Numpy Crash Course

In [ ]:

In [10]:
```
import numpy as np
```

In [11]:
```
import sys
sys.version
```

Out[11]:
```
'3.12.7 | packaged by Anaconda, Inc. | (main, Oct  4 2024, 13:17:27) [MSC v.1929 6
4 bit (AMD64)]'
```

In [12]:
```
import numpy as np
```

In [13]:
```
np.__version__
```

Out[13]:
```
'1.26.4'
```

In [14]:
```
#create list
my_list = [0,1,2,3,4,5]
my_list
```

Out[14]:
```
[0, 1, 2, 3, 4, 5]
```

In [15]:
```
type(my_list)
```

Out[15]:
```
list
```

In [16]:
```
arr = np.array(my_list)
arr
```

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

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

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

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

```
<class 'numpy.ndarray'>
<class 'list'>
```

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

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

In [13]:
```
np.arange(10,20)
```

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

In [15]:
```
np.arange(10,50,5)
```

Out[15]:
```
array([10, 15, 20, 25, 30, 35, 40, 45])
```

In [16]:
```
np.arange(10,30,3)
```

Out[16]:
```
array([10, 13, 16, 19, 22, 25, 28])
```

In [17]:
```
np.arange(10,30,30, 3)
```

```
---------------------------------------------------------------------------
TypeError                                 Traceback (most recent call last)
Cell In[17], line 1
----> 1 np.arange(10,30,30, 3)

TypeError: Cannot interpret '3' as a data type
```

In [20]:
```
np.arange(20,8)
```

Out[20]:
```
array([], dtype=int32)
```

In [21]:
```
np.arange(8,20)
```

Out[21]:
```
array([ 8,  9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19])
```

In [22]:
```
np.arange(-20,8) # 1st argument must be smaller than 2nd argument
```

Out[22]:
```
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])
```

In [23]:
```
n = np.arange(-20,8)
n
```

Out[23]:
```
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])
```

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

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

In [26]:
```
np.zeros(3, dtype=int)
```

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

In [28]:
```
z = np.zeros(5)
```

In [29]:
```
z
```

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

In [31]:
```
np.zeros((2,2))
```

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

In [32]:
```
np.zeros((3,3), dtype = int)
```

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

In [39]:
```
nd1 = np.zeros((5,9), dtype = int)
```

In [42]:
```
nd1
```

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

In [35]:
```
np.ones(3)
```

Out[35]:
```
array([1., 1., 1.])
```

In [36]:
```
np.ones(3, dtype=int)
```

Out[36]:
```
array([1, 1, 1])
```

In [37]:
```
np.ones((10,10), dtype=int)
```

Out[37]:
```
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],
       [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 [41]:
```
nd1
```

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]])
```

In [ ]:
```

```

In [44]:
```
range(5)
```

Out[44]:
```
range(0, 5)
```

In [45]:
```
r = range(5)
```

In [46]:
```
r
```

Out[46]:
```
range(0, 5)
```

In [47]:
```
for i in r:
    print(i)
```

```
0
1
2
3
4
```

In [48]:
```
list(range(5))
```

Out[48]:
```
[0, 1, 2, 3, 4]
```

In [49]:
```
range(1,10)
```

Out[49]:
```
range(1, 10)
```

In [50]:
```
list(range(1,10))
```

Out[50]:
```
[1, 2, 3, 4, 5, 6, 7, 8, 9]
```

In [51]:
```
list(range(1,10,3))
```

Out[51]:
```
[1, 4, 7]
```

In [52]:
```
y = list(range(12))
```

In [53]:
```
y
```

Out[53]:
```
[0, 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11]
```

In [54]:
```
rand(3,2)
```

```
---------------------------------------------------------------------------
NameError                                 Traceback (most recent call last)
Cell In[54], line 1
----> 1 rand(3,2)

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

In [55]:
```
rand(3,2)
random.rand(3,2)
```

```
---------------------------------------------------------------------------
NameError                                 Traceback (most recent call last)
Cell In[55], line 1
----> 1 rand(3,2)
      2 random.rand(3,2)

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

In [56]:
```
np.random.rand(5)
```

Out[56]:
```
array([0.85135519, 0.88667882, 0.3365225 , 0.41037762, 0.48716009])
```

