

NUMPY Crash Course

```
In [2]: import numpy as np
```

```
In [4]: np.__version__
```

```
Out[4]: '1.26.4'
```

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

```
Out[6]: '3.12.4 | packaged by Anaconda, Inc. | (main, Jun 18 2024, 15:03:56) [MSC v.192  
9 64 bit (AMD64)]'
```

Creating array

```
In [9]: list=[0,1,2,3,4,5]  
list
```

```
Out[9]: [0, 1, 2, 3, 4, 5]
```

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

```
Out[11]: list
```

```
In [13]: arr=np.array(list)
```

```
In [15]: arr
```

```
Out[15]: array([0, 1, 2, 3, 4, 5])
```

```
In [17]: type(arr)
```

```
Out[17]: numpy.ndarray
```

```
In [19]: np.arange(15)
```

```
Out[19]: array([ 0,  1,  2,  3,  4,  5,  6,  7,  8,  9, 10, 11, 12, 13, 14])
```

```
In [21]: np.arange(3.0)
```

```
Out[21]: array([0., 1., 2.])
```

```
In [23]: np.arange(10)
```

```
Out[23]: array([0, 1, 2, 3, 4, 5, 6, 7, 8, 9])
```

```
In [25]: np.arange(0,5)
```

```
Out[25]: array([0, 1, 2, 3, 4])
```

```
In [27]: np.arange(10,20)
```

```
Out[27]: array([10, 11, 12, 13, 14, 15, 16, 17, 18, 19])
```

```
In [29]: np.arange(20,10)
```

```
Out[29]: array([], dtype=int32)
```

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

```
Out[31]: 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 [33]: np.arange(-16,10)
```

```
Out[33]: 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 [35]: np.arange(-20,-10)
```

```
Out[35]: array([-20, -19, -18, -17, -16, -15, -14, -13, -12, -11])
```

```
In [37]: ar=np.arange(-30,20)
```

```
ar
```

```
Out[37]: 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 [39]: np.arange(10,10)
```

```
Out[39]: array([], dtype=int32)
```

```
In [41]: np.arange()
```

```
-----  
TypeError
```

```
Cell In[41], line 1  
----> 1 np.arange()
```

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

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

```
In [42]: np.arange(10,30,5)
```

```
Out[42]: array([10, 15, 20, 25])
```

```
In [45]: np.arange(0,10,3)
```

```
Out[45]: array([0, 3, 6, 9])
```

```
In [47]: np.arange(10,30,5,8)
```

```
-----  
TypeError                                 Traceback (most recent call last)  
Cell In[47], line 1  
      1 np.arange(10,30,5,8)  
  
TypeError: Cannot interpret '8' as a data type
```

```
In [49]: np.zeros(6) #1d
```

```
Out[49]: array([0., 0., 0., 0., 0., 0.])
```

```
In [51]: np.zeros(6,dtype=int)
```

```
Out[51]: array([0, 0, 0, 0, 0, 0])
```

```
In [53]: np.zeros((2,2),dtype=int) # 2d array
```

```
Out[53]: array([[0, 0],  
                 [0, 0]])
```

```
In [55]: zero =np.zeros([2,2])  
print(zero)
```

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

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

```
In [57]: np.zeros((2,10))
```

```
Out[57]: array([[0., 0., 0., 0., 0., 0., 0., 0., 0., 0.],  
                 [0., 0., 0., 0., 0., 0., 0., 0., 0., 0.]])
```

```
In [59]: n=(6,7)  
n1=(6,8)  
print=(np.zeros(n1))
```

```
In [61]: np.ones(3)
```

```
Out[61]: array([1., 1., 1.])
```

```
In [63]: np.ones(4,dtype=int)
```

```
Out[63]: array([1, 1, 1, 1])
```

```
In [65]: np.ones(4)
```

```
Out[65]: array([1., 1., 1., 1.])
```

```
In [67]: rand(3,2)
```

```
NameError Traceback (most recent call last)
Cell In[67], line 1
----> 1 rand(3,2)

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

```
In [69]: rand(3,2)
random.rand(3,2)
```

```
NameError Traceback (most recent call last)
Cell In[69], line 1
----> 1 rand(3,2)
      2 random.rand(3,2)

