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 [261…
```
mat
```

Out[261…
```
array([[ 0,  1,  2,  3,  4,  5,  6,  7,  8,  9],
       [10, 11, 12, 13, 14, 15, 16, 17, 18, 19],
       [20, 21, 22, 23, 24, 25, 26, 27, 28, 29],
       [30, 31, 32, 33, 34, 35, 36, 37, 38, 39],
       [40, 41, 42, 43, 44, 45, 46, 47, 48, 49],
       [50, 51, 52, 53, 54, 55, 56, 57, 58, 59],
       [60, 61, 62, 63, 64, 65, 66, 67, 68, 69],
       [70, 71, 72, 73, 74, 75, 76, 77, 78, 79],
       [80, 81, 82, 83, 84, 85, 86, 87, 88, 89],
       [90, 91, 92, 93, 94, 95, 96, 97, 98, 99]])
```

In [262…
```
mat[:4]
```

Out[262…
```
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 [263…
```
mat
```

Out[263…
```
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 [264…
```
mat[::-1]
```

Out[264…
```
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 [265…
```
mat
```

Out[265…
```
array([[ 0,  1,  2,  3,  4,  5,  6,  7,  8,  9],
       [10, 11, 12, 13, 14, 15, 16, 17, 18, 19],
       [20, 21, 22, 23, 24, 25, 26, 27, 28, 29],
       [30, 31, 32, 33, 34, 35, 36, 37, 38, 39],
       [40, 41, 42, 43, 44, 45, 46, 47, 48, 49],
       [50, 51, 52, 53, 54, 55, 56, 57, 58, 59],
       [60, 61, 62, 63, 64, 65, 66, 67, 68, 69],
       [70, 71, 72, 73, 74, 75, 76, 77, 78, 79],
       [80, 81, 82, 83, 84, 85, 86, 87, 88, 89],
       [90, 91, 92, 93, 94, 95, 96, 97, 98, 99]])
```

In [266…
```
mat[::-3]
```

Out[266…
```
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 [267…
```
mat
```

Out[267…
```
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 [268…
```
mat[::-3]
```

Out[268…
```
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 [269…
```
mat[::-5]
```

Out[269…
```
array([[90, 91, 92, 93, 94, 95, 96, 97, 98, 99],
       [40, 41, 42, 43, 44, 45, 46, 47, 48, 49]])
```

In [270…
```
mat
```

Out[270…
```
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 [271…
```
mat[2:6]
```

Out[271…
```
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 [272…
```
mat
```

Out[272…
```
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]])
```

Retrive specific matric values from matrix

In [274…
```
mat[2:6,2:4]
```

Out[274…
```
array([[22, 23],
       [32, 33],
       [42, 43],
       [52, 53]])
```

In [275…
```
mat
```

Out[275…
```
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 [276…
```
mat[0,1]
```

Out[276…
```
1
```

In [277…
```
mat[1,6]
```

Out[277…
```
16
```

In [278…
```
mat
```

Out[278…
```
array([[ 0,  1,  2,  3,  4,  5,  6,  7,  8,  9],
       [10, 11, 12, 13, 14, 15, 16, 17, 18, 19],
       [20, 21, 22, 23, 24, 25, 26, 27, 28, 29],
       [30, 31, 32, 33, 34, 35, 36, 37, 38, 39],
       [40, 41, 42, 43, 44, 45, 46, 47, 48, 49],
       [50, 51, 52, 53, 54, 55, 56, 57, 58, 59],
       [60, 61, 62, 63, 64, 65, 66, 67, 68, 69],
       [70, 71, 72, 73, 74, 75, 76, 77, 78, 79],
       [80, 81, 82, 83, 84, 85, 86, 87, 88, 89],
       [90, 91, 92, 93, 94, 95, 96, 97, 98, 99]])
```

In [279…
```
mat[1:6]
```

Out[279…
```
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 [280…
```
mat[1:]
```