In [57]:
```
np.rand(4)
```

```
---------------------------------------------------------------------------
AttributeError                            Traceback (most recent call last)
Cell In[57], 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 [58]:
```
np.random.rand(2,4)
```

Out[58]:
```
array([[0.992468  , 0.37859471, 0.5499475 , 0.16870245],
       [0.46376298, 0.11818319, 0.94869206, 0.1973226 ]])
```

In [62]:
```
np.random.randint(2,4)
```

Out[62]:
```
2
```

In [64]:
```
np.random.randint(2,20)
```

Out[64]:
```
16
```

In [65]:
```
np.random.randint(0,1)
```

Out[65]:
```
0
```

In [66]:
```
np.random.randint(10,20,5)
```

Out[66]:
```
array([12, 18, 14, 12, 13])
```

In [67]:
```
np.random.randint(1,6,4)
```

Out[67]:
```
array([3, 3, 3, 4])
```

In [68]:
```
np.random.rand(3)
```

Out[68]:
```
array([0.78316371, 0.58309739, 0.62125179])
```

In [69]:
```
np.random.randint(1)
```

Out[69]:
```
0
```

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

```
---------------------------------------------------------------------------
ValueError                                Traceback (most recent call last)
Cell In[70], 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._r
and_int32()

ValueError: low >= high
```

In [71]:
```
np.random.randint(-30,20,10)
```

Out[71]:
```
array([-27,   8,  11,  -8, -30,   7,   6, -17,  -1, -16])
```

In [72]:
```
np.random.randint(20,30,10)
```

Out[72]:
```
array([28, 26, 29, 29, 20, 28, 20, 24, 22, 21])
```

In [73]:
```
np.random.randint(5,9)
```

Out[73]:
```
8
```

In [74]:
```
np.random.randint(10,21,3)
```

Out[74]:
```
array([12, 12, 16])
```

In [75]:
```
np.random.randint(1,12,10)
```

Out[75]:
```
array([9, 7, 9, 2, 2, 7, 3, 5, 7, 8])
```

In [76]:
```
np.random.randint(10,40,(10,10))
```

Out[76]:
```
array([[24, 15, 27, 16, 12, 24, 28, 22, 38, 29],
       [20, 25, 38, 28, 12, 18, 25, 30, 14, 36],
       [21, 13, 16, 30, 31, 15, 20, 36, 34, 12],
       [30, 32, 35, 16, 29, 30, 27, 37, 39, 22],
       [18, 39, 22, 31, 12, 38, 31, 33, 31, 23],
       [37, 23, 12, 27, 26, 31, 14, 18, 14, 34],
       [20, 31, 20, 10, 29, 17, 36, 25, 18, 23],
       [17, 25, 24, 23, 33, 21, 34, 22, 20, 22],
       [37, 30, 14, 35, 22, 30, 12, 24, 37, 37],
       [39, 18, 31, 22, 34, 17, 35, 13, 11, 29]])
```

In [77]:
```
np.random.randint(1,100,(12,12))
```

Out[77]:
```
array([[41, 93,  8, 61, 75, 60, 73, 43, 92, 76,  5, 86],
       [95, 14, 38, 21, 30, 76, 25, 21, 31, 62, 27, 32],
       [ 8, 46, 30, 47, 71, 17, 67, 92, 71, 32, 83, 58],
       [95, 59, 32, 84, 13, 99, 68, 68, 87, 68, 10, 20],
       [26, 70, 27, 26, 82, 40, 67, 78, 43, 32, 46, 76],
       [29, 30, 64, 57, 16, 14, 68, 11, 70, 82, 75, 58],
       [81, 55, 36, 50, 46, 16,  8,  9, 46, 43, 94, 26],
       [64, 90, 75,  4, 36, 71, 94, 53, 30,  4,  9, 91],
       [26,  2, 41, 44,  5, 39, 43,  1, 27, 85, 68, 64],
       [83, 44, 40, 60, 54,  6, 35, 83, 28, 48, 12, 44],
       [71, 56, 54, 74, 20, 34, 86, 29, 78, 21, 80, 67],
       [88, 23, 21, 33, 82, 79,  8, 88, 63, 45, 69, 76]])
```

In [79]:
```