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

```
In [71]: np.random.rand(3)
```

```
Out[71]: array([0.05496737, 0.26267598, 0.9801633 ])
```

```
In [73]: np.rand(4)
```

```
AttributeError Traceback (most recent call last)
Cell In[73], 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 [75]: np.random.rand(2,4)
```

```
Out[75]: array([[0.68217039, 0.03893081, 0.21672833, 0.51619459],
                 [0.69317727, 0.81845906, 0.94308294, 0.42793111]])
```

```
In [77]: np.random.randint(2,4)
```

```
Out[77]: 3
```

```
In [79]: np.random.randint(2,4)# get only 2 value randomly
```

```
Out[79]: 2
```

```
In [81]: np.random.randint(2,20)
```

```
Out[81]: 18
```

```
In [83]: np.random.randint(0,1)# 0=inclusive, 1=exclusive
```

```
Out[83]: 0
```

```
In [85]: np.random.randint(1,20,3)
```

```
Out[85]: array([10, 13, 12])
```

```
In [87]: b=np.random.randint(10,20,(5,4))  
b
```

```
Out[87]: array([[18, 14, 11, 15],  
                 [12, 19, 10, 17],  
                 [15, 19, 19, 18],  
                 [13, 18, 18, 10],  
                 [16, 10, 17, 11]])
```

```
In [89]: type(b)
```

```
Out[89]: numpy.ndarray
```

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

```
Out[91]: array([[18, 14, 11, 15],  
                 [12, 19, 10, 17],  
                 [15, 19, 19, 18],  
                 [13, 18, 18, 10],  
                 [16, 10, 17, 11]])
```

```
In [93]: b[1:3]
```

```
Out[93]: array([[12, 19, 10, 17],  
                 [15, 19, 19, 18]])
```

```
In [95]: b[1,3]
```

```
Out[95]: 17
```

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

```
Out[97]: array([[18, 14, 11, 15],  
                 [12, 19, 10, 17],  
                 [15, 19, 19, 18],  
                 [13, 18, 18, 10],  
                 [16, 10, 17, 11]])
```

```
In [99]: b[2:3]
```

```
Out[99]: array([[15, 19, 19, 18]])
```

11 Nov 2024

```
In [102...]: a=np.random.randint(10,20,5)  
a
```

```
Out[102...]: array([19, 16, 13, 14, 18])
```

```
In [104...]: id(a)
```

```
Out[104... 1873068801744
```

```
In [106... arr
```

```
Out[106... array([0, 1, 2, 3, 4, 5])
```

```
In [108... arr2=np.random.randint(0,100,(10,10))  
arr2
```

```
Out[108... array([[24, 83, 82, 34, 72, 8, 65, 69, 79, 3],  
[71, 8, 33, 21, 72, 48, 59, 89, 42, 15],  
[41, 8, 68, 48, 72, 21, 18, 94, 47, 67],  
[95, 47, 13, 61, 6, 83, 26, 62, 17, 86],  
[99, 4, 6, 90, 89, 24, 0, 7, 74, 12],  
[23, 24, 98, 82, 98, 12, 10, 2, 25, 69],  
[94, 29, 82, 67, 24, 23, 17, 36, 94, 70],  
[15, 66, 7, 47, 34, 60, 68, 77, 45, 86],  
[83, 99, 61, 69, 19, 16, 56, 86, 94, 48],  
[0, 35, 5, 24, 15, 57, 3, 90, 36, 50]])
```

```
In [110... arr
```

```
Out[110... array([0, 1, 2, 3, 4, 5])
```

```
In [112... arr.max()  
)
```

```
Out[112... 5
```

```
In [114... arr.min()
```

```
Out[114... 0
```

```
In [140... arr.mean()
```

```
Out[140... 2.5
```

```
In [144... arr
```

```
Out[144... array([0, 1, 2, 3, 4, 5])
```

```
In [146... arr.median()
```

```
-----  
AttributeError  
Cell In[146], line 1  
----> 1 arr.median()
```

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

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

```
In [152... from numpy import *  
a=array([1,2,3,4,9])  
median (a)
```

```
Out[152... 3.0
```

```
In [154... arr.reshape(3,2)
```

```
Out[154... array([[0, 1],  
                  [2, 3],  
                  [4, 5]])
```

```
In [156... arr.reshape(6,1)
```