Out[280…
```
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 [281…
```
mat
```

Out[281…
```
array([[ 0,  1,  2,  3,  4,  5,  6,  7,  8,  9],
       [10, 11, 12, 13, 14, 15, 16, 17, 18, 19],
       [20, 21, 22, 23, 24, 25, 26, 27, 28, 29],
       [30, 31, 32, 33, 34, 35, 36, 37, 38, 39],
       [40, 41, 42, 43, 44, 45, 46, 47, 48, 49],
       [50, 51, 52, 53, 54, 55, 56, 57, 58, 59],
       [60, 61, 62, 63, 64, 65, 66, 67, 68, 69],
       [70, 71, 72, 73, 74, 75, 76, 77, 78, 79],
       [80, 81, 82, 83, 84, 85, 86, 87, 88, 89],
       [90, 91, 92, 93, 94, 95, 96, 97, 98, 99]])
```

In [282…
```
mat[:6]
```

Out[282…
```
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 [283…
```
mat[0:1]
```

Out[283…
```
array([[0, 1, 2, 3, 4, 5, 6, 7, 8, 9]])
```

In [284…
```
mat
```

Out[284…
```
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 [285…
```
mat[3:5]
```

Out[285…
```
array([[30, 31, 32, 33, 34, 35, 36, 37, 38, 39],
       [40, 41, 42, 43, 44, 45, 46, 47, 48, 49]])
```

In [286…
```
mat[3,5]
```

Out[286…
```
35
```

In [287…
```
mat
```

Out[287…
```
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 [288…
```
mat[1:2,2:4]
```

Out[288…
```
array([[12, 13]])
```

In [289…
```
mat
```

Out[289…
```
array([[ 0,  1,  2,  3,  4,  5,  6,  7,  8,  9],
       [10, 11, 12, 13, 14, 15, 16, 17, 18, 19],
       [20, 21, 22, 23, 24, 25, 26, 27, 28, 29],
       [30, 31, 32, 33, 34, 35, 36, 37, 38, 39],
       [40, 41, 42, 43, 44, 45, 46, 47, 48, 49],
       [50, 51, 52, 53, 54, 55, 56, 57, 58, 59],
       [60, 61, 62, 63, 64, 65, 66, 67, 68, 69],
       [70, 71, 72, 73, 74, 75, 76, 77, 78, 79],
       [80, 81, 82, 83, 84, 85, 86, 87, 88, 89],
       [90, 91, 92, 93, 94, 95, 96, 97, 98, 99]])
```

In [290…
```
mat[2:3,2:3]
```

Out[290…
```
array([[22]])
```

In [291…
```
mat
```

Out[291…
```
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 [292…
```
mat[2:4,3:5]
```

Out[292…
```
array([[23, 24],
       [33, 34]])
```

In [293…
```
mat[3:5,2:4]
```

Out[293…
```
array([[32, 33],
       [42, 43]])
```

In [294…
```
mat
```

Out[294…
```
array([[ 0,  1,  2,  3,  4,  5,  6,  7,  8,  9],
       [10, 11, 12, 13, 14, 15, 16, 17, 18, 19],
       [20, 21, 22, 23, 24, 25, 26, 27, 28, 29],
       [30, 31, 32, 33, 34, 35, 36, 37, 38, 39],
       [40, 41, 42, 43, 44, 45, 46, 47, 48, 49],
       [50, 51, 52, 53, 54, 55, 56, 57, 58, 59],
       [60, 61, 62, 63, 64, 65, 66, 67, 68, 69],
       [70, 71, 72, 73, 74, 75, 76, 77, 78, 79],
       [80, 81, 82, 83, 84, 85, 86, 87, 88, 89],
       [90, 91, 92, 93, 94, 95, 96, 97, 98, 99]])
```

In [295…
```
mat[2:3,4:5]
```

Out[295… array([[24]])

Masking (Matrix Filter)

In [296…
```
mat
```

Out[296…
```
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 [297…
```
id(mat)
```

Out[297… 2140800516912

In [298…
```
mat
```

Out[298…
```
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 [299…
```
mat[mat<50]
```

Out[299…
```
array([ 0,  1,  2,  3,  4,  5,  6,  7,  8,  9, 10, 11, 12, 13, 14, 15, 16,
       17, 18, 19, 20, 21, 22, 23, 24, 25, 26, 27, 28, 29, 30, 31, 32, 33,
       34, 35, 36, 37, 38, 39, 40, 41, 42, 43, 44, 45, 46, 47, 48, 49])
```

In [300…
```
mat[mat<=50]
```

Out[300…
```
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 [301…
```
mat
```