np.arange(1,13).reshape(3,4)
```

Out[79]:
```
array([[ 1,  2,  3,  4],
       [ 5,  6,  7,  8],
       [ 9, 10, 11, 12]])
```

In [80]:
```
np.arange(1,13).reshape(12,1)
```

Out[80]:
```
array([[ 1],
       [ 2],
       [ 3],
       [ 4],
       [ 5],
       [ 6],
       [ 7],
       [ 8],
       [ 9],
       [10],
       [11],
       [12]])
```

In [81]:
```
b = np.random.randint(10,20, (5,4))
```

In [82]:
```
b
```

Out[82]:
```
array([[14, 15, 10, 16],
       [12, 11, 16, 15],
       [16, 16, 10, 19],
       [14, 15, 18, 12],
       [15, 17, 12, 19]])
```

In [83]:
```
type(b)
```

Out[83]:
```
numpy.ndarray
```

In [84]:
```
b
```

Out[84]:
```
array([[14, 15, 10, 16],
       [12, 11, 16, 15],
       [16, 16, 10, 19],
       [14, 15, 18, 12],
       [15, 17, 12, 19]])
```

In [85]:
```
b[:]
```

Out[85]:
```
array([[14, 15, 10, 16],
       [12, 11, 16, 15],
       [16, 16, 10, 19],
       [14, 15, 18, 12],
       [15, 17, 12, 19]])
```

In [86]:
```
b[1:3]
```

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

In [87]:
```
b
```

Out[87]:
```
array([[14, 15, 10, 16],
       [12, 11, 16, 15],
       [16, 16, 10, 19],
       [14, 15, 18, 12],
       [15, 17, 12, 19]])
```

In [88]:
```
b[1,2]
```

Out[88]:
```
16
```

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

Out[89]:
```
array([[14, 15, 10, 16],
       [12, 11, 16, 15],
       [16, 16, 10, 19],
       [14, 15, 18, 12],
       [15, 17, 12, 19]])
```

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

Out[90]:
```
15
```

In [91]:
```
b[1,-1]
```

Out[91]:
```
15
```

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

Out[92]:
```
array([[14, 15, 10, 16],
       [12, 11, 16, 15],
       [16, 16, 10, 19],
       [14, 15, 18, 12],
       [15, 17, 12, 19]])
```

In [93]:
```
b[2:3]
```

Out[93]:
```
array([[16, 16, 10, 19]])
```

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

Out[94]:
```
array([[14, 15, 10, 16],
       [12, 11, 16, 15],
       [16, 16, 10, 19],
       [14, 15, 18, 12],
       [15, 17, 12, 19]])
```

In [97]:
```
b[0:-2]
```

Out[97]:
```
array([[14, 15, 10, 16],
       [12, 11, 16, 15],
       [16, 16, 10, 19]])
```

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

Out[98]:
```
array([[14, 15, 10, 16],
       [12, 11, 16, 15],
       [16, 16, 10, 19],
       [14, 15, 18, 12],
       [15, 17, 12, 19]])
```

In [99]:
```
b[0,2]
```

Out[99]:
```
10
```

In [100…
```
b
```

Out[100…
```
array([[14, 15, 10, 16],
       [12, 11, 16, 15],
       [16, 16, 10, 19],
       [14, 15, 18, 12],
       [15, 17, 12, 19]])
```

In [101…
```
b[-5,-3]
```

Out[101…
```
15
```

In [102…
```
b
```

Out[102…
```
array([[14, 15, 10, 16],
       [12, 11, 16, 15],
       [16, 16, 10, 19],
       [14, 15, 18, 12],
       [15, 17, 12, 19]])
```

In [103…
```
b[-4,2]
```

Out[103…
```
16
```

In [104…
```
np.random.randint(10,20,(4,4))
```

Out[104…
```
array([[12, 14, 18, 17],
       [14, 19, 12, 18],
       [12, 19, 13, 16],
       [15, 17, 16, 18]])
```

In [105…
```
b
```

Out[105…
```
array([[14, 15, 10, 16],
       [12, 11, 16, 15],
       [16, 16, 10, 19],