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

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

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

```
In [163... arr.reshape(2,3,order='f') # print element with fortron
```

```
Out[163... array([[0, 2, 4],  
                  [1, 3, 5]])
```

```
In [165... arr.reshape(2,3,order='a')
```

```
Out[165... array([[0, 1, 2],  
                  [3, 4, 5]])
```

```
In [118... arr2
```

```
Out[118... array([[24, 83, 82, 34, 72, 8, 65, 69, 79, 3],  
                  [71, 8, 33, 21, 72, 48, 59, 89, 42, 15],  
                  [41, 8, 68, 48, 72, 21, 18, 94, 47, 67],  
                  [95, 47, 13, 61, 6, 83, 26, 62, 17, 86],  
                  [99, 4, 6, 90, 89, 24, 0, 7, 74, 12],  
                  [23, 24, 98, 82, 98, 12, 10, 2, 25, 69],  
                  [94, 29, 82, 67, 24, 23, 17, 36, 94, 70],  
                  [15, 66, 7, 47, 34, 60, 68, 77, 45, 86],  
                  [83, 99, 61, 69, 19, 16, 56, 86, 94, 48],  
                  [0, 35, 5, 24, 15, 57, 3, 90, 36, 50]])
```

```
In [120... b = np.random.randint(10,20,(5,4))  
b
```

```
Out[120... array([[17, 14, 18, 19],  
                  [10, 16, 12, 10],  
                  [15, 16, 11, 10],  
                  [10, 18, 19, 15],  
                  [14, 11, 11, 11]])
```

```
In [122... b[:]
```

```
Out[122... array([[17, 14, 18, 19],  
                  [10, 16, 12, 10],  
                  [15, 16, 11, 10],  
                  [10, 18, 19, 15],  
                  [14, 11, 11, 11]])
```

```
In [124... b[0:2]
```

```
Out[124... array([[17, 14, 18, 19],  
                  [10, 16, 12, 10]])
```

```
In [126... b[:-1]
```

```
Out[126... array([[17, 14, 18, 19],  
                  [10, 16, 12, 10],  
                  [15, 16, 11, 10],  
                  [10, 18, 19, 15]])
```

```
In [128... b[0,2]
```

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

```
In [130... np.random.randint(10,20,(4,4))
```

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

Operation

```
In [133... a=np.random.randint(10,20,5)
```

```
In [135... a
```

```
Out[135... array([13, 12, 13, 12, 10])
```

```
In [137... arr
```

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

```
In [139... arr2
```

```
Out[139... array([[24, 83, 82, 34, 72, 8, 65, 69, 79, 3],  
                  [71, 8, 33, 21, 72, 48, 59, 89, 42, 15],  
                  [41, 8, 68, 48, 72, 21, 18, 94, 47, 67],  
                  [95, 47, 13, 61, 6, 83, 26, 62, 17, 86],  
                  [99, 4, 6, 90, 89, 24, 0, 7, 74, 12],  
                  [23, 24, 98, 82, 98, 12, 10, 2, 25, 69],  
                  [94, 29, 82, 67, 24, 23, 17, 36, 94, 70],  
                  [15, 66, 7, 47, 34, 60, 68, 77, 45, 86],  
                  [83, 99, 61, 69, 19, 16, 56, 86, 94, 48],  
                  [0, 35, 5, 24, 15, 57, 3, 90, 36, 50]])
```

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

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

```
In [143... arr[:]
```

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

```
In [145... arr[:4]
```