Out[301…
```
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 [302…
```
mat > 50
```

Out[302…
```
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 [303…
```
mat[mat==50]
```

Out[303…
```
array([50])
```

In [304…
```
mat
```

Out[304…
```
array([[ 0,  1,  2,  3,  4,  5,  6,  7,  8,  9],
       [10, 11, 12, 13, 14, 15, 16, 17, 18, 19],
       [20, 21, 22, 23, 24, 25, 26, 27, 28, 29],
       [30, 31, 32, 33, 34, 35, 36, 37, 38, 39],
       [40, 41, 42, 43, 44, 45, 46, 47, 48, 49],
       [50, 51, 52, 53, 54, 55, 56, 57, 58, 59],
       [60, 61, 62, 63, 64, 65, 66, 67, 68, 69],
       [70, 71, 72, 73, 74, 75, 76, 77, 78, 79],
       [80, 81, 82, 83, 84, 85, 86, 87, 88, 89],
       [90, 91, 92, 93, 94, 95, 96, 97, 98, 99]])
```

In [305…
```
mat == 50
```

Out[305…
```
array([[False, False, False, False, False, False, False, False, False,
        False],
       [False, False, False, False, False, False, False, False, False,
        False],
       [False, False, False, False, False, False, False, False, False,
        False],
       [False, False, False, False, False, False, False, False, False,
        False],
       [False, False, False, False, False, False, False, False, False,
        False],
       [ True, False, False, False, False, False, False, False, False,
        False],
       [False, False, False, False, False, False, False, False, False,
        False],
       [False, False, False, False, False, False, False, False, False,
        False],
       [False, False, False, False, False, False, False, False, False,
        False],
       [False, False, False, False, False, False, False, False, False,
        False]])
```

In [306…
```
mat
```

Out[306…
```
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 [307…
```
a1 = mat[mat<50]
a1
```

Out[307…
```
array([ 0,  1,  2,  3,  4,  5,  6,  7,  8,  9, 10, 11, 12, 13, 14, 15, 16,
       17, 18, 19, 20, 21, 22, 23, 24, 25, 26, 27, 28, 29, 30, 31, 32, 33,
       34, 35, 36, 37, 38, 39, 40, 41, 42, 43, 44, 45, 46, 47, 48, 49])
```

In [309…
```
mat
```

Out[309…
```
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 [310…
```
a2 = mat[mat>50]
a2
```

Out[310…
```
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 [311…
```
a3 = mat[mat<=50]
a3
```

Out[311…
```
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 [312…
```
a4 = mat[mat==50]
a4
```

Out[312…
```
array([50])
```

NumPy Complete Buildin Functions

1. Array Creation Functions

In [313…
```
import numpy as np
```

In [314…
```
a = np.array([1,2,3]) # create an array from a list
print("Array a:" , a)
```

```
Array a: [1 2 3]
```

In [320…
```
b = np.arange(0,10,2) # Values from 0 to 10 with step2
print("Array b:" , b)
```

```
Array b: [0 2 4 6 8]
```

In [321…
```
c = np.linspace(0, 1, 5)  # 5 values evenly spaced between 0 and 1
print("Array c:", c)
```

```
Array c: [0.   0.25 0.5  0.75 1.  ]
```

In [317…
```
d = np.zeros((2,3)) # create an array filled with zeros(2x3)
print("Array d:\n",d)
```

```
Array d:
 [[0. 0. 0.]
 [0. 0. 0.]]
```

In [318…
```
e = np.ones((3,2)) # Create an array filled with ones(3x2)
print("Array e:\n", e)
```

```
Array e:
 [[1. 1.]
 [1. 1.]
 [1. 1.]]
```

In [319…
```
f = np.eye(4) # Create an identity matrix (4x4)
print("Identity matrix f:\n", f)
```

```
Identity matrix f:
 [[1. 0. 0. 0.]
 [0. 1. 0. 0.]
 [0. 0. 1. 0.]
 [0. 0. 0. 1.]]
```

2. Array Manipulation Functions

In [323…
```
a1 = np.array([1,2,3])
a1
```

Out[323…
```
array([1, 2, 3])
```

In [ ]:
```
```