       [14, 15, 18, 12],
       [15, 17, 12, 19]])
```

In [106…
```
b[-4,-2]
```

Out[106…
```
16
```

In [107…
```
b
```

Out[107…
```
array([[14, 15, 10, 16],
       [12, 11, 16, 15],
       [16, 16, 10, 19],
       [14, 15, 18, 12],
       [15, 17, 12, 19]])
```

In [111…
```
b[-4:2]
```

Out[111…
```
array([[12, 11, 16, 15]])
```

In [112…
```
b[:]
```

Out[112…
```
array([[14, 15, 10, 16],
       [12, 11, 16, 15],
       [16, 16, 10, 19],
       [14, 15, 18, 12],
       [15, 17, 12, 19]])
```

Operators

In [114…
```
a = np.random.randint(10,20,10)
a
```

Out[114…
```
array([18, 19, 13, 16, 18, 12, 10, 12, 15, 11])
```

In [115…
```
id(a)
```

Out[115…
```
1965070208912
```

In [120…
```
arr
```

Out[120… array([0, 1, 2, 3, 4, 5])

In [121…
```
arr2 = np.random.randint(0,100,(10,10))
```

In [122…
```
arr2
```

Out[122…
```
array([[71, 22, 93, 51, 93, 25, 74, 95, 64, 29],
       [ 7,  6, 97, 87, 34,  0, 67, 94, 59, 71],
       [54, 27, 36,  7, 16, 98, 50, 92, 23,  1],
       [77, 44, 83, 81, 88,  0, 32, 33,  3, 52],
       [49, 88, 71, 45, 43, 87, 70, 95, 35,  0],
       [36, 78, 19, 80, 10, 96, 24, 54, 72, 57],
       [62, 28,  0, 51, 24, 18, 14, 91, 69, 81],
       [55, 16,  1, 91, 28, 64, 20,  3, 79, 55],
       [15, 72, 30, 28, 21,  4, 40, 90, 50, 56],
       [ 0, 35, 23, 93, 18, 40, 84, 16, 51, 98]])
```

In [123…
```
arr
```

Out[123… array([0, 1, 2, 3, 4, 5])

In [124…
```
arr[:]
```

Out[124… array([0, 1, 2, 3, 4, 5])

In [125…
```
arr
```

Out[125… array([0, 1, 2, 3, 4, 5])

In [126…
```
arr[:4]
```

Out[126… array([0, 1, 2, 3])

In [127…
```
arr2[:]
```

Out[127…
```
array([[71, 22, 93, 51, 93, 25, 74, 95, 64, 29],
       [ 7,  6, 97, 87, 34,  0, 67, 94, 59, 71],
       [54, 27, 36,  7, 16, 98, 50, 92, 23,  1],
       [77, 44, 83, 81, 88,  0, 32, 33,  3, 52],
       [49, 88, 71, 45, 43, 87, 70, 95, 35,  0],
       [36, 78, 19, 80, 10, 96, 24, 54, 72, 57],
       [62, 28,  0, 51, 24, 18, 14, 91, 69, 81],
       [55, 16,  1, 91, 28, 64, 20,  3, 79, 55],
       [15, 72, 30, 28, 21,  4, 40, 90, 50, 56],
       [ 0, 35, 23, 93, 18, 40, 84, 16, 51, 98]])
```

In [128…
```
arr2[0:5]
```

Out[128…
```
array([[71, 22, 93, 51, 93, 25, 74, 95, 64, 29],
       [ 7,  6, 97, 87, 34,  0, 67, 94, 59, 71],
       [54, 27, 36,  7, 16, 98, 50, 92, 23,  1],
       [77, 44, 83, 81, 88,  0, 32, 33,  3, 52],
       [49, 88, 71, 45, 43, 87, 70, 95, 35,  0]])
```

In [129…
```
arr2
```

Out[129…
```
array([[71, 22, 93, 51, 93, 25, 74, 95, 64, 29],
       [ 7,  6, 97, 87, 34,  0, 67, 94, 59, 71],
       [54, 27, 36,  7, 16, 98, 50, 92, 23,  1],
       [77, 44, 83, 81, 88,  0, 32, 33,  3, 52],
       [49, 88, 71, 45, 43, 87, 70, 95, 35,  0],
       [36, 78, 19, 80, 10, 96, 24, 54, 72, 57],
       [62, 28,  0, 51, 24, 18, 14, 91, 69, 81],
       [55, 16,  1, 91, 28, 64, 20,  3, 79, 55],
       [15, 72, 30, 28, 21,  4, 40, 90, 50, 56],
       [ 0, 35, 23, 93, 18, 40, 84, 16, 51, 98]])
```

In [130…
```
arr2[1,4]
```

Out[130…
```
34
```

In [131…
```
arr2
```

Out[131…
```
array([[71, 22, 93, 51, 93, 25, 74, 95, 64, 29],