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

```
In [147... arr2[:4]
```

```
Out[147... array([[24, 83, 82, 34, 72, 8, 65, 69, 79, 3],  
                  [71, 8, 33, 21, 72, 48, 59, 89, 42, 15],  
                  [41, 8, 68, 48, 72, 21, 18, 94, 47, 67],  
                  [95, 47, 13, 61, 6, 83, 26, 62, 17, 86]])
```

```
In [149... arr2[0:5]
```

```
Out[149... array([[24, 83, 82, 34, 72, 8, 65, 69, 79, 3],  
                  [71, 8, 33, 21, 72, 48, 59, 89, 42, 15],  
                  [41, 8, 68, 48, 72, 21, 18, 94, 47, 67],  
                  [95, 47, 13, 61, 6, 83, 26, 62, 17, 86],  
                  [99, 4, 6, 90, 89, 24, 0, 7, 74, 12]])
```

```
In [151... arr2
```

```
Out[151... array([[24, 83, 82, 34, 72, 8, 65, 69, 79, 3],  
                  [71, 8, 33, 21, 72, 48, 59, 89, 42, 15],  
                  [41, 8, 68, 48, 72, 21, 18, 94, 47, 67],  
                  [95, 47, 13, 61, 6, 83, 26, 62, 17, 86],  
                  [99, 4, 6, 90, 89, 24, 0, 7, 74, 12],  
                  [23, 24, 98, 82, 98, 12, 10, 2, 25, 69],  
                  [94, 29, 82, 67, 24, 23, 17, 36, 94, 70],  
                  [15, 66, 7, 47, 34, 60, 68, 77, 45, 86],  
                  [83, 99, 61, 69, 19, 16, 56, 86, 94, 48],  
                  [0, 35, 5, 24, 15, 57, 3, 90, 36, 50]])
```

```
In [153... arr2[1,5]
```

```
Out[153... 48
```

```
In [157... arr2[-5,5]
```

```
Out[157... 12
```

```
In [159... arr2[-5,-5]
```

```
Out[159... 12
```

```
In [161... arr2[-1,-2]
```

```
Out[161... 36
```

```
In [163... arr2[::-1]
```

```
Out[163... array([[ 0, 35, 5, 24, 15, 57, 3, 90, 36, 50],  
                  [83, 99, 61, 69, 19, 16, 56, 86, 94, 48],  
                  [15, 66, 7, 47, 34, 60, 68, 77, 45, 86],  
                  [94, 29, 82, 67, 24, 23, 17, 36, 94, 70],  
                  [23, 24, 98, 82, 98, 12, 10, 2, 25, 69],  
                  [99, 4, 6, 90, 89, 24, 0, 7, 74, 12],  
                  [95, 47, 13, 61, 6, 83, 26, 62, 17, 86],  
                  [41, 8, 68, 48, 72, 21, 18, 94, 47, 67],  
                  [71, 8, 33, 21, 72, 48, 59, 89, 42, 15],  
                  [24, 83, 82, 34, 72, 8, 65, 69, 79, 3]])
```

```
In [165... arr2[::-2]
```

```
Out[165... array([[ 0, 35,  5, 24, 15, 57,  3, 90, 36, 50],  
[15, 66,  7, 47, 34, 60, 68, 77, 45, 86],  
[23, 24, 98, 82, 98, 12, 10,  2, 25, 69],  
[95, 47, 13, 61,  6, 83, 26, 62, 17, 86],  
[71,  8, 33, 21, 72, 48, 59, 89, 42, 15]])
```

```
In [169... arr2[::-3]
```

```
Out[169... array([[ 0, 35,  5, 24, 15, 57,  3, 90, 36, 50],  
[94, 29, 82, 67, 24, 23, 17, 36, 94, 70],  
[95, 47, 13, 61,  6, 83, 26, 62, 17, 86],  
[24, 83, 82, 34, 72,  8, 65, 69, 79,  3]])
```

```
In [171... arr.max()
```

```
Out[171... 5
```

```
In [173... arr.min()
```

```
Out[173... 0
```

```
In [175... arr.mean()
```

```
Out[175... 2.5
```

```
In [177... ar.median()
```

```
-----  
AttributeError  
Cell In[177], line 1  
----> 1 ar.median()
```

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

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

```
In [179... arr
```

```
Out[179... array([0, 1, 2, 3, 4, 5])
```

```
In [181... arr.reshape(2,3)
```

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

```
In [183... arr.reshape(6,1)
```

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

```
In [185... arr.reshape(1,6)
```

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

```
In [187... arr.reshape(3,2,order='c')
```

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

```
In [189... arr.reshape(3,2,order='f')
```

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

```
In [191... arr.reshape(3,2,order='a')
```

```
Out[191... array([[0, 1],  
[2, 3],  
[4, 5]])
```