       [ 7,  6, 97, 87, 34,  0, 67, 94, 59, 71],
       [54, 27, 36,  7, 16, 98, 50, 92, 23,  1],
       [77, 44, 83, 81, 88,  0, 32, 33,  3, 52],
       [49, 88, 71, 45, 43, 87, 70, 95, 35,  0],
       [36, 78, 19, 80, 10, 96, 24, 54, 72, 57],
       [62, 28,  0, 51, 24, 18, 14, 91, 69, 81],
       [55, 16,  1, 91, 28, 64, 20,  3, 79, 55],
       [15, 72, 30, 28, 21,  4, 40, 90, 50, 56],
       [ 0, 35, 23, 93, 18, 40, 84, 16, 51, 98]])
```

In [132…
```
arr2[::-1]
```

Out[132…
```
array([[ 0, 35, 23, 93, 18, 40, 84, 16, 51, 98],
       [15, 72, 30, 28, 21,  4, 40, 90, 50, 56],
       [55, 16,  1, 91, 28, 64, 20,  3, 79, 55],
       [62, 28,  0, 51, 24, 18, 14, 91, 69, 81],
       [36, 78, 19, 80, 10, 96, 24, 54, 72, 57],
       [49, 88, 71, 45, 43, 87, 70, 95, 35,  0],
       [77, 44, 83, 81, 88,  0, 32, 33,  3, 52],
       [54, 27, 36,  7, 16, 98, 50, 92, 23,  1],
       [ 7,  6, 97, 87, 34,  0, 67, 94, 59, 71],
       [71, 22, 93, 51, 93, 25, 74, 95, 64, 29]])
```

In [133…
```
arr2
```

Out[133…
```
array([[71, 22, 93, 51, 93, 25, 74, 95, 64, 29],
       [ 7,  6, 97, 87, 34,  0, 67, 94, 59, 71],
       [54, 27, 36,  7, 16, 98, 50, 92, 23,  1],
       [77, 44, 83, 81, 88,  0, 32, 33,  3, 52],
       [49, 88, 71, 45, 43, 87, 70, 95, 35,  0],
       [36, 78, 19, 80, 10, 96, 24, 54, 72, 57],
       [62, 28,  0, 51, 24, 18, 14, 91, 69, 81],
       [55, 16,  1, 91, 28, 64, 20,  3, 79, 55],
       [15, 72, 30, 28, 21,  4, 40, 90, 50, 56],
       [ 0, 35, 23, 93, 18, 40, 84, 16, 51, 98]])
```

In [134…
```
arr2[::-3]
```

Out[134…
```
array([[ 0, 35, 23, 93, 18, 40, 84, 16, 51, 98],
       [62, 28,  0, 51, 24, 18, 14, 91, 69, 81],
       [77, 44, 83, 81, 88,  0, 32, 33,  3, 52],
       [71, 22, 93, 51, 93, 25, 74, 95, 64, 29]])
```

In [135…
```
arr2
```

Out[135…
```
array([[71, 22, 93, 51, 93, 25, 74, 95, 64, 29],
       [ 7,  6, 97, 87, 34,  0, 67, 94, 59, 71],
       [54, 27, 36,  7, 16, 98, 50, 92, 23,  1],
       [77, 44, 83, 81, 88,  0, 32, 33,  3, 52],
       [49, 88, 71, 45, 43, 87, 70, 95, 35,  0],
       [36, 78, 19, 80, 10, 96, 24, 54, 72, 57],
       [62, 28,  0, 51, 24, 18, 14, 91, 69, 81],
       [55, 16,  1, 91, 28, 64, 20,  3, 79, 55],
       [15, 72, 30, 28, 21,  4, 40, 90, 50, 56],
       [ 0, 35, 23, 93, 18, 40, 84, 16, 51, 98]])
```

In [136…
```
arr2[:-3]
```

Out[136…
```
array([[71, 22, 93, 51, 93, 25, 74, 95, 64, 29],
       [ 7,  6, 97, 87, 34,  0, 67, 94, 59, 71],
       [54, 27, 36,  7, 16, 98, 50, 92, 23,  1],
       [77, 44, 83, 81, 88,  0, 32, 33,  3, 52],
       [49, 88, 71, 45, 43, 87, 70, 95, 35,  0],
       [36, 78, 19, 80, 10, 96, 24, 54, 72, 57],
       [62, 28,  0, 51, 24, 18, 14, 91, 69, 81]])
```

In [137…
```
arr
```

Out[137…
```
array([0, 1, 2, 3, 4, 5])
```

In [138…
```
arr.max()
```

Out[138…
```
5
```

In [140…
```
arr.min()
```

Out[140…
```
0
```

In [141…
```
arr
```

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

In [142…
```
arr.mean()
```

Out[142…
```
2.5
```

In [146…
```
arr
```

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

In [147…
```
arr.median()
```