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

```
-----  
ValueError Traceback (most recent call last)  
Cell In[193], line 1  
----> 1 arr.reshape(3,2,order='k')  
  
ValueError: order 'K' is not permitted for reshaping
```

```
In [195... arr
```

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

```
In [197... arr.reshape(2,3)
```

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

```
In [199... arr.reshape(1,6)
```

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

```
In [201... arr.reshape(0,4)
```

```
-----  
ValueError Traceback (most recent call last)  
Cell In[201], line 1  
----> 1 arr.reshape(0,4)  
  
ValueError: cannot reshape array of size 6 into shape (0,4)
```

```
In [203... arr.reshape(6,1)
```

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

Indexing

```
In [206...]: mat=np.arange(0,100).reshape(10,10)
```

```
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 [212...]: row=4  
          col=5
```

```
In [214...]: col
```

```
Out[214...]: 5
```

```
In [216...]: row
```

```
Out[216...]: 4
```

```
In [218...]: mat
```

```
Out[218...]: array([[ 0,  1,  2,  3,  4,  5,  6,  7,  8,  9],
       [10, 11, 12, 13, 14, 15, 16, 17, 18, 19],
       [20, 21, 22, 23, 24, 25, 26, 27, 28, 29],
       [30, 31, 32, 33, 34, 35, 36, 37, 38, 39],
       [40, 41, 42, 43, 44, 45, 46, 47, 48, 49],
       [50, 51, 52, 53, 54, 55, 56, 57, 58, 59],
       [60, 61, 62, 63, 64, 65, 66, 67, 68, 69],
       [70, 71, 72, 73, 74, 75, 76, 77, 78, 79],
       [80, 81, 82, 83, 84, 85, 86, 87, 88, 89],
       [90, 91, 92, 93, 94, 95, 96, 97, 98, 99]])
```

```
In [222...]: mat[row,col]
```

```
Out[222...]: 45
```

```
In [224...]: mat[4,5]
```

```
Out[224...]: 45
```

```
In [226...]: mat[:]
```

```
Out[226... array([[ 0,  1,  2,  3,  4,  5,  6,  7,  8,  9],
   [10, 11, 12, 13, 14, 15, 16, 17, 18, 19],
   [20, 21, 22, 23, 24, 25, 26, 27, 28, 29],
   [30, 31, 32, 33, 34, 35, 36, 37, 38, 39],
   [40, 41, 42, 43, 44, 45, 46, 47, 48, 49],
   [50, 51, 52, 53, 54, 55, 56, 57, 58, 59],
   [60, 61, 62, 63, 64, 65, 66, 67, 68, 69],
   [70, 71, 72, 73, 74, 75, 76, 77, 78, 79],
   [80, 81, 82, 83, 84, 85, 86, 87, 88, 89],
   [90, 91, 92, 93, 94, 95, 96, 97, 98, 99]])
```

```
In [228... col=6
```

```
In [230... mat[:col]
```

```
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]])
```

```
In [234... mat[:,6]
```

```
Out[234... array([ 6, 16, 26, 36, 46, 56, 66, 76, 86, 96])
```

```
In [238... mat[row,:]
```

```
Out[238... array([40, 41, 42, 43, 44, 45, 46, 47, 48, 49])
```

```
In [240... mat[:row]
```

```
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]])
```

```
In [242... mat[row:]
```

```
Out[242... 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 [244... mat[:,8]
```

```
Out[244... array([ 8, 18, 28, 38, 48, 58, 68, 78, 88, 98])
```

```
In [246... mat[:, -1]
```

```
Out[246... array([ 9, 19, 29, 39, 49, 59, 69, 79, 89, 99])
```

```
In [248... mat[:,col]
```

```
Out[248... array([ 6, 16, 26, 36, 46, 56, 66, 76, 86, 96])
```

```
In [252... mat[1,4]
```

```
Out[252... 14
```

```
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 [256... mat[3:-3]
```

```
Out[256... 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 [258... mat[0]
```

```
Out[258... array([0, 1, 2, 3, 4, 5, 6, 7, 8, 9])
```

```
In [260... mat[6]
```

```
Out[260... array([60, 61, 62, 63, 64, 65, 66, 67, 68, 69])
```

```
In [262... mat
```

```
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],  
                   [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 [265... mat[6:]
```

```
Out[265... 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 [269... mat[:6]
```

```
Out[269... 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 [271... mat[5,7]
```

```
Out[271... 57
```

```
In [273... mat
```

```
Out[273... 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[0:10]
```

```
Out[276... 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 [278... mat[0:10:3]
```

```
Out[278... 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 [280... mat[2:6]
```

```
Out[280... 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 [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 [282...]: mat[2:6,2:4]
```

```
Out[282...]: array([[22, 23],
       [32, 33],
       [42, 43],
       [52, 53]])
```

```
In [286...]: mat[5:8,2:9]
```

```
Out[286...]: array([[52, 53, 54, 55, 56, 57, 58],
       [62, 63, 64, 65, 66, 67, 68],
       [72, 73, 74, 75, 76, 77, 78]])
```

```
In [290...]: mat[1:2,2:4]
```

```
Out[290...]: array([[12, 13]])
```

```
In [292...]: mat[2:3,2:3]
```

```
Out[292...]: array([[22]])
```

```
In [294...]: mat[3:5,2:4]
```

```
Out[294...]: array([[32, 33],
       [42, 43]])
```

```
In [296...]: mat[3:5,2:4,]
```

```
Out[296...]: array([[32, 33],
       [42, 43]])
```

Masking

```
In [299...]: mat
```

```
Out[299...]: array([[ 0,  1,  2,  3,  4,  5,  6,  7,  8,  9],
       [10, 11, 12, 13, 14, 15, 16, 17, 18, 19],
       [20, 21, 22, 23, 24, 25, 26, 27, 28, 29],
       [30, 31, 32, 33, 34, 35, 36, 37, 38, 39],
       [40, 41, 42, 43, 44, 45, 46, 47, 48, 49],
       [50, 51, 52, 53, 54, 55, 56, 57, 58, 59],
       [60, 61, 62, 63, 64, 65, 66, 67, 68, 69],
       [70, 71, 72, 73, 74, 75, 76, 77, 78, 79],
       [80, 81, 82, 83, 84, 85, 86, 87, 88, 89],
       [90, 91, 92, 93, 94, 95, 96, 97, 98, 99]])
```

```
In [301... id(mat)
```

```
Out[301... 1873069976880
```

```
In [303... type(mat)
```

```
Out[303... numpy.ndarray
```

```
In [305... mat
```

```
Out[305... 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... mat < 50
```

```
Out[307... array([[ True,  True,  True,  True,  True,  True,  True,  True,  True,
   [ True,  True,  True,  True,  True,  True,  True,  True,  True],
   [ True,  True,  True,  True,  True,  True,  True,  True,  True,
   [ True,  True,  True,  True,  True,  True,  True,  True,  True,
   [ True,  True,  True,  True,  True,  True,  True,  True,  True,
   [ True,  True,  True,  True,  True,  True,  True,  True,  True,
   [False, False, False, False, False, False, False, False, False],
   [False, False, False, False, False, False, False, False, False],
   [False, False, False, 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 [309... mat>50
```

```
Out[309... 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]])
```

```
In [311... mat == 50
```

```
Out[311... array([[False, False, False, False, False, False, False, False, False,
   False],
   [False, False, False, False, False, False, False, False, False, False],
   [False, False, False, False, False, False, False, False, False, False],
   [False, False, False, False, False, False, False, False, False, False],
   [False, False, False, False, False, False, False, False, False, False],
   [False, False, False, False, False, 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, False, False, False, False, False]])
```

```
In [313... mat[mat==50]
```

```
Out[313... array([50])
```

```
In [315... a1=mat[mat<50]
a1
```

```
Out[315... 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 [317... mat
```

```
Out[317...]: 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 [319]: a2=mat[mat>=50]  
a2
```

```
Out[319... 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 [323]: a3=mat[mat==50]
a3

Out[323... array([50])

In [325... mat>23

In [327... a1]

```
Out[327... 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 [329... a2

```
Out[329...]: 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 「332... a3

```
Out[332]: array([50])
```

```
In [334]: mat
```

```
Out[334]: 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]])
```

Bacic NUMPY function completed