```
---------------------------------------------------------------------------
AttributeError                            Traceback (most recent call last)
Cell In[147], line 1
----> 1 arr.median()

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

In [148…
```
from numpy import *
```

In [149…
```
a = array([1,2,3,4,9])
median(a)
```

Out[149… 3.0

Without work on import* can you please fine the median, mode

In [150…
```
arr
```

Out[150… array([0, 1, 2, 3, 4, 5])

In [151…
```
arr.reshape(3,2)
```

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

In [152…
```
arr.reshape(6,1)
```

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

In [153…
```
arr.reshape(1,6)
```

Out[153… array([[0, 1, 2, 3, 4, 5]])

In [154…
```
arr
```

Out[154… array([0, 1, 2, 3, 4, 5])

In [157…
```
arr.reshape(2,3)
```

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

In [158…
```
arr.reshape(2,3, order='C')
```

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

In [159…
```
arr.reshape(2,3, order='F')
```

Out[159…
```
array([[0, 2, 4],
       [1, 3, 5]])
```

In [160…
```
arr.reshape(2,3, order='A')
```

Out[160…
```
array([[0, 1, 2],
       [3, 4, 5]])
```

In [161…
```
arr
```

Out[161…
```
array([0, 1, 2, 3, 4, 5])
```

In [162…
```
arr.reshape(2,3)
```

Out[162…
```
array([[0, 1, 2],
       [3, 4, 5]])
```

In [168…
```
arr.reshape(1,4)
```

```
---------------------------------------------------------------------------
ValueError                                Traceback (most recent call last)
Cell In[168], line 1
----> 1 arr.reshape(1,4)

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

In [164…
```
arr.reshape(1,6)
```

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

In [169…
```
arr.reshape(6,1)
```

Out[169…
```
array([[0],
       [1],
       [2],
       [3],
       [4],
       [5]])
```

In [170…
```
arr.reshape(3,3)
```

```
---------------------------------------------------------------------------
ValueError                                Traceback (most recent call last)
Cell In[170], line 1
----> 1 arr.reshape(3,3)

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

In [171…
```
arr
```

Out[171…
```
array([0, 1, 2, 3, 4, 5])
```

In [172…
```
arr.reshape(3,2)
```

Out[172…
```
array([[0, 1],
       [2, 3],
       [4, 5]])
```

Indexing

In [18]:
```
mat = np.arange(0,100).reshape(10,10)
```

In [174…
```
mat
```

Out[174…
```
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 [175…
```
row = 4
col = 5
```

In [176…
```
col
```

Out[176…
```
5
```

In [177…
```
row
```

Out[177…
```
4
```

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…
```
mat[row,col]
```

Out[179…
```
45
```

In [181…
```
mat[4,5]
```

Out[181…
```
45
```

In [182…
```
mat
```

Out[182…
```
array([[ 0,  1,  2,  3,  4,  5,  6,  7,  8,  9],
       [10, 11, 12, 13, 14, 15, 16, 17, 18, 19],
       [20, 21, 22, 23, 24, 25, 26, 27, 28, 29],
       [30, 31, 32, 33, 34, 35, 36, 37, 38, 39],
       [40, 41, 42, 43, 44, 45, 46, 47, 48, 49],
       [50, 51, 52, 53, 54, 55, 56, 57, 58, 59],
       [60, 61, 62, 63, 64, 65, 66, 67, 68, 69],
       [70, 71, 72, 73, 74, 75, 76, 77, 78, 79],
       [80, 81, 82, 83, 84, 85, 86, 87, 88, 89],
       [90, 91, 92, 93, 94, 95, 96, 97, 98, 99]])
```

In [183…
```
mat[:]
```

Out[183…
```
array([[ 0,  1,  2,  3,  4,  5,  6,  7,  8,  9],
       [10, 11, 12, 13, 14, 15, 16, 17, 18, 19],
       [20, 21, 22, 23, 24, 25, 26, 27, 28, 29],
       [30, 31, 32, 33, 34, 35, 36, 37, 38, 39],
       [40, 41, 42, 43, 44, 45, 46, 47, 48, 49],
       [50, 51, 52, 53, 54, 55, 56, 57, 58, 59],
       [60, 61, 62, 63, 64, 65, 66, 67, 68, 69],
       [70, 71, 72, 73, 74, 75, 76, 77, 78, 79],
       [80, 81, 82, 83, 84, 85, 86, 87, 88, 89],
       [90, 91, 92, 93, 94, 95, 96, 97, 98, 99]])
```

In [184…
```
col = 6
```

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[6]
```

Out[186…
```
array([60, 61, 62, 63, 64, 65, 66, 67, 68, 69])
```

In [187…
```
mat
```

Out[187…
```
array([[ 0,  1,  2,  3,  4,  5,  6,  7,  8,  9],
       [10, 11, 12, 13, 14, 15, 16, 17, 18, 19],
       [20, 21, 22, 23, 24, 25, 26, 27, 28, 29],
       [30, 31, 32, 33, 34, 35, 36, 37, 38, 39],
       [40, 41, 42, 43, 44, 45, 46, 47, 48, 49],
       [50, 51, 52, 53, 54, 55, 56, 57, 58, 59],
       [60, 61, 62, 63, 64, 65, 66, 67, 68, 69],
       [70, 71, 72, 73, 74, 75, 76, 77, 78, 79],
       [80, 81, 82, 83, 84, 85, 86, 87, 88, 89],
       [90, 91, 92, 93, 94, 95, 96, 97, 98, 99]])
```

In [188…
```
mat[row,:]
```

Out[188…
```
array([40, 41, 42, 43, 44, 45, 46, 47, 48, 49])
```

In [189…
```
mat[:,col]
```

Out[189…
```
array([ 6, 16, 26, 36, 46, 56, 66, 76, 86, 96])
```

In [190…
```
mat[:,8]
```

Out[190…
```
array([ 8, 18, 28, 38, 48, 58, 68, 78, 88, 98])
```

In [191…
```
mat[:col]
```

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]])
```

In [192…
```
mat[:6]
```

Out[192…
```
array([[ 0,  1,  2,  3,  4,  5,  6,  7,  8,  9],
       [10, 11, 12, 13, 14, 15, 16, 17, 18, 19],
       [20, 21, 22, 23, 24, 25, 26, 27, 28, 29],
       [30, 31, 32, 33, 34, 35, 36, 37, 38, 39],
       [40, 41, 42, 43, 44, 45, 46, 47, 48, 49],
       [50, 51, 52, 53, 54, 55, 56, 57, 58, 59]])
```

In [193…
```
row
```

Out[193…
```
4
```

In [196…
```
mat[6:]
```

Out[196…
```
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 [197…
```
mat[6]
```

Out[197… array([60, 61, 62, 63, 64, 65, 66, 67, 68, 69])

In [198…
```
mat
```

Out[198…
```
array([[ 0,  1,  2,  3,  4,  5,  6,  7,  8,  9],
       [10, 11, 12, 13, 14, 15, 16, 17, 18, 19],
       [20, 21, 22, 23, 24, 25, 26, 27, 28, 29],
       [30, 31, 32, 33, 34, 35, 36, 37, 38, 39],
       [40, 41, 42, 43, 44, 45, 46, 47, 48, 49],
       [50, 51, 52, 53, 54, 55, 56, 57, 58, 59],
       [60, 61, 62, 63, 64, 65, 66, 67, 68, 69],
       [70, 71, 72, 73, 74, 75, 76, 77, 78, 79],
       [80, 81, 82, 83, 84, 85, 86, 87, 88, 89],
       [90, 91, 92, 93, 94, 95, 96, 97, 98, 99]])
```

In [199…
```
mat[5:7]
```

Out[199…
```
array([[50, 51, 52, 53, 54, 55, 56, 57, 58, 59],
       [60, 61, 62, 63, 64, 65, 66, 67, 68, 69]])
```

In [200…
```
mat[0:10]
```

Out[200…
```
array([[ 0,  1,  2,  3,  4,  5,  6,  7,  8,  9],
       [10, 11, 12, 13, 14, 15, 16, 17, 18, 19],
       [20, 21, 22, 23, 24, 25, 26, 27, 28, 29],
       [30, 31, 32, 33, 34, 35, 36, 37, 38, 39],
       [40, 41, 42, 43, 44, 45, 46, 47, 48, 49],
       [50, 51, 52, 53, 54, 55, 56, 57, 58, 59],
       [60, 61, 62, 63, 64, 65, 66, 67, 68, 69],
       [70, 71, 72, 73, 74, 75, 76, 77, 78, 79],
       [80, 81, 82, 83, 84, 85, 86, 87, 88, 89],
       [90, 91, 92, 93, 94, 95, 96, 97, 98, 99]])
```

In [201…
```
mat
```

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 [202…
```
mat[0:10:3]
```

Out[202…
```
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 [203…
```
mat
```

Out[203…
```
array([[ 0,  1,  2,  3,  4,  5,  6,  7,  8,  9],
       [10, 11, 12, 13, 14, 15, 16, 17, 18, 19],
       [20, 21, 22, 23, 24, 25, 26, 27, 28, 29],
       [30, 31, 32, 33, 34, 35, 36, 37, 38, 39],
       [40, 41, 42, 43, 44, 45, 46, 47, 48, 49],
       [50, 51, 52, 53, 54, 55, 56, 57, 58, 59],
       [60, 61, 62, 63, 64, 65, 66, 67, 68, 69],
       [70, 71, 72, 73, 74, 75, 76, 77, 78, 79],
       [80, 81, 82, 83, 84, 85, 86, 87, 88, 89],
       [90, 91, 92, 93, 94, 95, 96, 97, 98, 99]])
```

In [204…
```
mat[4]
```

Out[204…
```
array([40, 41, 42, 43, 44, 45, 46, 47, 48, 49])
```

In [206…
```

```

Out[206…
```
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 [207…
```
mat[4]
```

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

In [19]:
```
mat[0:10:3]
```

Out[19]:
```
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 [20]:
```
mat[0:10]
```

Out[20]:
```
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 [21]:
```
mat[0:10:3]
```

Out[21]:
```
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 [22]:
```
mat
```

Out[22]:
```
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 [23]:
```
mat[4:]
```

Out[23]:
```
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 [24]:
```
mat[:4]
```

Out[24]:
```
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 [29]:
```
mat[::-1]
```

Out[29]:
```
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 [26]:
```
mat[::-3]
```

Out[26]:
```
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 [27]:
```
mat[::-5]
```

Out[27]:
```
array([[90, 91, 92, 93, 94, 95, 96, 97, 98, 99],
       [40, 41, 42, 43, 44, 45, 46, 47, 48, 49]])
```

In [30]:
```
mat[2:6]
```

Out[30]:
```
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 [31]:
```
mat
```

Out[31]:
```
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 [32]:
```
mat[2:6,2:4]
```

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

In [33]:
```
mat
```

Out[33]:
```
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 [34]:
```
mat[0,1]
```

Out[34]:
```
1
```

In [35]:
```
mat[1,6]
```

Out[35]:
```
16
```

In [36]:
```
mat
```

Out[36]:
```
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 [37]:
```
mat[1:6]
```

Out[37]:
```
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 [38]:
```
mat[1:]
```

Out[38]:
```
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 [39]:
```
mat
```

Out[39]:
```
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 [40]:
```
mat[:6]
```

Out[40]:
```
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 [41]:
```
mat[0:1]
```

Out[41]:
```
array([[0, 1, 2, 3, 4, 5, 6, 7, 8, 9]])
```

In [42]:
```
mat[3:5]
```

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

In [43]:
```
mat[1:2,2:4]
```

Out[43]:
```
array([[12, 13]])
```

In [46]:
```
mat[2:3,2:3]
```

Out[46]:
```
array([[22]])
```

In [47]:
```
mat[2:4,3:5]
```

Out[47]:
```
array([[23, 24],
       [33, 34]])
```

In [48]:
```
mat[3:5,2:4]
```

Out[48]:
```
array([[32, 33],
       [42, 43]])
```

In [49]:
```
mat
```

Out[49]:
```
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 [50]:
```
mat[2:3,4:5]
```

Out[50]:
```
array([[24]])
```

Masking

In [51]:
```
mat
```

Out[51]:
```
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 [52]:
```
id(mat)
```

Out[52]:
```
1830657688560
```

In [53]:
```
mat
```

Out[53]:
```
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 [54]:
```
mat[mat<50]
```

Out[54]:
```
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 [55]:
```
mat[mat<=50]
```

Out[55]:
```
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 [56]:
```
mat > 50
```

Out[56]:
```
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 [57]:
```
mat[mat == 50]
```

Out[57]:
```
array([50])
```

In [58]:
```
mat == 50
```

Out[58]:
```
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 [59]:
```
mat
```

Out[59]:
```
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 [60]:
```
a1 = mat[mat<50]
```

In [61]:
```
a1
```

Out[61]:
```
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 [62]:
```
mat
```

Out[62]:
```
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 [63]:
```
a2 = mat[mat>50]
```

In [64]:
```
a2
```

Out[64]:
```
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 [65]:
```
a3 = mat[mat<=50]
```

In [66]:
```
a3
```

Out[66]:
```
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 [67]:
```
a4 = mat[mat>=50]
a4
```

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

In [ ]:

Python program to generate otp

In [ ]:

In [68]:
```
import random
```

In [70]:
```
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
```

In [71]:
```
otp_length = 4
otp = generate_otp(otp_length)
print(f"you OTP is: {otp}")
```

```
you OTP is: 4 3 2 5
```

In [72]:
```
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 [73]:
```
def wish():
    print('good even')
wish()

wish()

wish()
```

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

In [74]:
```
list1=['a','b','g',1,5]
print(list1.pop)
```

```
<built-in method pop of list object at 0x000001AA3BD5E440>
```

In [75]:
```
x = [1,2,3]
y = x.copy()
x.append(4)
print(x)
```

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

In [76]:
```
print(y)
```

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

In [ ]:
```

```